3.3.1	Institution has created an ecosystem for innovations, Indian Knowledge System (IKS) including awareness about IPR, establishment of IPR cell, Incubation centre and other initiatives for the creation and transfer of technology/knowledge and the outcomes of the same are evident

S. No.	Details/Particulars	Academic Year	Page No.
1	Sample Evaluated projects report / field work submitted by the students.	AY 2023-2024	2-402
		AY 2022-2023	403-599
		AY 2021-2022	600-890
		AY 2020-2021	891-1081
		AY 2019-2020	1082-1363

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A

Comprehensive Project Report

On

Unified Payments Interface (UPI)

Submitted By :

Samarth Sanghani

Enrollment No:

200341041

Program :

Integrated MBA

Semester :

8

Under the Guidance of

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STUDENT'S DECLARATION

I hereby declare that the Summer Internship Project Report titled **"Unified Payments Interface (UPI)"** is a result of my own work and my indebtedness to other work publications, references, if any, has been duly acknowledged. If I am found guilty of copying from any other report or published information and showing as my original work, or extending plagiarism limit, I understand that I shall be liable and punishable by the university, which may include Failing me in examination or any other punishment that university may deem fit.

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UNIVERSITY CERTIFICATE

"This is to Certify that this Summer Internship Project Report Titled **"Unified Payments Interface (UPI)"** is the bonafide work of **Samarth Sanghani (Enrolment No. 200341041),** who has carried out his project under my supervision. I also certify further that, to the best of my knowledge, the work reported herein does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

Rating of Project Report [A/B/C/D/E]: B

(A=Excellent; B=Good; C=Average; D=Poor; E=Worst)

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CONTENT

Sr No.	Topic	Page No.
1	Introduction & Body of Report	1
2	Literature Review	2
3	Objectives of the Study	5
4	Research Gap	6
5	Data Analysis of the Study	10
6	Findings	21
7	Suggestions	23
8	Conclusion	24
9	References	25

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INTRODUCTION & BODY OF REPORT

Unified Payment Interface (UPI) is an innovative online banking product in India which has reached heights of popularity within a short span. Growth in UPI has also resulted in higher frequency of data breach. Social engineering attacks were the greatest security risk India faced in the lockdown period. Users of Unified Payment Interface are easily lured for cyber frauds. These frauds are not due to default in the UPI system or interface but are tactics to deceive customers by the way of phishing, vishing, or smishing. Social engineering attack techniques are plotted to exploit users with the use of significant UPI features like 'Collect Request', 'Virtual Private Address', or 'QR code'.

A study was conducted to generate the phishing score of the users with real-time attack simulating case lets. Responses were analyzed to understand the psychological behavior of user while they interact with fraudulent tactics. Most users blindly follow the instructions received through SMS or phone calls and become victim of cyber fraud. Analysis of the data collected from respondents reveals the dark truth that age or profession has no bearing in the behavior of users responding to social engineering attack techniques.

UPI (Unified Payment Interface) is developed for the benefit of the common man with simple functionalities after demonetization in 2016. The main aim of launching UPI was to have a single app to link all bank accounts. Different payment methods provided through UPI are 'Send money', 'Collect Money' and 'Scan QR'. The amount can be transferred through virtual address or by account id & IFSC code of beneficiary where as in 'Collect money' mode beneficiary ask for money by generating 'COLLECT' request. Generating a QR code for the virtual id with a linked Bank account is the safest method since all the details are hidden.

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Today UPI has become the most popular payment method. Transactions are increasing exponentially that the year 2020 ended with the count above 2 billion. As the number of transactions and usage of UPI is increasing, on the other hand, more and more fraudulent transactions are reported by customers. Since March 2020, India being in lockdown due to

COVID 19 people were confined indoors and performed online transactions to meet their everyday requirement. Cybercriminals have grabbed this opportunity to make fraudulent transactions. These transactions are done by deceiving people for fake reasons and forcibly make them obey the instructions of the fraudster. These criminal activities are done by making use of social engineering techniques which mainly includes phishing, vishing and smishing and by exploiting one of the UPI features.

Unified Payment Interface

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LITERATURE REVIEW

Thomas & Chatterjee, (2017) The introduction of Unified Interface Payment (UPI) services has opened a new payment channel to the user. User across all age groups have accepted UPI as its 'Perceived Usefulness' and 'Perceived ease of use' is high. The features of UPI motivates the respondents of service sectors to adopt the tool and UPI Transactions and findings revealed that the respondent has a positive attitude towards the UPI transaction for ushering in a less-cash society in India.

Gochhwal, 2017 UPI opens unique opportunities for businesses to collect payments via unique UPI ID and QR code, where customers are not physically present and payment request can be sent to the customer and customer can pay remotely using mobile phones.

Neema & Neema, 2016 UPI developed m- payment technology by facilitating mobile phone to be used as the main payment device for giving and accepting payments.

K. D. Mishra, 2017 It was found that demographic factor except education does not have much impact on the adoption of the UPI. There was no significant difference is perceived by the respondents on the basis of gender age, profession and annual income.

Zulkurnain et al., 2015 Several human psychological traits have been used by social engineers to manipulate human as a human is the weakest link in information security. By using these traits, an attacking strategy is laid out to accomplish the attacker's mission whether to gain access or to gather critical information.

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Albladi & Weir, 2018 User vulnerability to social engineering be defined as the set of user attributes that incline that particular user (rather than other individuals) to be a victim of social engineering attacks.

Rastogi, 2021 current study brings out the peripheral factors which affects the financial inclusion and the relationship between the financial inclusion and the economic development. He finds that the major drivers which support the sustainability of the UPI platform are accessibility to the technology, convenience, cost effective and citizens voluntary exclusion in the financial inclusion. One of the biggest risks to online payments is the loss of payment information, personal information, and false customer rejection

Franciska, 2017 learned that moving towards a cashless economy is not only a safer option compared to cash transactions, but it is also a time-efficient method that aids in maintaining records of all transactions. As of March 2016, India had over 100 crore active mobile connections and over 22 crore smartphone users. The most significant hurdle facing the government in its bid to establish a cashless economy is the public's lack of knowledge and awareness, as well as their concerns about the possibility of financial loss and the risk of hacking associated with digital payment methods.

Neema, 2018 Found out that, Rural area consumers are still not aware of this existing technology (UPI), they further concluded, Consumers focus majorly on Security issues i.e. in case if the mobile is stolen than its bank details & account are unlocked by anyone. Thus, some customers are not in support to install UPI apps in their phones. Banks and the government are working to increase citizen knowledge of UPI in order to advance the engagement and use of UPI technologies and achieve the goal of Digital India.

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Arvind, 2021 learned that the level of consuming is also increased and low-cost service that it provides to their users is more-effective and the people feels easy to use this application. UPI makes the mobile phones as the primary device to make all payments and brings enormous changes in digital payment sector. The study throws light on mobile based era for all the transaction.

Thomas, 2017 said that India holds enormous growth potential particularly in the field of mobile internet due to high population and increasing penetration of internet into rural population. These statistics again indicate a huge potential for adoption of UPI by the Indian customers. Easy and fast Transaction, Secure and Cheap, Convenience, Prizes and reward Points, security Issues, Poor Network Connectivity and Lack Of technical Knowledge, are some of the important factors that, impacted the Growth of UPI.

George, 2021 said have analyzed that there were various reasons such as contactless payment, convenience, and ease of pay for the adoption of mobile wallets during this period.

Sahoo, 2022 concluded that the usage of smartphones and the internet in rural services has increased significantly in recent years. This creates a significant opportunity for Indian consumers to embrace UPI. We are aware that the difficulty of moving hard currency throughout the country will be lessened or eliminated via cashless payment.

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OBJECTIVES OF THE STUDY

The primary goal of this case study is to look into the growth and prospects of the Unified Payment Interface (UPI). In this context, the following objectives are framed.

(1) To understand the Unified Payment Interface (UPI) system's growth.

(2) To assess UPI's position in the digital payment ecosystem.

(3) To know the progression of UPI in retail digital payments.

(4) To conduct a SWOT analysis of the UPI of NPCI.

(5) To investigate the adoption and usage rates of UPI in India.

(6) To explore the potential future of UPI in digital payments.

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RESEARCH GAP

User Adoption and Behavior:

- While there is considerable research on the adoption of UPI among consumers and merchants, further investigation is needed to understand the factors influencing user behavior, such as usage patterns, frequency of use, and reasons for discontinuation.

Security and Privacy:

- UPI transactions raise concerns about security and privacy.
- Research could delve deeper into the security vulnerabilities of the UPI infrastructure, potential threats, and user perceptions of security and privacy risks associated with UPI transactions.

Interoperability and Standardization:

- UPI's interoperability across different banks and payment service providers (PSPs) has been a significant factor in its success.
- However, there is a need for research on the challenges and opportunities related to interoperability, as well as the role of standardization in enhancing UPI's effectiveness.

Financial Inclusion and Impact:

- Despite UPI's widespread adoption, its impact on financial inclusion and access to

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digital financial services among marginalized communities needs further exploration.

- Research could assess how UPI has affected the unbanked and underbanked populations and identify strategies to promote greater financial inclusion through UPI.

UPI for Healthcare Payments:

- Develop solutions for healthcare payments using UPI, allowing individuals to pay for medical services, insurance premiums, and prescription drugs digitally.
- This could improve transparency, reduce cash transactions in the healthcare sector, and enhance access to healthcare services.

Regulatory Framework:

- UPI operates within a regulatory framework established by the Reserve Bank of India (RBI).
- Research could focus on assessing the effectiveness of existing regulations in ensuring the safety, stability, and efficiency of the UPI ecosystem, as well as exploring potential areas for regulatory improvement or innovation.

Merchant Perspective:

- While there is research on consumer adoption of UPI, there is relatively less focus on the perspectives and experiences of merchants.
- Investigating merchants' attitudes, challenges, and opportunities related to accepting UPI payments could provide valuable insights for enhancing the merchant experience and promoting wider UPI acceptance.

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Microfinance and UPI Integration:

- Explore integrating UPI with microfinance institutions to facilitate microloan disbursements, repayments, and other financial services for underserved populations.
- This could enhance financial inclusion by providing convenient and accessible financial services to those in need.

UPI for Government Disbursements:

- Propose using UPI as a primary platform for government disbursements such as welfare payments, subsidies, pensions, and grants.
- This could streamline the disbursement process, reduce leakages, and ensure timely delivery of funds to beneficiaries.

UPI-Based Loyalty Programs:

- Explore the integration of UPI with loyalty programs offered by businesses and retailers.
- Customers could earn loyalty points or rewards directly into their UPI-linked accounts for making purchases, thereby incentivizing the use of UPI for transactions and fostering customer loyalty.

UPI for Utility Bill Payments:

- Develop solutions to enable seamless payment of utility bills (electricity, water, gas, etc.) through UPI.
- Integrating UPI with utility providers' billing systems could simplify bill payments for

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consumers and improve the efficiency of bill collection processes for service providers.

UPI-Based Peer-to-Peer Lending Platforms:

- Explore the development of peer-to-peer lending platforms leveraging UPI for loan disbursements and repayments.
- This could provide an alternative source of financing for individuals and small businesses while offering attractive returns for lenders.

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DATA ANALYSIS OF THE STUDY

1. Evolution and Growth of Unified Payments Interface (UPI) in India:

Pre-UPI payment systems in India transitioned from cash to include credit and debit cards. The establishment of NEFT and IMPS facilitated transactions. The government's initiative under NPCI enabled the introduction of IMPS, enhancing digital payments. UPI emerged as the definitive solution, surpassing its predecessors and becoming the preferred mode of payment. Its convenience and ease of use led to rapid adoption and growth. UPI seamlessly integrates with banking apps, providing a standardized platform. Robust security features ensure secure transactions. UPI's impact on the Indian payment landscape is transformative, solidifying its position as the gold standard in digital transactions. It has revolutionized payments and paved the way for a digitized future.

1.1 Pre-UPI Payment Systems

Credit cards were the first cashless payment systems, introduced in 1958 and still in use. Debit cards emerged in the early 1980s in the western world and in the mid-1990s in Asia, offering the convenience and advantages of a credit card but directly linked to the user's account, thus offering multiple benefits. Prepaid debit cards developed in the mid-2000s as a system to serve the unbanked population. An e-wallet is, as the name suggests, a virtual wallet where consumers can store various types of their own funds; it also evolved in the early 2000s. The unified payments interface was launched in 2016 in India.

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1.2 Launch of UPI

The launch of UPI was preceded by the ability to electronically transfer funds in real time between any bank account in the country. An initiative taken by RBI and called Immediate Payment Service (IMPS), it serves as the underlying platform for money transfers for UPI. IMPS gained significant acceptance in the recent years as a majority of the banks started integrating it into their payments technology. The transfer of money was cumbersome and required the remitter to know the receivers account number, IFSC code and their bank account type etc. Also the receiver was expected to share his account number and IFSC code as well. The introduction of mobile banking and wallets came next in which only the mobile number was required to complete the transaction. However the RBI saw potential to create a platform which not only clubbed all the underlying bank accounts but also made it easier for the remitter to transact using only the recipient's mobile number. That is when the National Payment Corporation of India (NPCI) came up with UPI.

1.3 Adoption and Growth

One of the key factors that lead to the widespread adoption of Unified Payments Interface (UPI) was the strong support and unwavering promotion it received from the Government of India or GOI. The government played a pivotal role in ensuring the successful implementation and smooth operation of UPI through its collaboration with the National Payments Corporation of India or NPCI. Furthermore, the government took another significant step by launching not just one, but two versions of the revolutionary BHIM mobile application, aimed at bolstering the adoption of the UPI platform.

Recognizing the immense potential of UPI, the Indian Parliament passed a comprehensive finance bill in the year 2017. This legislation officially stated that all Indian banks and financial institutions would be integral components of the UPI platform, emphasizing the importance and inclusivity of the system. Furthermore, the Reserve Bank of India (RBI), in close coordination with the Government and the NPCI, made commendable efforts to catapult UPI adoption among the Indian populace.

The RBI, being a stalwart in the Indian banking landscape, took up the responsibility of creating awareness programs specifically designed to educate and train Indian merchants and users on the intricacies and advantages of the UPI platform. These enlightening initiatives not only transformed the way individuals perceive digital transactions but also empowered them to realize the vast potential of UPI in revolutionizing the entire Indian financial ecosystem.

Putting the needs of the people at the forefront, the Government of India, GOI, the NPCI, and the RBI consistently strive to drive UPI's widespread acceptance. Their collaborative efforts exemplify their unwavering commitment to facilitating a seamless, secure, and inclusive financial landscape for all Indians. As the journey of UPI unfolds, more and more Indian citizens embrace this transformative payment system, propelling India into the digital age with unprecedented momentum and progress.

2. Impact of UPI on Indian Economy

A change in the economy is conspicuous, thanks to UPI. As the country moves from cash to digital, people are now open to coming out and spending, after the impact of demonetization, according to the report by Credit Suisse analysts Ashish Gupta and Sunil Tirumalai. The only worry after demonetization was would Kung spam the excess money in a bank account or would big firms continue to shop for capital goods. The way people were using cash is changing. The value of cash once hoarded, stuffed in mattresses, hid in homes and temples has now come back into the banking system through deposits; hence the money supply remains unchanged. There chances for the monetary policy committee to pull in more demands on the fourth quarter review on February 8 is slim. The Kung spam is mainly something that has to be paid attention to, the report says. However, "there could be a medium-term slowdown due to tighter liquidity conditions, something the MPC will certainly tread carefully about," the report states. Based on the UPI platform, banks now offer services that a mobile wallet does. This platform is an entry to greater products and services.

2.1 Financial Inclusion

There are 190 million adults in India without bank accounts. Because the support in schools and the financial institutions is not the same, 64% of Indian adults don't rely on banks to make or receive payments. For example, many small businesses pay their employees with physical notes or coins. The hope is that the UPI could render itself as a service for merchants and small businesses for casual transactions, as well as an option for payroll. UPI will help different organizations, groups and individuals to make safer cash transactions.

2.2 Cashless Transactions

The first such noticeable effect was on the transactional patterns in India. Citizens of the country started shifting from the traditional cash transactions to digital payments through means of UPI. With growing awareness about UPI, majority of the people started using the platform for every possible mode of payment, like mobile recharges, utility bills, person to person transfers and also for grocery shopping. The masses that previously did not have access to bank accounts opened Jan Dhan accounts, which are zero balance account that was opened under prime minister Narendra Modi's Financial inclusion drive. The UPI application was compatible with all the bank account and also the Jan dhan accounts. That furthered the increase in number of transactions. Individuals who had bank accounts but no debit cards could also make use of their UPI ID and PIN to make transactions thus increasing their digital transactions.

2.3 Significant Increase in Adoption of Digital Payments

Rapid advances in technology coupled with the implementation of favourable government policies and regulations have played a significant role in fostering the popularity and widespread adoption of digital payments in India. In recent times, more and more individuals are embracing digital means as their preferred mode of making payments. The exponential

growth in the number of users opting for digital payments has correspondingly led to a remarkable surge in transaction volumes. Looking ahead, industry experts firmly believe that these transformative trends will not only persist but also gain even more momentum, shaping the future of payment systems in the country.

POSITION OF UPI IN INDIA'S DIGITAL PAYMENT ECOSYSTEM :

Digital Payment Ecosystem consists of the payer (initiator), receiver (accepter), acquirers (receiver's bank), and issuers (payer's bank). A digital payment ecosystem can be referred to as a system that connects all of these parties through a paperless mode of payment or fund transfers. As per the RBI database, India's digital payment ecosystem includes various digital payment instruments such as Banking cards (Debit/Credit Cards), Unstructured Supplementary Service Data (USSD), AADHAR enables payment system (AePS), Internet Banking (NEFT, IMPS, and RTGS), M – Wallets, Prepaid Payment Instruments (PPIs), and Unified Payment Interface (UPI). According to the most recent RBI data of May 2021, UPI is accounting for 58.47 percent of all digital payment transactions, totalling 2.53 billion transactions (Chart1). UPI was developed to facilitate payment systems in retail digital payment transactions, and it now accounts for more than half of the total transactions performed in the digital payment ecosystem. Due to the maximum ceiling restriction of Rs. 2,00,000 in the UPI payment system, NEFT, and RTGS continue to dominate in terms of volume, accounting for 89.29 percent of digital transactions during May 2021 amounting to 104.52 trillion rupees.

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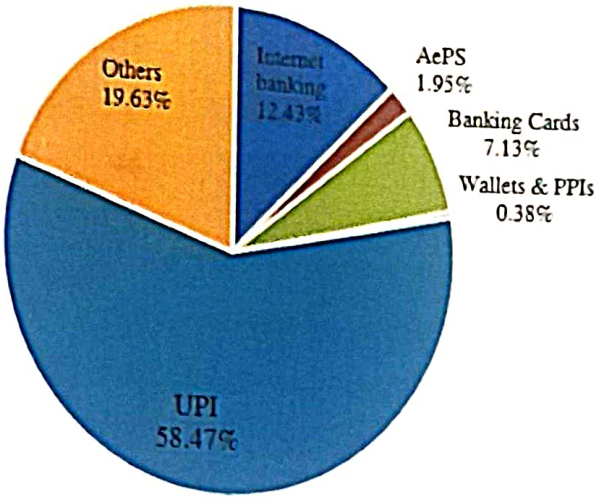

Fig. 1: Digital Payment and Settlement System data of May, 2021 (in terms of volume of transactions)

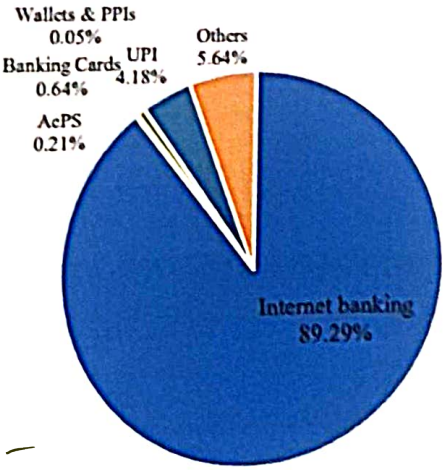

Fig. 2: Digital Payment and Settlement System data of May, 2021 (in terms of value of transactions)

SWOT ANALYSIS OF UNIFIED PAYMENT INTERFACE (UPI):

The SWOT analysis of UPI is as follows:

Strengths:

The strengths of UPI platform are as follows:

(1) **Caters to Bottom of the Pyramid:** UPI allows even the petty business person to start accepting digital payments without the need for a POS machine in India, where payment infrastructure is poor for accepting digital payments. UPI has eliminated the need for transacting parties to know the complicated payment credentials, and hence, making payments convenient and transparent for all parties involved. UPI operates on a safe, stable, and robust platform that includes numerous security features that make it more secure than any other payment system currently in use. Biometric authentication in UPI will not only make payments more reliable but will also mark a significant step forward in the integration of next-generation technology with current payment systems. UPI has the potential to be a major facilitator of financial inclusion in India, enabling a large portion of the population to engage in the digital economy.

(2) **Corruption Deterrent:** In developing countries, digital financial transactions contribute to a lessening of corruption and reduction in the contagion of the parallel economy.

(3) **Simplified Payment Mechanism:** It enables to use of the mobile phone as the primary payment mechanism for all transactions, including P2P, P2B, and B2P.

(4) **Pay & Collect:** Users can use their mobile phones to "pay" (push) and "collect" (pull) money from others.

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(5) **Multiple payment options:** Multiple identifiers, such as customised Virtual Payment Address (VPA), 12-digit AADHAR Number allotted by Unique Identification Authority of India (UIDAI) or Bank Account Number, and Indian Financial System Code (IFSC) can be used to make payments.

(6) **Secure sensitive information:** Users of UPI can make payments through a Virtual Payment Address without revealing account credentials.

(7) **Notified of Future Payment:** Ability to send collect requests to someone with a "pay by" deadline (i.e., P2P or B2B). It sends a "snooze" notification to the payer, allowing them to pay before the expiration date. It does not hold money in the account until the consumer has paid it.

(8) **Multiple Virtual Payment Address (VPA) across PSPs:** In UPI 2.0, users can add numerous bank accounts, including overdraft accounts, and create an unlimited number of Virtual Payment Addresses via mobile apps offered by PSPs (Payment Service Providers).

(9) **Open usage:** Ability to use a completely interoperable system across all payment system players without relying on closed networks and silos.

(10) **Bill Payment:** Payment of utility bills on a single platform through Bharath Bill Pay Service (BBPS) available in UPI.

Weaknesses:

The NPCI's UPI platform has the following weaknesses:

(1) **Delayed Transaction:** Payment settlement may be delayed due to technical glitches leaving a transaction to be interrupted.

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(2) **Irritation on Double verification:** Two-factor authentication like mobile and PIN verification may irritate the users.

(3) **Transaction limit:** The maximum amount that may be transferred is Rs.2,00,000. As a result, it is limited to the retail payment segment.

(4) **Requirement of cooling period:** Payments done through means other than VPA, such as Account Number and IFSC, are subject to the same cooling period as NEFT/RTGS transactions.

(5) **Cybercrimes:** The greatest downside of using UPI is that the banks are not assisting customers with security issues. The majority of fraudsters nowadays ask for money to be transferred via UPI. Customers should be careful enough while performing transactions over UPI.

Opportunities:

The opportunities available for UPI are:

(1) **Strong Banking Network:** A strong Banking network, and the launch of Digital India especially after demonetization, propelled the country toward a cashless economy.

(2) **Growth in Retail Digital Payment:** During FY 2020-21, the retail payment segment has seen rapid growth in the use of digital payment services, with transaction volume doubling from 12.5 billion to 22.3 billion and value double from Rs 21.3 trillion to Rs. 41 trillion.

(3) **Internet Penetration:** A large portion of the country's population lives in semi-urban and rural areas. The prospective consumer base in these geographical areas will rise as the use of the internet and mobile phones grow.

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(4) **Widening the scope of services:** Initially, UPI was used for fund transfers between bank accounts. Presently it is providing a wide range of digital payment services such as bill payments, investments, insurance, donations, handling overdraft accounts, one-time payment mandate, etc.

(5) **PMJDY:** Prime Ministers Jhan Dhan Yojana (PMJDY) programme as a financial inclusion strategy related to opening bank account among poorer households particularly those engaged in casual labour activities and illiterate. This enlarged the base of account holders.

(6) **Cash-lite economy:** RBI's Vision 2021 aims at building a strong digital payment ecosystem by shifting to a cash-lite economy. The government wants to reduce the use of real currency by implementing easy digital payment channels.

(7) **Zero Merchant Discount Rate (MDR):** To encourage the use of digital payments, the government has exempted UPI and RuPay-based payments from the Merchant Discount Rate. This has increased the use of UPI and RuPay in making payments on e-payment gateways.

Threats:

The following are the obstacles that UPI must overcome:

(1) **Awareness:** UPI usage awareness creation among the rural and illiterate population of the country is most challenging.

(2) **Cash is the King:** Even though many e-commerce sites have adopted digital payment methods, consumers still prefer to pay with cash. This trend is linked to concerns about cybersecurity in digital transactions.

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(3) **Emergence of FinTech players:** Strengthening of the traditional Banking system to compete with tech generation companies i.e., FinTech Players.

(4) **Grievance redressal:** Pathetic Grievance redressal system for transactions performed over UPI platform.

(5) **Tax on UPI service:** Levy of Tax/GST on UPI payment service in future days may demotivate usage of UPI platform. The regulators need to be cautious in this regard.

(6) **Restoration of Merchant Discount Rate:** Users may shift to cash payments in retail payments after the government reinstates the exempted MDR fee on UPI payments.

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FINDINGS

Credit cards, Debit cards, Internet Banking (NEFT/IMPS/RTGS), Mobile banking, Digi-wallets, Aadhar enables Payment Service (AePS), and the Unified Payments Interface (UPI) are the different options available for digital payments and transfers. UPI offers superior advantages through services such as instant payment using QR code, payment of various fees, fund transfers between bank accounts & wallets, donations, buying & renewal of insurance, payment of utility bills through Bharath BillPay, etc.

With UPI 2.0 NPCI has allowed users to add their overdraft accounts, one-time payment mandate with enhanced security measures. It has the unique advantage of 'No need to add a beneficiary'. It allows users to make transactions through a Virtual Payment Address (VPA) without revealing technical credentials such as account number, IFS Code, Name, etc. Even though UPI faces cyber threats and technological challenges, it has a lot of opportunities in today's digital world due to its key strengths SIASC - Simplicity, Innovation, Adoption, Security, and Cost-effective.

"Most people are rushing to cashless transactions because they have little cash on hand and an impending cash crunch". The growth of users of smartphones and internet penetration facilitated in such situations to adopting for digital payment service. Due to the covid pandemic outbreak, people are preferring contactless payment methods over other payment options. Because of the widespread use of smartphones and related apps, a mobile payment system is an enticing alternative that has recently blossomed. Expected performance, social impact, pricing rate, safety, and data privacy are considered to be important factors influencing the adoption of the mobile payment system.

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Users benefit from the convenience and speed of digital transactions through UPI. Because it is easier to access via smartphone than other digital payment options, it is gaining in popularity, especially in the retail payment industry. The main disadvantage of UPI is that it can only be used by people who have Bank accounts. It is deafeningly silent among the unbanked rural population. User's attitudes toward UPI and other e-Payment alternatives could be studied in the future, and the results could be analysed using systematic behaviour models.

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SUGGESTIONS

- The main objective of introducing digital payment system is to have paperless and cashless transactions in the country, it is necessary to organize campaigns to create awareness among the citizens of India to use digital payment system.
- The average knowledge of the respondents to be upgraded through different means of promotional channels.
- Women have to be encouraged more to use digital payment system.
- Apart from using Google Pay and Pay TM apps, the other remaining apps are to be made known to public and encourage them to use.
- Cash back offers to be continued to motivate users to use digital payment system.
- The digital payment system is used mainly for fund transfer. Steps must be taken to use for other financial/banking transactions.
- Universities can initiate students to pay their college fees/examination fees through these digital payment apps.
- If the transactions get failed due to connectivity or technical issues, those are to be redressed within a short span of time.

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CONCLUSION

The study of UPI and its applications has shown that UPI has revolutionized the digital payment industry in India. It offers a seamless and secure payment experience, making it a popular payment option for individuals and businesses alike. The adoption and usage rates of UPI have been increasing rapidly, with UPI transactions growing at an unprecedented rate. This indicates a high level of acceptance and trust among users, highlighting the potential of UPI in the digital payment industry.

Contrary to H01, India has shown significant interest in adopting UPI technology as a payment system, with UPI becoming a popular payment option in India. Additionally, the study has shown that UPI is playing a significant role in India's vision of a cashless economy. So H02 is rejected. UPI has become the backbone of the digital payment ecosystem in India and is driving the shift towards a cashless economy. With the government's push towards a digital economy and the increasing popularity of UPI, India is poised to become a leader in the digital payment space.

Looking towards the future, UPI is expected to continue its growth trajectory, with increased adoption, innovation, and international expansion. This will further drive the shift towards a cashless economy in India and could serve as an inspiration for other countries looking to transform their payment systems. In conclusion, UPI is a disruptive and innovative technology that has already transformed the digital payment landscape in India, and its potential for the future is vast.

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Wedify.com

“Crafting Forever After Together.”

A PROJECT SUBMITTED TO

Atmiya University

Department of Computer Application

RAJKOT

Submitted in partial fulfillment of the requirements for the degree of

“Bachelor of Computer Application”

Sem-6

(Year 2023-2024)

Submitted By:-

Riya Jha

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Guided By:-

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(Established under the Gujarat Private University Act 11, 2018)
Yogidham Gurukul, Kalawad Road, Rajkot - 360005, Gujarat (INDIA)

Date: 6-03-2024

CERTIFICATE

This is to certify that,

Ms. Riya Jha

of Bachelor of Computer Application

Semester VI

Has satisfactorily completed the project on

Wedify.com
"Crafting Forever After Together."

For, Department of Computer Application,

ATMIYA University, Rajkot.

Signature

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PROJECT PROFILE

Project Title	**“Wedify.com”**
Organization	**Atmiya University-Rajkot**
Front-End Tools	**XAMPP**
Back-End Tools	**MYSQL**
Language	**1) HTML** **2) CSS** **3) JavaScript** **4) PHP** **5) SQL**
Platform Used	**1) IDE - Vs code** **2) Google chrome** **3) Creatively**
Developed By	**1) Riya Jha**
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DECLARATION

I, hereby declare that the project work entitled **"Wedify.com"** is the original work done by me, and I further declare that it is never submitted anywhere else in part or in full.

"Riya Jha"

"[210801144]"

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ABSTRACT:

'Wedify.com' stands as a trailblazer in wedding management, not only simplifying processes but also enhancing the entire planning journey. With its commitment to minimizing stress and errors, the platform acts as an intuitive hub for coordination, offering real-time accessibility and effective tools.

Incorporating a modern, technology-driven ethos, 'Wedify.com' goes beyond efficiency, optimizing resource allocation, and reducing operational costs. Its robust planning toolsenable seamless guest list management, RSVP tracking, and coordination of diverse wedding events.

Available across devices, 'Wedify.com' ensures a personalized touch by enabling the creation of couples' profiles, storing their preferences and special requests. Beyond core planning, the platform efficiently handles additional services like venue bookings, transportation, and entertainment, exhibiting scalability and customization to suit weddings of various sizes and complexities.

The streamlined planning process not only reduces stress but also fosters easy communication among stakeholders. Couples' feedback is valued, contributing to continuous improvements in wedding services. 'Wedify.com' takes a step further by prioritizing safety features, ensuring the well-being of both couples and event staff, culminating in a holistic and secure solution for modern wedding management.

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TABLE OF CONTENTS

Sr. No.	Chapter Title	Page no
CHAPTER 1 : INTRODUCTION		**1**
1.1	Problem Statement	2
1.2	Project Scope	3
1.3	Purpose	4
CHAPTER 2 : REQUIREMENTS AND ANALYSIS		**6**
2.1	System Analysis	7
2.2	Software and Hardware Requirements	10
CHAPTER 3: PROJECT PLANNING AND SCHEDULING		**12**
CHAPTER 4: SYSTEM DESIGN		**17**
4.1	Logical Design	18
	4.1.1 Use Case	18
	4.1.2 Data flow diagram (DFD)	21
	4.1.3 ER Diagram	25
	4.1.4 Module Design	28
	4.1.5 Data Dictionary	30
CHAPTER 5 :SCREENLAYOUT AND TESTING		**34**
5.1	Screen Layout	34
	5.1.1 Admin Side	35
	5.1.2 User Side	44
5.2	Testing Approach	50
CHAPTER 6 : SYSTEM SECURITY AND MEASURES		**54**
CHAPTER 7 : FUTURE SCOPE AND ENHANCEMENT		**56**
CHAPTER 8 : CONCLUSION AND LIMITATIONS		**58**
CHAPTER 9: BIBLIOGRAPHY		**61**

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Rajkot

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Chapter 1: Introduction

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1.1 Problem Statement :

In the realm of wedding planning, the complexity of orchestrating a memorable event has surged alongside evolving preferences. To address these challenges, there's a critical need for an advanced Wedding Management System (WMS) like "Wedify." This system aims to streamline planning, enhance communication, and ensure seamless execution, offering a comprehensive solution to modern wedding intricacies.

Key Problems to Solve:

1.Fragmented Information Management:

Current wedding planning processes often involve multiple stakeholders,including couples, vendors, and wedding planners. The information exchange is fragmented across various platforms, leading to confusion, delays, and the risk of crucial details being overlooked.

2.Vendor Coordination:

Coordinating with numerous vendors, such as caterers, florists, photographers,and decorators, is a daunting task. Lack of a centralized system for vendor management results in inefficiencies, potential miscommunication, and difficulties in tracking contracts and commitments.

3.Budget Overruns:

The absence of a dedicated budget tracking mechanism contributes to overspending. Couples frequently find it challenging to monitor and control expenses, leading to financial stress and compromises in the overall quality of the wedding.

4.Guest Management Complexity:

Managing guest lists, RSVPs, and seating arrangements manually is time-consuming and prone to errors. Couples often struggle with guest communication and seating logistics,impacting the overall guest experience.

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The Solution: Wedify - A Comprehensive Wedding Management System

Wedify is envisioned as an end-to-end solution addressing the challenges prevalent in wedding planning. This sophisticated Wedding Management System aims to revolutionize the industry by providing a centralized platform that integrates all aspects of wedding coordination.

1.2 Project Scope:

Comprehensive Information Hub:

Develop a centralized platform that serves as a comprehensive information hub for wedding-related data, fostering collaboration and real-time updates among couples, wedding planners, and vendors.

Enhanced Vendor Collaboration:

Implement an innovative vendor collaboration module within Wedify,fostering seamless communication, efficient contract management, and improved coordination between couples and diverse service providers.

Smart Budgeting and Financial Transparency:

Integrate an intelligent budget tracking system that empowers couples and planners to set, monitor, and analyze budgets in real-time, providing financial transparency and preventing budget overruns.

Guest Engagement and Communication:

Design a dynamic guest management module within Wedify, streamlining the RSVP process, optimizing seating arrangements, and enhancing communication with guests through advanced messaging tools.

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Automated Task Management:

Incorporate state-of-the-art task automation features to streamline routine wedding planning tasks, ensuring timely execution and reducing the workload on wedding planners.

1.3 Purpose:

Unified Information Hub:

At the core of Wedify's purpose is the creation of a unified information hub. By consolidating all wedding-related information in one platform, it ensures that every stakeholder has access to real-time updates, fostering transparency and collaboration.

Vendor Collaboration Module:

Wedify fulfills its purpose of enhancing vendor coordination through a dedicatedcollaboration module. Vendors can communicate seamlessly, manage contracts efficiently, and cultivate stronger professional relationships, ultimately delivering enhanced services to couples.

Budget Tracking and Analysis:

Wedify's purpose is manifested in its robust budget tracking system, which empowers couples and planners to take control of their finances. Real-time tracking, personalized alerts, and insightful analytics contribute to informed decision-making and financial well-being.

Guest Management and Communication:

Wedify's purpose extends to optimizing the guest experience. With features like RSVP tracking, seating arrangements, and integrated communication tools, it ensures that couples can focus on creating a warm and welcoming environment for their guests.

Task Automation and Reminders:

Wedify fulfills its purpose of optimizing task efficiency by automating routine tasks and sending timely reminders. This not only reduces the workload on wedding planners but also ensures that every aspect of the wedding is executed with precision and timeliness.

Personalized Theme Customization:

In line with its purpose, Wedify offers personalized theme customization, allowing couples to express their unique style. The platform provides a range of themes, color palettes, and design elements, ensuring each wedding reflects the couple's vision.

Real-time Collaboration Board:

Wedify facilitates real-time collaboration through a dedicated board where all stakeholders, including couples, planners, and vendors, can share ideas, inspirations, and updates. This purposeful feature promotes a collaborative and creative wedding planning process.

Interactive Checklist and Milestones:

With a purpose-driven interactive checklist, Wedify ensures that couples and planners stay organized and meet essential milestones. This feature aids in tracking progress, setting priorities, and achieving a well-organized wedding planning journey.

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Chapter 2: Requirement and Analysis

2.1 System Analysis:

System analysis for developing a Wedding Planner Management System involves understanding and defining the requirements, functionalities, and processes of the system, addressing the needs of users such as couples, wedding planners, and vendors.

SDLC for Wedding Planner Management System:

1. Requirements Gathering and Analysis:

Collect project requirements from stakeholders (couples, planners, vendors) to understand needs and expectations, defining the system's scope, objectives, and constraints.

2. System Design:

Design the software architecture based on gathered requirements, involving components, data architecture, software architecture, and interface design tailored for wedding planning.

3. Implementation (Coding):

Developers commence coding based on design specifications, actualizing the system's functionalities according to the chosen programming language and development environment.

4. Testing:

Thorough testing ensures the system meets specified requirements and functions correctly. Stages include unit testing, integration testing, system testing, and acceptance testing, with bug fixes as necessary.

5. Integration and System Testing:

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Integrate individual components/modules into a cohesive system, conducting thorough testing to ensure seamless interactions between integrated components.

6. Deployment:

Deploy the software to the production environment or the intended platform, involving installation, configuration, data migration, and other necessary tasks to make the system operational.

7. Maintenance and Support:

Post-deployment, the system enters a maintenance phase with ongoing updates, enhancements, and bug fixes. This is driven by user feedback and evolving requirements in the wedding planning industry.

Applying SDLC to Wedding Planner Management System:

1. Problem Identification:

Identify challenges in wedding planning such as coordination issues, communication gaps, and stressors for couples and planners.

2. Solutions:

Outline potential solutions to address identified problems, providing the direction for system design tailored to wedding planning.

3. Analysis of Admin and User Side:

Admin Side Analysis:

Event Management: Defining and managing wedding events, timelines, and vendor coordination.

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Vendor Management: Streamlining interactions with photographers, caterers, florists, and other service providers.

User Side Analysis:

Couple (User) Management: Simplifying registration, profile management, and communication channels.

Planner (User) Management: Enhancing functionalities for planners, including tools for efficient planning.

4. Analysis of Admin side - Event Management:

Define admin functionalities for managing wedding events, including schedules, timelines, and coordination with vendors.

5. Analysis of Admin side - Vendor Management:

Detail how admin manages interactions with vendors, including setting up, updating, and coordinating services.

6. Analysis of User side - Couple Management:

Understand user experience for couples, analyzing registration, login processes, profile management, and communication channels.

7. Analysis of User side - Planner Management:

Analyze how planners interact with the system, defining functionalities like logins, access to couple information, and efficient planning tools.

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2.2 Software and Hardware Requirements:

What is Hardware Requirements:

Hardware requirements refer to the physical components necessary for running software applications effectively. This includes the specifications of the computer or server on which the software will be installed and used. Hardware requirements typically encompass factors such as processor speed, memory (RAM), storage capacity, graphics capabilities, and network connectivity.

In addition to the fundamental hardware specifications mentioned earlier, comprehensive hardware requirements also delve into specifics to ensure optimal performance and user experience. The processor speed specification often encompasses details such as the number of cores and the architecture, crucial for handling the software's computational demands efficiently. Memory (RAM) requirements may extend to detailing the minimum and recommended RAM capacities, considering the software's operational complexity.

What is Software Requirements:

Software requirements specify the essential components like operating systems, libraries, and frameworks for an application. These details define the optimal software environment, including specific versions of OS, databases, and web browsers. Meeting these requirements is vital for ensuring smooth, efficient, and secure software operation, ensuring a satisfactory user experience.

Expanding on software requirements involves considering various components critical for the application's functionality and compatibility. The specification of operating systems may include not only the minimum and recommended versions but also any specific configurations or updates necessary for seamless operation. Compatibility with databases is another crucial aspect, encompassing details about supported database management systems, versions, and connectivity protocols.

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Software Requirements to make and use my website :

1. **Operating System** : Windows operating system
2. **Front End languages** : HTML,CSS, JavaScript
3. **Back End languages** : PHP
4. **Back End Tools** : XAMPP
5. **Back End Tools** : MySQL
6. **Tools** : VS Code, Git , GitHub

Hardware Requirements to make and use my website:

1. **Processor Type** : Intel core i3 or above versions
2. **RAM** : 4GB
3. **Operating System** : Windows 7 or above versions

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Chapter 3: Project Planning and Scheduling

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3.1 PLANNING:

Welcome to the core of our project journey, where we delve into the critical processes of planning and scheduling for 'Wedify.com - Wedding Planner Management System.' Effective planning is our compass, guiding us through development, deployment, and achieving our project goals.

Section 1: Getting Started

Project Goals:

Our ambitious goal is to redefine wedding planning with 'Wedify.com.' We aim to create a seamless and delightful platform, transforming the wedding experience for both couples and planners.

Who's in on This?:

Picture our project as a grand celebration. We have a director, our project manager, leading the way, supported by a dedicated team – wedding planners, vendors, and tech experts – each contributing their expertise for a harmonious collaboration.

What We're Doing:

Our project is a multifaceted journey. Some key objectives include:

Event Coordination:

Simplifying the intricate process of wedding planning for both couples and planners.

Vendor Management:

Streamlining interactions with photographers, caterers, florists, and other service providers.

User-Friendly Features:

Adding personalized services to make the wedding planning experience exceptional.

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Section 2: Gathering What We Need

Finding the Requirements:

Similar to a treasure hunt, we're on a quest to discover unique project requirements. These range from functional (what the system must do) to non-functional (how well it must do it), shaping the foundation of 'Wedify.com.'

Mapping the Journey:

Creating a detailed map of how our system will be used, visualizing interactions between couples, planners, and the platform. This map guides us in crafting a system tailored to their needs.

Checking the Path:

Ensuring our ship is seaworthy, examining technical aspects like software and hardware requirements. This checklist ensures 'Wedify.com' is robust and ready for its journey.

Our requirements:

Web Application: Develop a user-friendly and responsive website or web application for seamless interaction.

Event Planning System: Create a comprehensive event planning module for couples and planners to coordinate wedding details effectively. Implement a real-time calendar for scheduling and managing events.

Booking Management: Provide a dashboard for planners to oversee bookings, manage reservations, and modify details. Enable staff to assign resources and view client details.

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Vendor Interaction: Develop a module for vendor interactions, facilitating communication, agreements, and service coordination.

Reporting and Analytics: Implement tools for tracking key metrics like successful events, client satisfaction, and revenue.

Mobile-Friendly Design: Optimize the system for mobile devices, ensuring couples and planners can access services conveniently.

Section 3: Writing the Code

Coding Sprint:
Embarking on the coding journey, where algorithms, data structures, and logic are implemented to bring 'Wedify.com' to life.

Regular Code Reviews:
Fostering continuous improvement with regular code reviews, ensuring code quality, adherence to standards, and identifying and fixing any issues.

Regular Testing:
Integral to our development process, regular testing ensures 'Wedify.com' meets the highest standards of quality and reliability.

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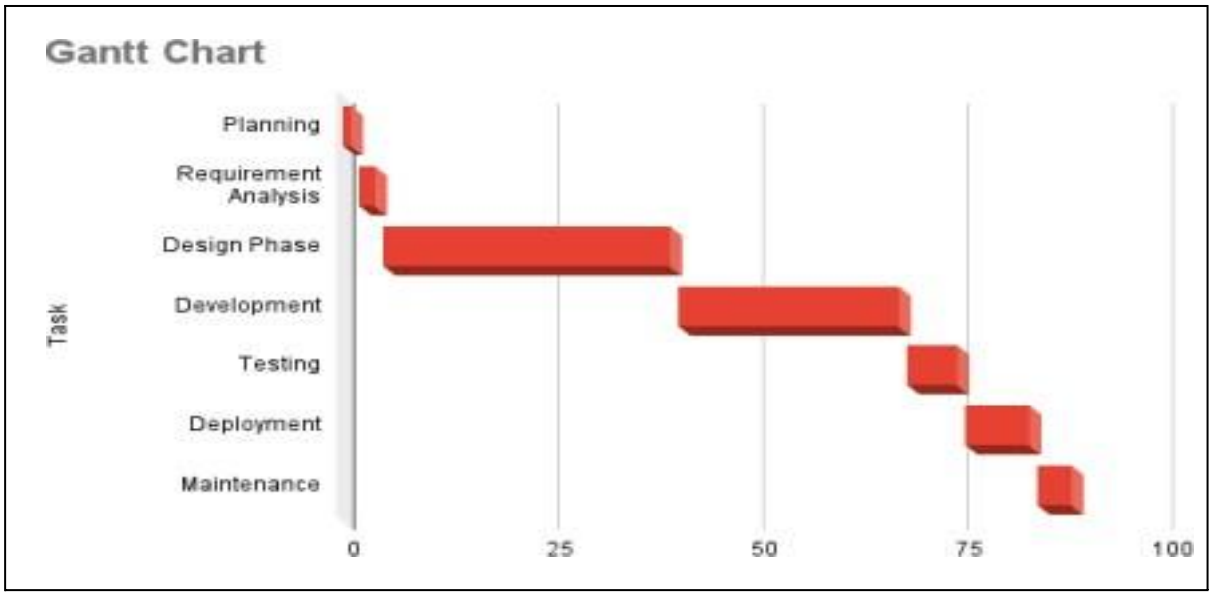
3.2 SCHEDULING :

Gantt Chart:



Planning	12/12/2023	13/12/2023
Requirement Analysis	14/12/2023	16/12/2023
Design Phase	17/12/2023	21/01/2024
Development	22/01/2024	18/02/2024
Testing	19/02/2024	25/02/2024
Deployment	26/02/2024	05/03/2024
Maintenance	06/03/2024	10/03/2024
Task	Start Date	Task Duration
Planning	0	1
Requirement Analysis	2	2
Design Phase	5	35
Development	41	27
Testing	69	6
Deployment	76	8
Maintenance	85	4

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Chapter 4: System Design

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Logical Designs :

4.1.1 Use case :

A Use Case Diagram visually illustrates the interactions between various actors (users,external systems, etc.) and the system under consideration, emphasizing the system's functionality from a user's perspective. Actors are depicted as stick figures, and use cases are represented as ovals. Arrows connecting actors and use cases indicate the interactions.

Actors:

1. Customer - A user who visits the website without logging in.

2. Admin - An administrator who manages the website, including managing hotel listings and user accounts.

Use Cases:

1. Book Vendors:
Users can book vendors.

2.Book Packages:
Users can book packages.

3.Book Venue:
Users can book a venue.

4. Manage Bookings:
Admin can view and modify their existing bookings.

5. Manage Vendors:
Admin can manage employees.

6. Manage Venues:
Admin can manage venues.

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7. Manage Customers:
Admin can manage various customers.

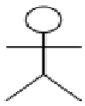
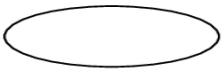
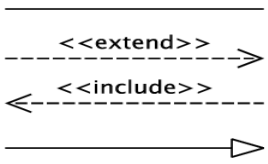
8. Manage Registration:
Admin can manage registrations.

9. Manage Login/Logout:
Admin can manage logins and logouts.

10. Cancel bookings:
Admin can manage bookings and cancel them.

11..Manage packages:
Admin can manage packages.

Symbols of Use Case

Symbol	Reference Name
	Actor
	Use case
	Relationship

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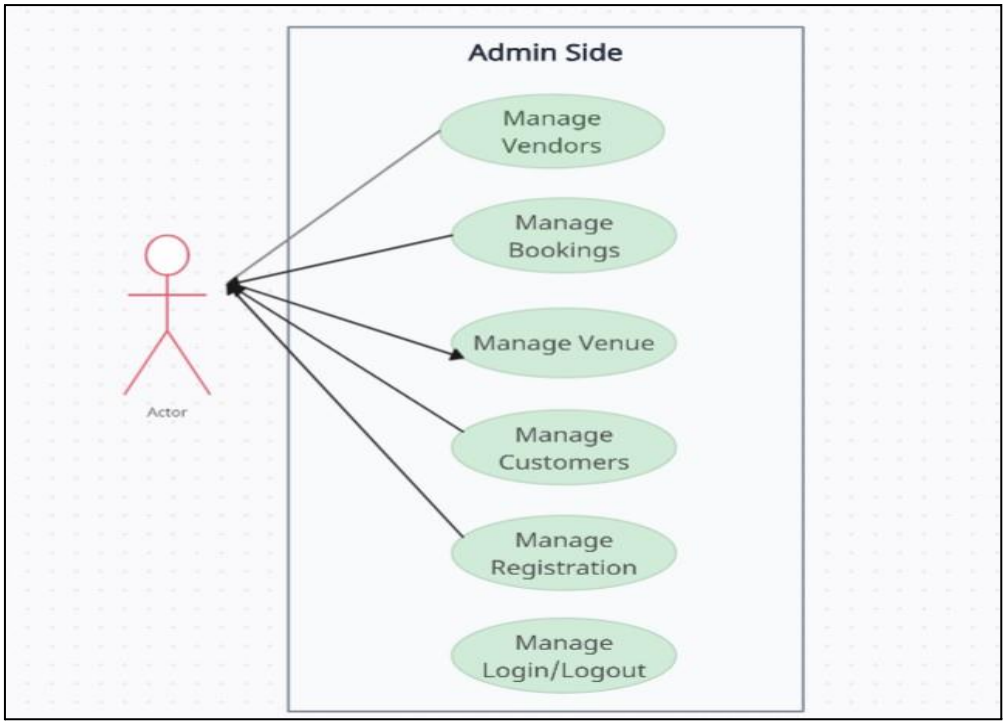
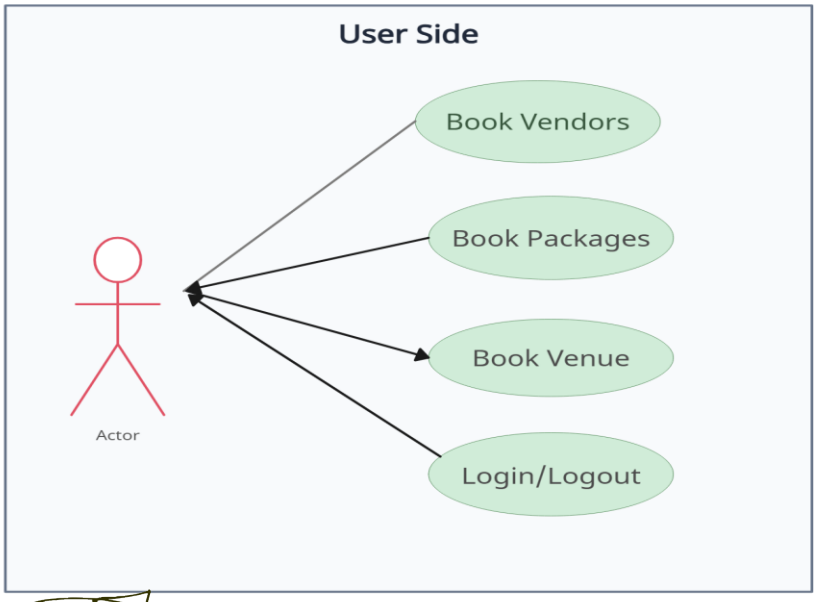
Admin :



User :



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4.1.2 DFD :

Data Flow Diagrams (DFDs) are visual representations of how data moves through a system. They illustrate processes, data stores, data flow, and external entities in a system. DFDs are crucial for understanding system functionality and interactions.

Level 0 DFD (Context Diagram):

- Objective: Offers a high-level view of system interactions.
- Components: Single process symbol, data flows, external entities.
- Purpose: Broad overview of external interactions without detailing internal processes.

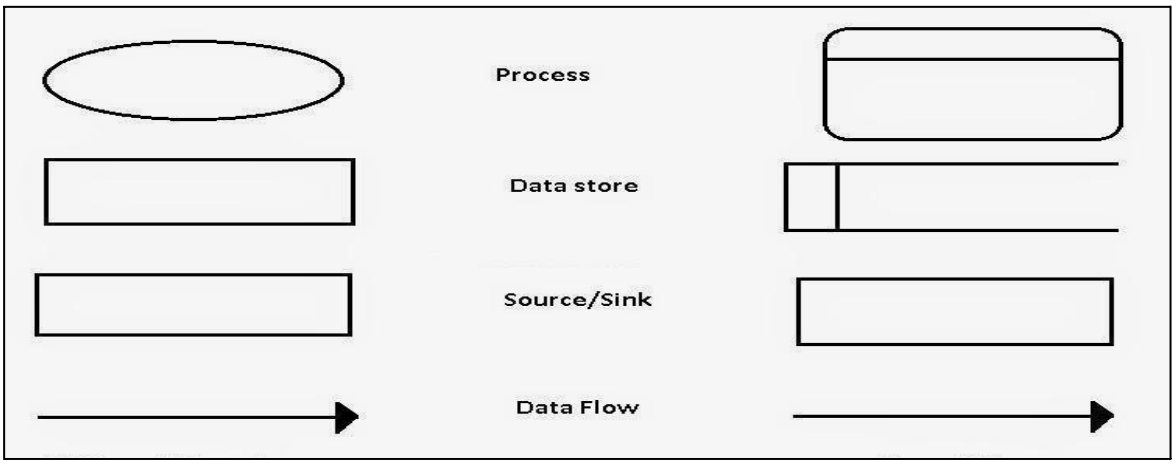
Level 1 DFD:

- Objective: Elaborates on Level 0 processes.
- Components: Processes exploded into sub-processes, detailed data flows.
- Purpose: In-depth view by breaking down major processes.

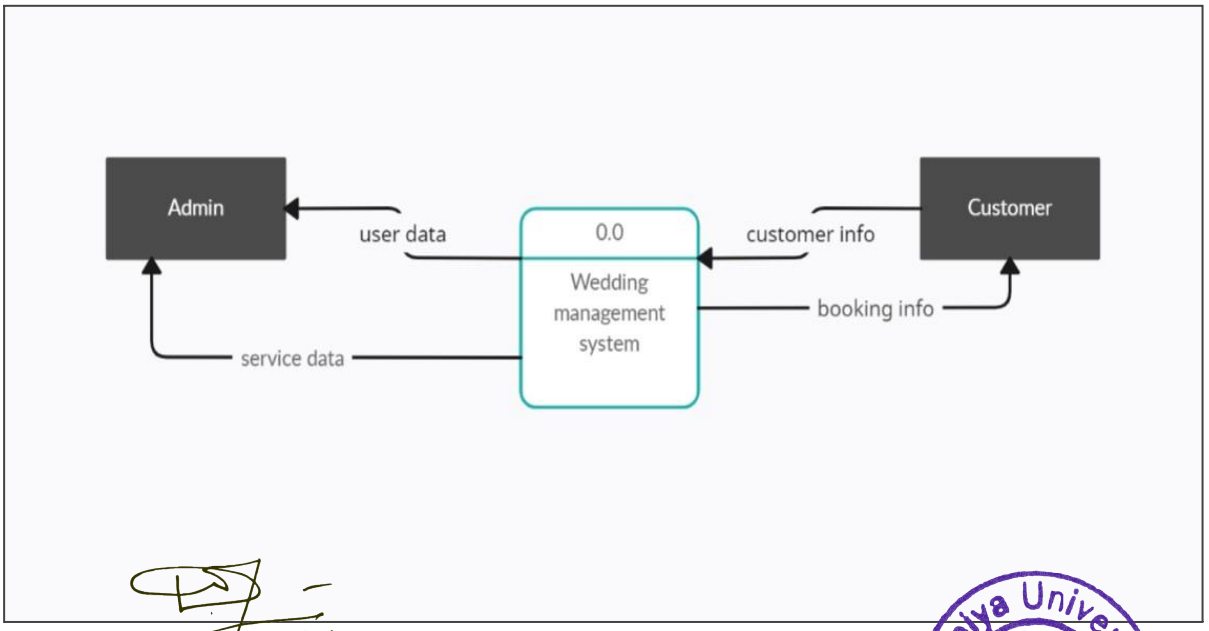
Level 2 DFD:

- Objective: Details Level 1 sub-processes.
- Components: Further exploded sub-processes, specific data stores.
- Purpose: Highly detailed understanding of data processing within sub-processes.

Symbols of DFD



0-Level DFD :



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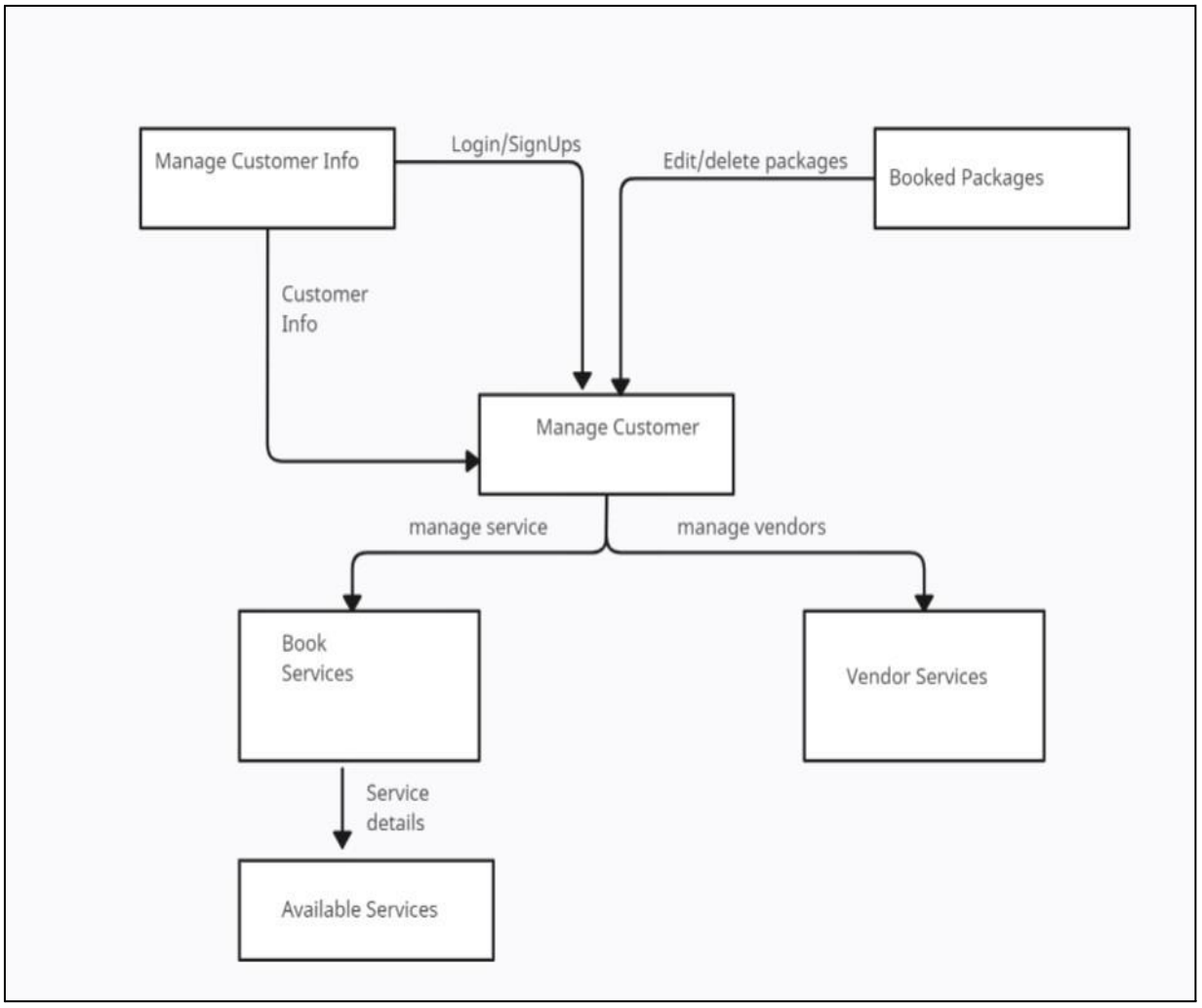
1 - Level DFD:



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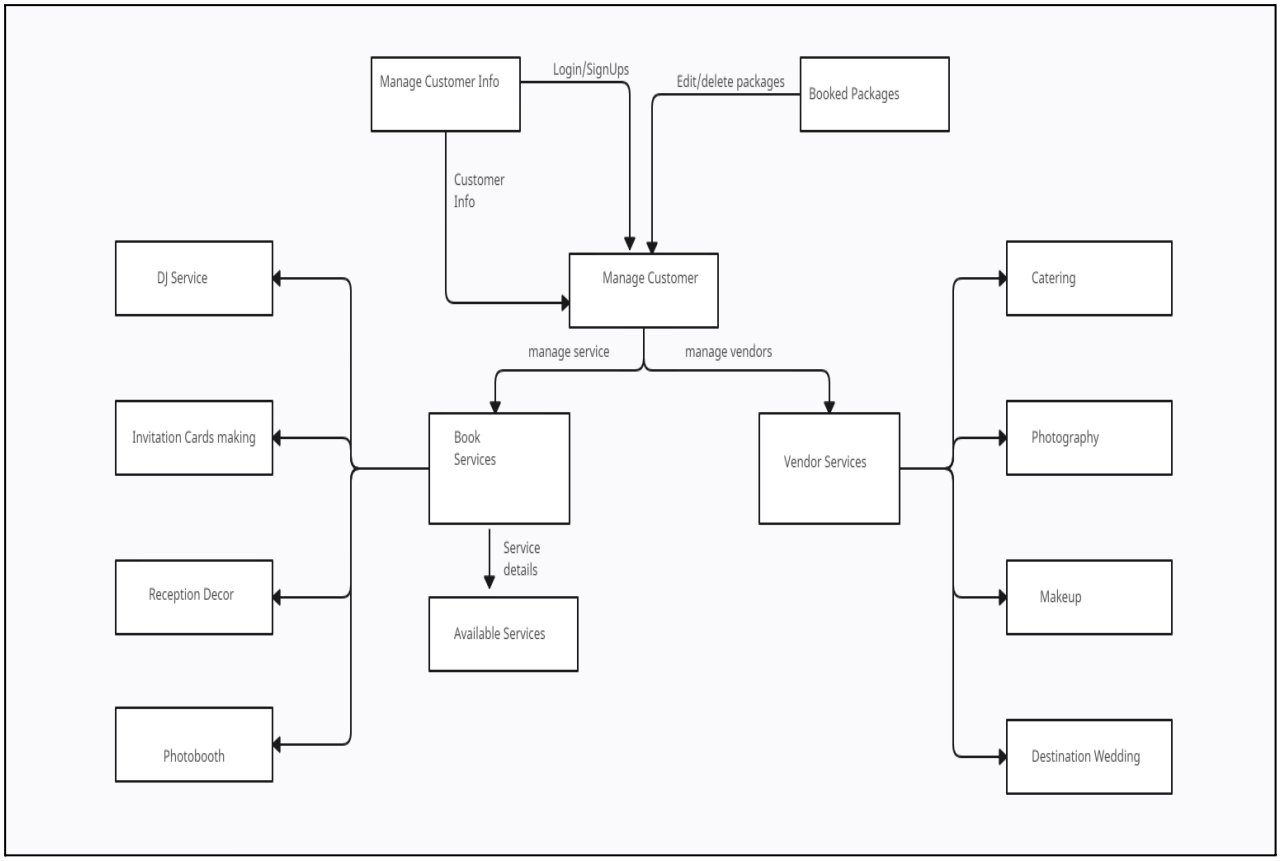
2 - level DFD:



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4.1.3 E-R Diagram

An Entity-Relationship (ER) diagram is a visual representation of the data model for a system. It shows how different entities (like tables in a database) are related to each other. Fora wedding planner management website, the ER diagram helps in understanding how various aspects of the website's data are structured and connected.

The ER diagram for the Wedding Planner Management System captures the essential entities and their relationships, providing a concise representation of the system's data mode

Entities:

Couple: Represents the engaged couple, storing details like names, contact information, and wedding date.

Venue: Represents wedding venues with attributes such as venue ID, name, capacity, and location.

Service: Represents various services offered, such as catering, photography, and entertainment, with corresponding details.

Guest: Represents individual guests invited to weddings, including their names, RSVP status, and relationships.

Vendor: Represents external vendors providing services, storing vendor details and contact information.

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Relationships:

Books: Connects the Couple and Venue entities, indicating the booking of a venue by a couple for their wedding.

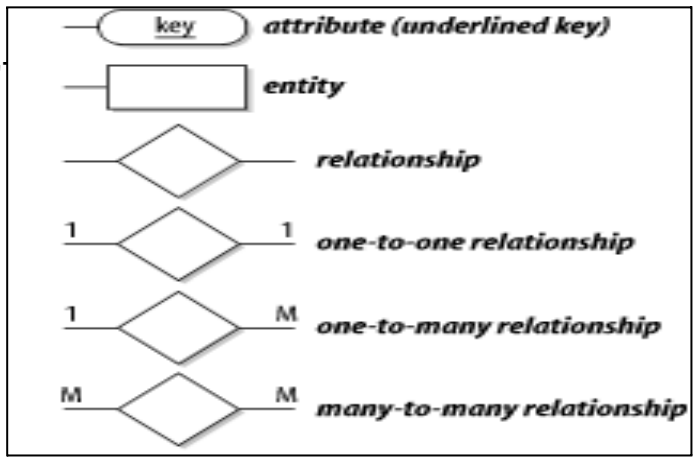
Requests: Links the Couple and Service entities, representing the couple's request for specific services.

Attributes:

Each entity has specific attributes capturing relevant information, such as the Couple entity having attributes like Couple_ID, Partner1_Name, Partner2_Name, etc.

This ER diagram serves as a visual guide to the relationships between entities within the Wedding Planner Management System, facilitating a clear understanding of the system's data structure.

Symbols of E-



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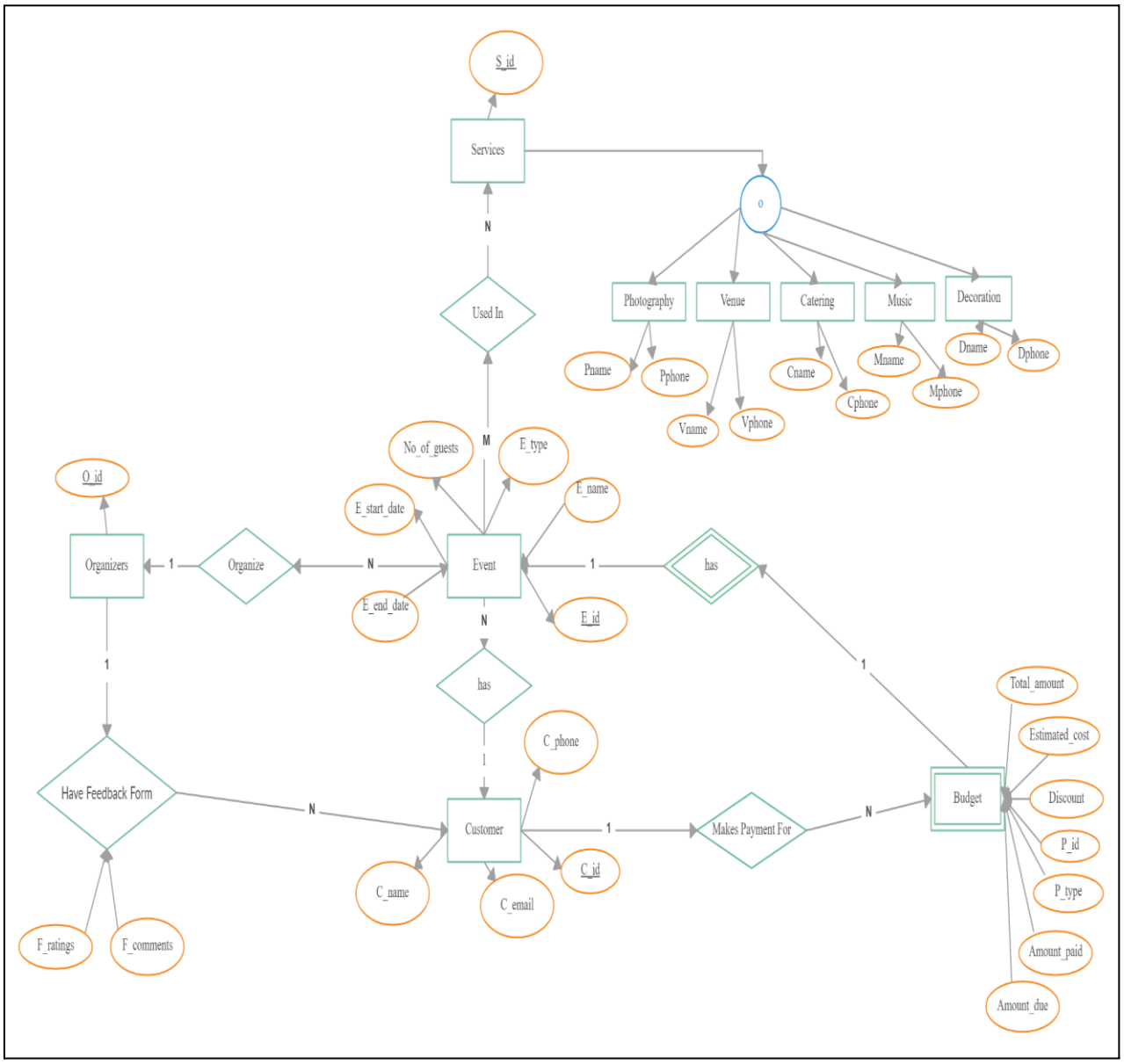
E-R Diagram :



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4.1.4 Module Design :

1) Admin Side :

- Login Or sign Up
- Forgot password
- After Login /Sign Up
    - Dashboard
        - Total customers
        - Total Bookings
        - Photos
        - Blogs
    - Blogs & Events
        - Add new information
        - Edit new information
        - Delete new information
    - Clients
        - Add new clients
        - Edit clients
        - Delete clients
        - Detail of pending clients
        - Detail of confirmed clients
    - Services
        - Add new package
        - Edit package
        - Delete package
        - Add new feature
        - Edit feature
        - Delete feature

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        - Search service
    - Gallery
        - Upload image
        - edit image
    - User Management
        - Add new user
        - Delete user
        - Edit Booking
        - Details About User
    - Task Calendar
        - Add event

2) User Side :

- Login Or sign Up
- Forgot password
- After Login /Sign Up
    - Home Page
    - Pricing
        - Select package
        - Book package
        - package detail
    - Inspiration
        - Latest Inspiration
    - About Us
    - Contact Us
        - Form

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4.1.5 Data Dictionary - Project table structure screenshots

Database Name : dbwedding

Table name: tblusers

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
1	id	int(11)			No	None		AUTO_INCREMENT	Change Drop More
2	firstname	varchar(32)	latin1_swedish_ci		No	None			Change Drop More
3	lastname	varchar(32)	latin1_swedish_ci		No	None			Change Drop More
4	gender	enum('m', 'f')	latin1_swedish_ci		No	None			Change Drop More
5	username	varchar(50)	latin1_swedish_ci		No	None			Change Drop More
6	password	varchar(50)	latin1_swedish_ci		No	None			Change Drop More
7	email	varchar(100)	latin1_swedish_ci		No	None			Change Drop More
8	designation	varchar(100)	latin1_swedish_ci		No	None			Change Drop More
9	address	text	latin1_swedish_ci		No	None			Change Drop More
10	access_level	enum('0', '1', '2')	latin1_swedish_ci		No	None			Change Drop More
11	profile_picture	varchar(100)	latin1_swedish_ci		No	None			Change Drop More
12	date_created	varchar(100)	latin1_swedish_ci		No	None			Change Drop More

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Table Name: tblguest

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
1	id	int(11)			No	None		AUTO_INCREMENT	Change Drop More
2	booking_id	int(11)			No	None			Change Drop More
3	fullname	varchar(100)	latin1_swedish_ci		No	None			Change Drop More
4	guestname	varchar(100)	latin1_swedish_ci		No	None			Change Drop More
5	address	text	latin1_swedish_ci		No	None			Change Drop More
6	state	char(4)	latin1_swedish_ci		No	None			Change Drop More
7	zipcode	char(10)	latin1_swedish_ci		No	None			Change Drop More
8	priority	enum('A', 'B', 'C', 'D', 'E')	latin1_swedish_ci		No	None			Change Drop More
9	out_of_town	enum('y', 'n')	latin1_swedish_ci		No	None			Change Drop More
10	relationship	varchar(32)	latin1_swedish_ci		No	None			Change Drop More
11	tracks_and_gifts	text	latin1_swedish_ci		No	None			Change Drop More
12	city	varchar(100)	latin1_swedish_ci		No	None			Change Drop More

Table Name: tblorganizer

Table structure | Relation view

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
1	organizer_id	int(11)			No	None		AUTO_INCREMENT	Change Drop More
2	fullname	varchar(100)	latin1_swedish_ci		No	None			Change Drop More
3	designation	varchar(100)	latin1_swedish_ci		No	None			Change Drop More
4	datetime_created	timestamp			No	current_timestamp()			Change Drop More

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Table name: tbl_features

Table structure | Relation view

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra
1	feature_id	int(11)			No	None		AUTO_INCREMENT
2	category_id	int(11)			No	None		
3	title	varchar(100)	latin1_swedish_ci		No	None		
4	description	text	latin1_swedish_ci		No	None		

Table name: tblweddingbook

Table structure | Relation view

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra
1	booking_id	int(11)			No	None		AUTO_INCREMENT
2	user_id	int(11)			No	None		
3	bride	varchar(32)	latin1_swedish_ci		No	None		
4	groom	varchar(32)	latin1_swedish_ci		No	None		
5	wedding_type	int(11)			No	None		
6	user_email	varchar(100)	latin1_swedish_ci		No	None		
7	wedding_date	varchar(100)	latin1_swedish_ci		No	None		
8	organizer_id	int(11)			No	None		

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Table name : events

Table structure | Relation view

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra
1	id	int(11)			No	*None*		AUTO_INCREMENT
2	booking_id	int(11)			No	*None*		
3	title	varchar(255)	utf8_general_ci		No	*None*		
4	location	text	utf8_general_ci		No	*None*		
5	date_created	datetime			No	current_timestamp()		
6	color	varchar(7)	utf8_general_ci		Yes	*NULL*		
7	start	datetime			No	*None*		
8	end	datetime			Yes	*NULL*		

Table name: tblpostwedding

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra
1	id	int(11)			No	*None*		AUTO_INCREMENT
2	title	varchar(100)	latin1_swedish_ci		No	*None*		
3	description	text	latin1_swedish_ci		No	*None*		
4	preview_image	text	latin1_swedish_ci		No	*None*		
5	location	varchar(100)	latin1_swedish_ci		No	*None*		
6	status	enum('0', '1')	latin1_swedish_ci		No	*None*		
7	wedding_date	varchar(100)	latin1_swedish_ci		No	*None*		
8	wedding_type	varchar(100)	latin1_swedish_ci		No	*None*		
9	date_created	varchar(100)	latin1_swedish_ci		No	*None*		
10	date_published	varchar(100)	latin1_swedish_ci		No	*None*		

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Chapter 5: Screen Layout and Testing

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1) Login:


```
if (isset($_POST['login'])) {
    $input_email = clean($_POST['input_email']);
    $input_password= clean($_POST['input_password']);
    $logged = Users::user_account_login($input_email, $input_password);

    if($logged) {
       $session->login($logged);
       redirect_to("dashboard.php");
    } else {
       redirect_to("login.php");
       $session->message("
         <div class=\"alert alert-danger alert-dismissible fade show\" role=\"alert\">
             <strong><i class='mdi mdi-alert'></i></strong> Invalid email or password. Please
try again
           <button type=\"button\" class=\"close\" data-dismiss=\"alert\" aria-label=\"Close\">
             <span aria-hidden=\"true\">&times;</span>
           </button>
         </div>");
    }
```

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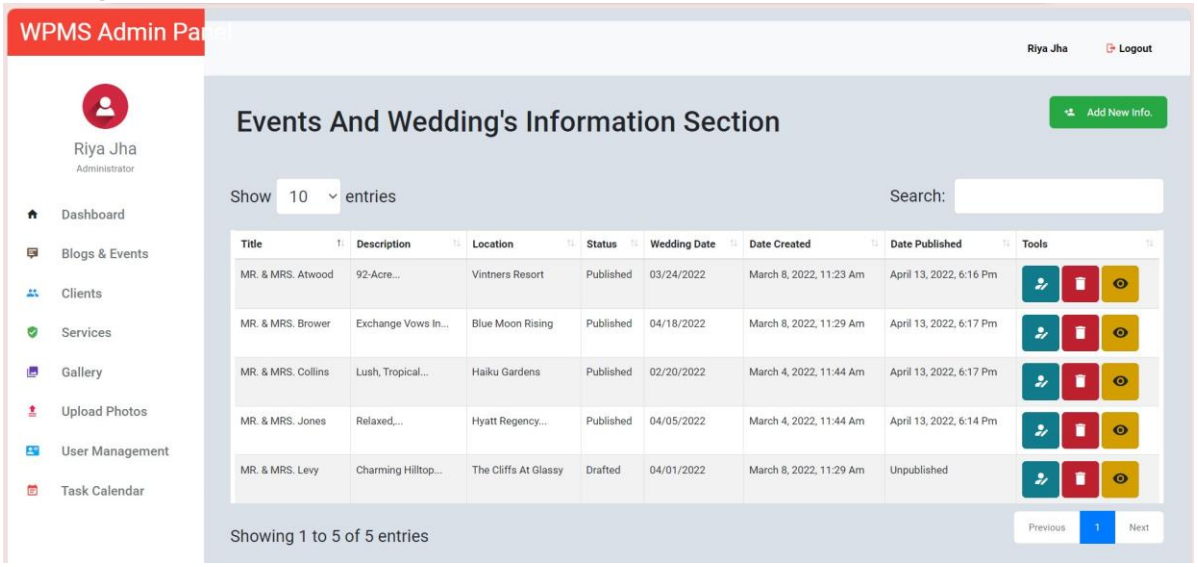
2) Blogs & Events




```
<?php foreach ($event_wedding as $events) : ?>
        <tr>
            <td class="special"><?= trim_body($events->title, 30); ?></td>
            <td class="special"><?= trim_body($events->description, 20); ?></td>
            <td class="special"><?= trim_body($events->location, 20); ?></td>
        <td class="special"><?= ($events->status == 0) ? 'Drafted' : 'Published'; ?></td>
            <td class="special"> <?= $events->wedding_date; ?></td>
            <td class="special"><?= $events->date_created; ?></td>
                    <td class="special"><?=  empty($events->date_published)  ?  'Unpublished'  :
$events->date_published; ?></td>

            <td>
                    <a href="blog_events_edit.php?id=<?= $events->id; ?>" class="btn btn-info
btn-sm active"><i class="mdi mdi-account-edit"></i></a>
                <a href="blog_events_delete.php?id=<?= $events->id; ?>" class="btn btn-danger
btn-sm active"><i class="mdi mdi-delete"></i></a>
                    <a href="../wedding_details.php?id=<?= $events->id; ?>" target="_blank"
class="btn btn-warning btn-sm active"><i class="mdi mdi-eye"></i></a>
            </td>

        </tr>

    <?php endforeach; ?>
```

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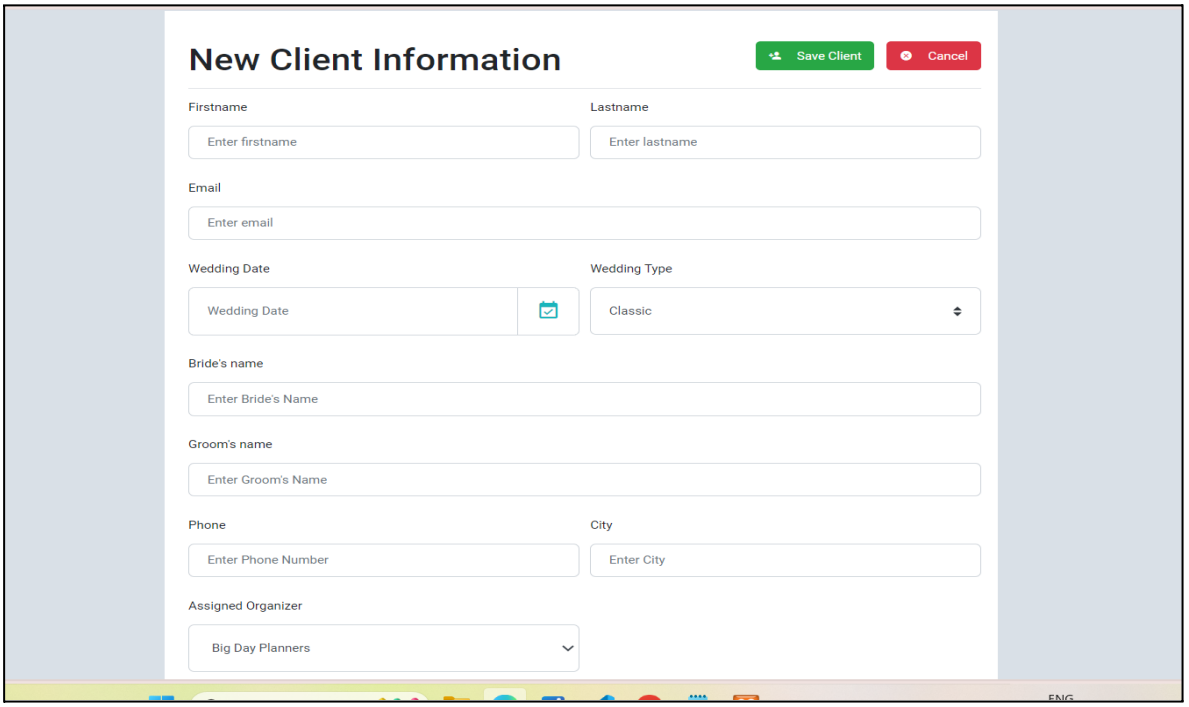
3) Add new Client




```
<?php
  $count = 0;
   $error = '';
   $firstname = $lastname = $email = $wedding_date = $bride = $groom = $phone = $city =
'';
   if (!isset($_SESSION['id'])) { redirect_to("../"); }
    $category = Category::find_all()
    $accounts = new Accounts();
   $account_detail = new Account_Details();
   $booking_detail = new Booking();

   if (isset($_POST['submit'])) {
           $user_password1 = htmlspecialchars($_POST['user_password1']);
           $user_password2 = htmlspecialchars($_POST['user_password2']);
 if ($user_password1 != $user_password2) {
           redirect_to("client_add.php");
         $session->message("
                        </div>");
         die();
```

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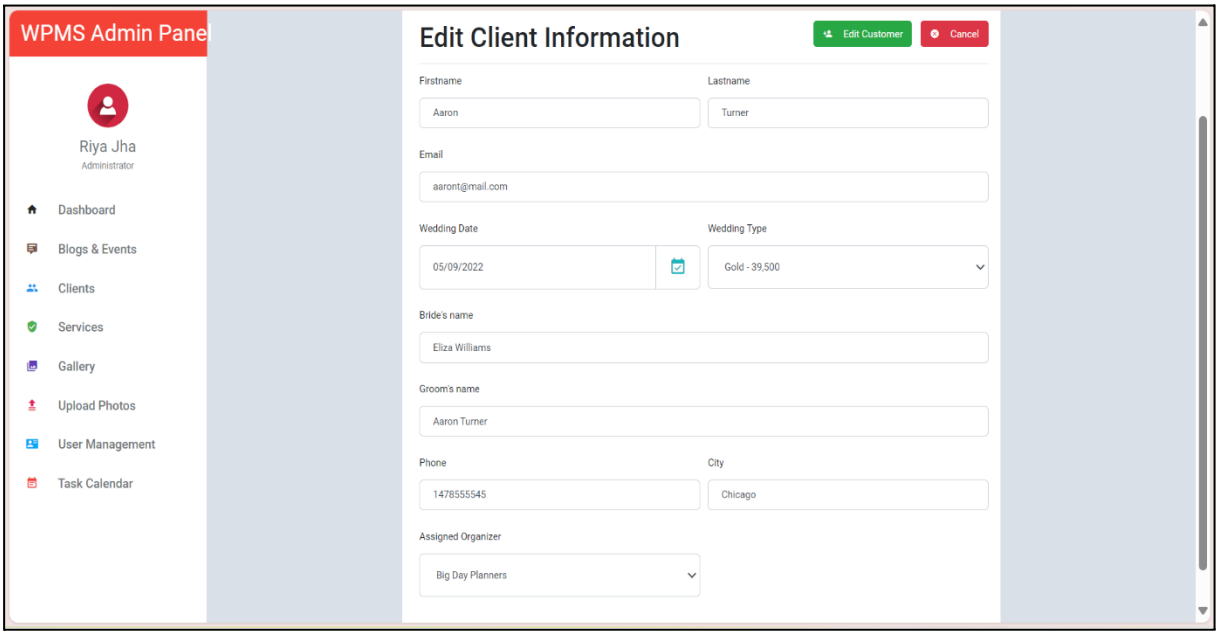
4) Edit Client




```
if ($booking_detail) {
        $firstname = clean($_POST['firstname']);
        $lastname = clean($_POST['lastname']);
        $email = clean($_POST['email']);
        $wedding_date = clean($_POST['wedding_date']);
        $bride = clean($_POST['bride']);
        $groom = clean($_POST['groom']);
        $phone = clean($_POST['phone']);
        $city = clean($_POST['city']);
        $wedding_type = clean($_POST['wedding_type']);
        $organizer_id = clean($_POST['organizer_id']);

        $booking_detail->bride = $bride;
        $booking_detail->groom = $groom;
        $booking_detail->wedding_type = $wedding_type;
        $accounts->user_email = $booking_detail->user_email = $email;
        $booking_detail->wedding_date = $wedding_date;
        $booking_detail->organizer_id = $organizer_id;
        $account_detail->firstname = $firstname;
        $account_detail->lastname = $lastname;
        $account_detail->phone = $phone;
        $account_detail->city = $city;
    }
```

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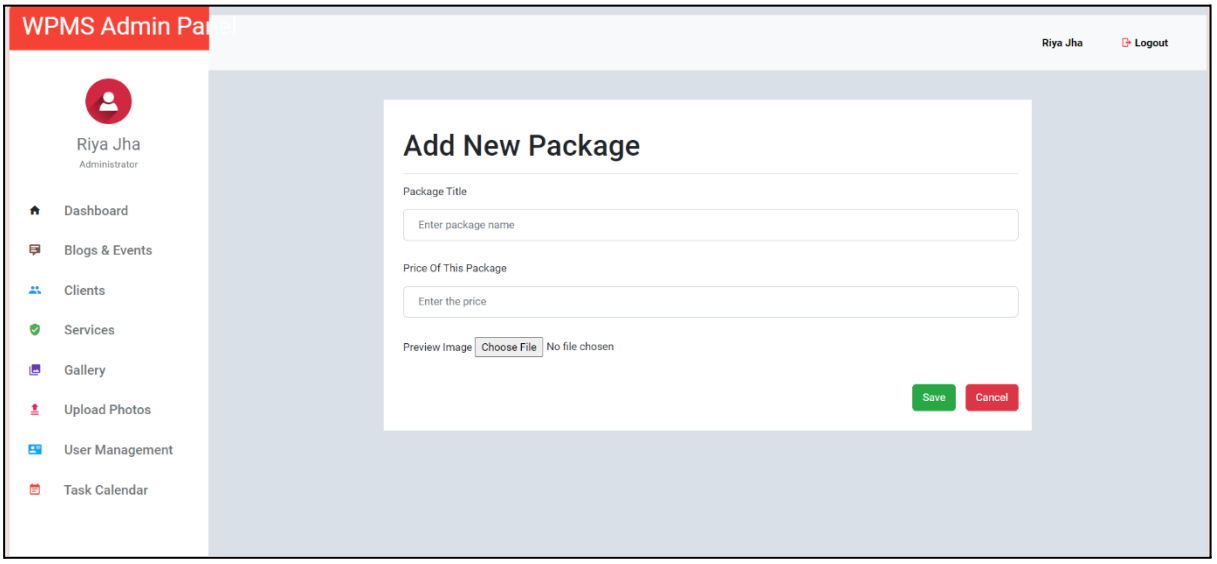
5) Add Package:




```
if (isset($_POST['submit'])) {
        $wedding_type = clean($_POST['wedding_type']);
    $price = clean($_POST['price']);
        if (empty($wedding_type) || empty($price)) {
                        redirect_to("services_list.php");
                $session->message("
        <div class=". ..." </div>;
        die();
    }
    $category->set_file($_FILES['preview_image']);
    $category->wedding_type = $wedding_type;
    $category->price = $price;
    $category->save_image();
    $category->save();
    redirect_to("service_list.php");
    $session->message("
        <div class="..." </div>";
  }
```

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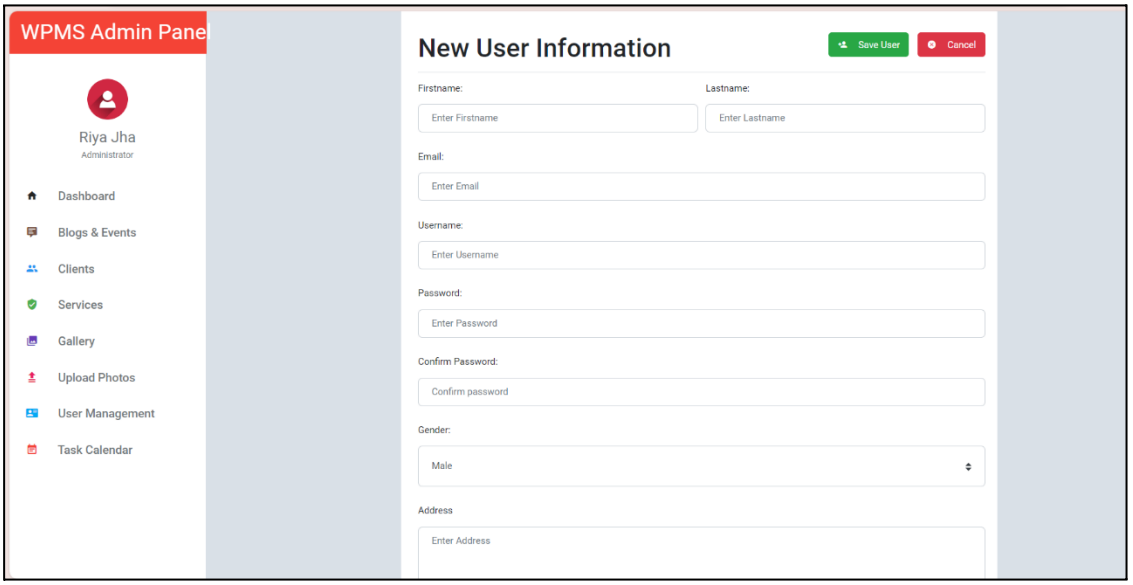
6) Add New Customer:




```
if (isset($_POST['submit'])) {
        $firstname   = clean($_POST['firstname']);
        $lastname    = clean($_POST['lastname']);
        $address     = clean($_POST['address']);
        $email       = clean($_POST['email']);
        $username    = clean($_POST['username']);
        $password    = clean($_POST['password']);
        $password2  = clean($_POST['password2']);
        $gender      = clean($_POST['gender']);
        $designation = clean($_POST['designation']);

          if (empty($firstname) || empty($lastname) || empty($address) || empty($email) ||
empty($username)) {
            redirect_to("users_add.php");
            die();
        }if ($password != $password2) {
            redirect_to("users_add.php");
            $session->message("...");

            die();
  }
```

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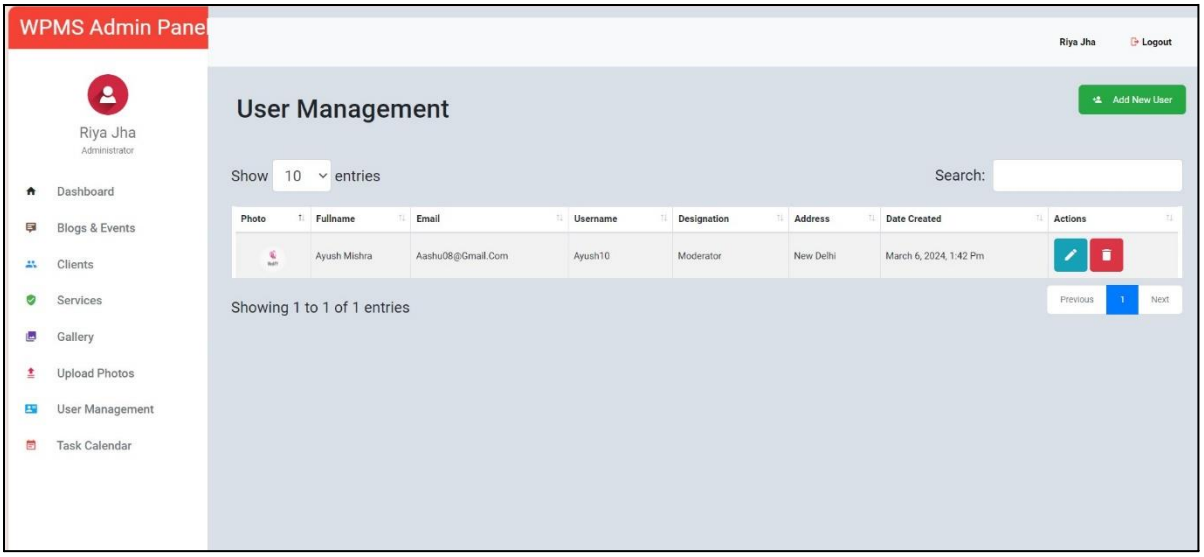
7) User Management:




```
<?php include 'include/init.php'; ?>

<?php
    if (!isset($_SESSION['id'])) {
        redirect_to("../");
    }
    $users =  Users::find_all();

?>
<?php $users_profile = Users::find_by_id($_SESSION['id']); ?>
```

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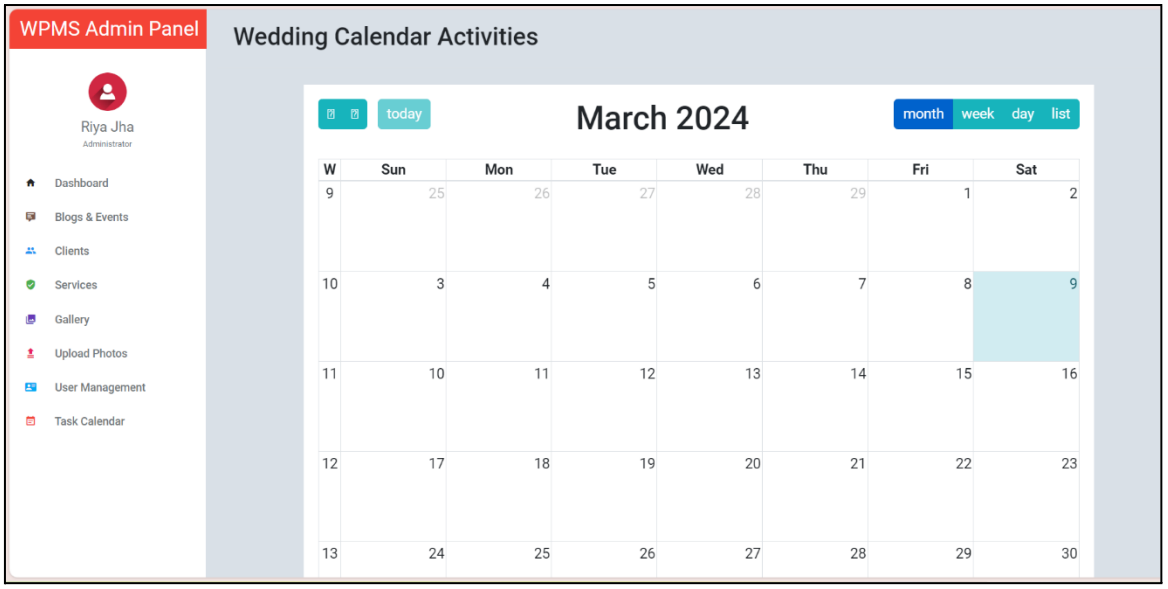
8) Task Calendar:




```
<?php

    $booking = Booking::find_booking_all();
    if (!isset($_SESSION['id'])) { redirect_to("../");}
    $bdd = new PDO('mysql:host=localhost;dbname=dbwedding', 'root', '');
    $sql = "SELECT id, title, location, start, end, color FROM events";
    $req = $bdd->prepare($sql);
    $req->execute();
    $events = $req->fetchAll();

?>
```

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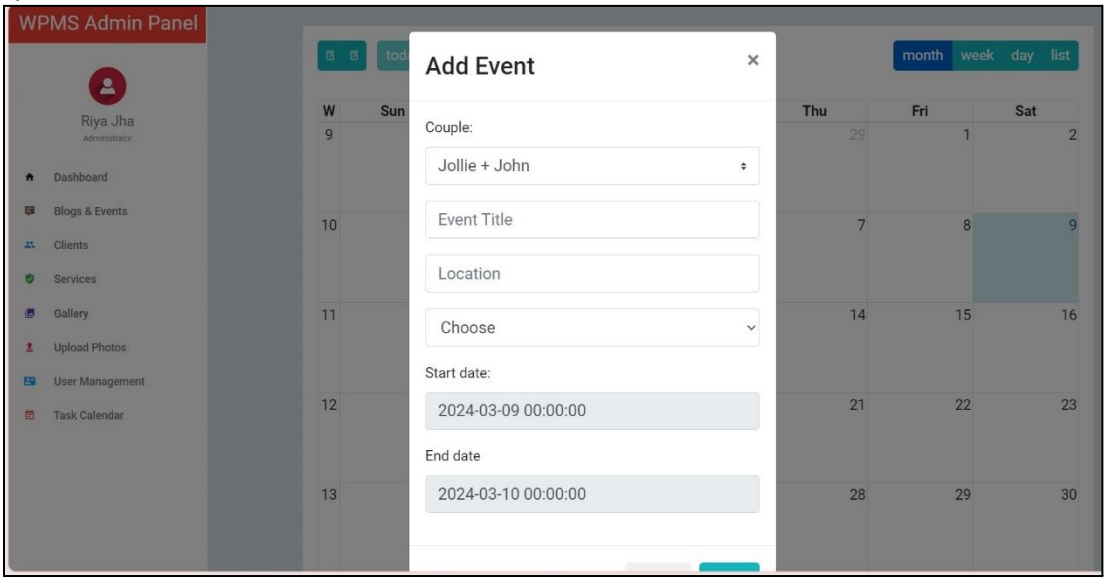
9) Add Event:




```
<?php
    if (!isset($_SESSION['id'])) { redirect_to("../");}

    $booking_id = $_GET['booking_id'];
    $user_id = $_GET['user_id'];
    $links='booking_id='.$booking_id.'&user_id='.$user_id;
    // $guest_list =  Guest::getGuest($booking_id);
    // $booking = Booking::find_by_booking_id($booking_id);

    $bdd = new PDO('mysql:host=localhost;dbname=dbwedding', 'root', '');
        $sql = "SELECT id, title, location, start, end, color FROM events WHERE
booking_id = {$_GET['booking_id']}";
    $req = $bdd->prepare($sql);
    $req->execute();

    $events = $req->fetchAll();

?>
```

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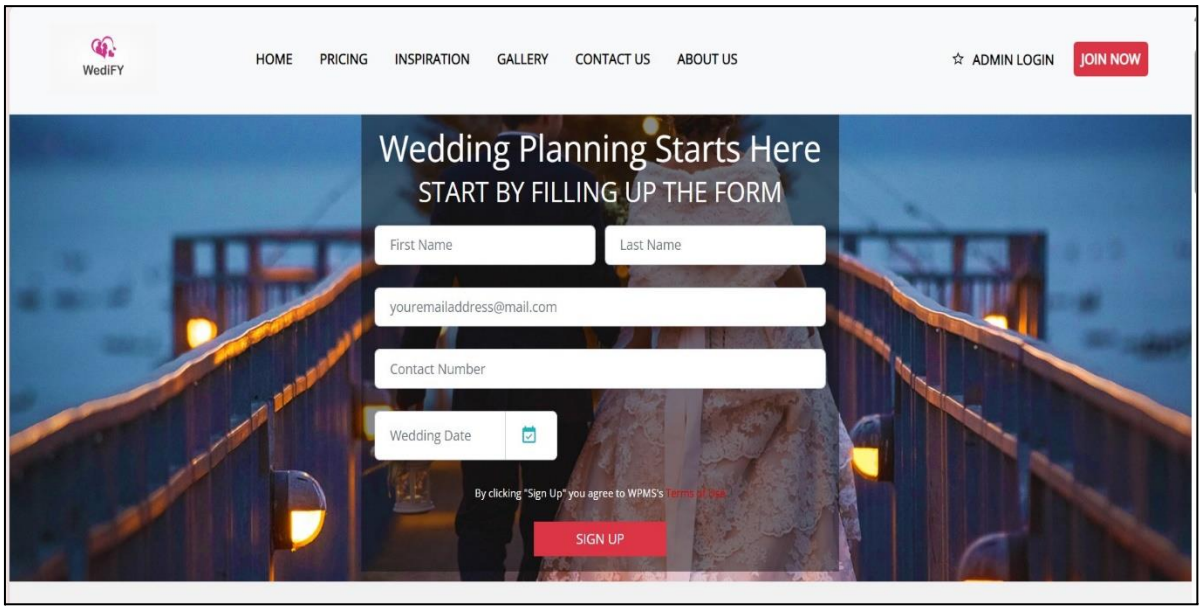
5.1.2 User Side

1)HomePage




```
<?php
   $count = 0;
   $error = '';
   $user_firstname = $user_lastname = $user_password = $user_email = $wedding_date = '';

         if (isset($_POST['register'])) {
        $user_firstname = clean($_POST['user_firstname']);
         $user_lastname = clean($_POST['user_lastname']);
         $user_email = clean($_POST['user_email']);
        $user_phone = clean($_POST['user_phone']);
        $wedding_date = clean($_POST['wedding_date']);
        $checkdate = $booking->check_wedding_date($wedding_date);
                if ($checkdate) {
                redirect_to("index.php");
         $session->message;
        die();
     }
```

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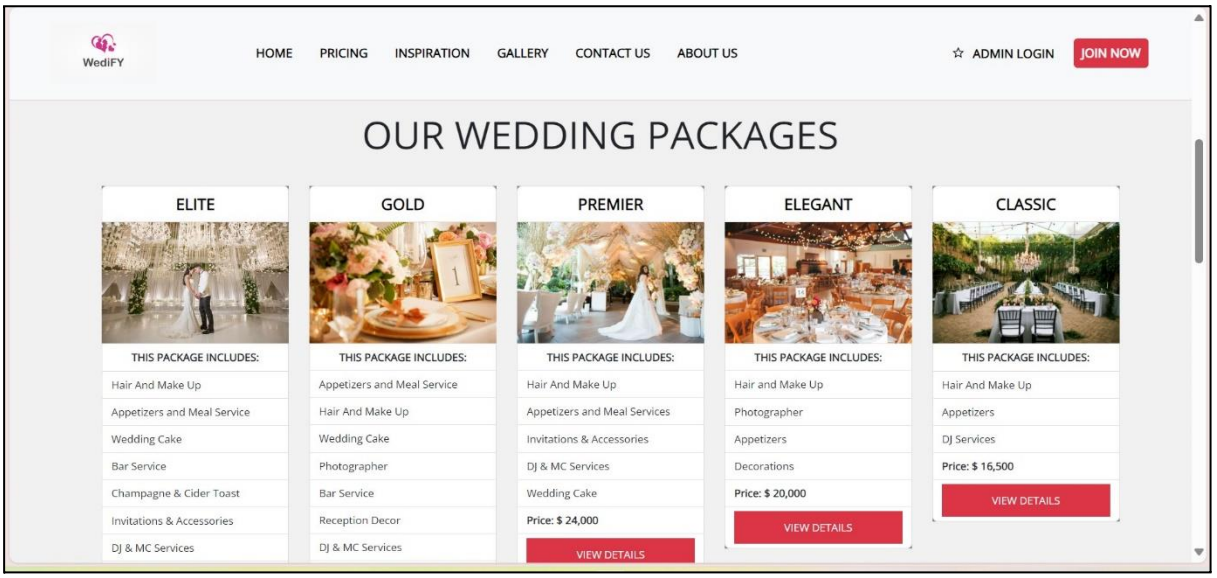
2)Package details:




```
if ($account_details->save()) {
            $account_details->user_id = mysqli_insert_id($db->connection);

            if($account_details->update()) {
               $accounts->user_id = $account_details->user_id;
               $accounts->user_email= $user_email;

                if($accounts->save()) {
                   $booking->user_id = $accounts->user_id;
                   $booking->wedding_type = $bid;
                   $booking->user_email = $user_email;
                   $booking->wedding_date =  $wedding_date;
                   $booking->save();
                   redirect_to("package_detail.php?id=".$bid);
                }
            }
        }
```

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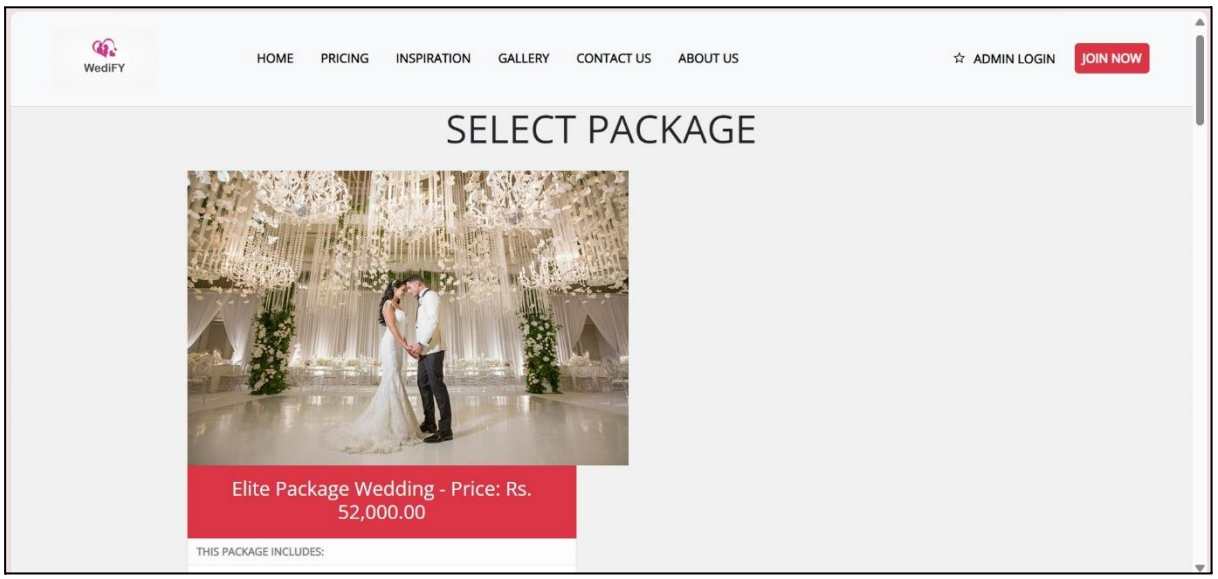
3) Pricing:




```
<?php foreach ($category as $category_row) : ?>
    <div class="row">
            <div class="col-md-12 p-0" style="margin-bottom: 20px;"> <!-- border:1px solid rgba(0,0,0,.125) →
  <div class="float-left">
                        <img src="admin/<?= $category_row->preview_image_picture(); ?>" style="width: 500px;" alt="">
          </div>
     <div class="float-left" style="width: 47%;">
              <ul class="list-group">
                    <li class="list-group-item bg-danger active" style="padding-top: 12px;"><h6 class="h6 text-center"><?= $category_row->wedding_type; ?> Package Wedding - Price: Rs. <?= number_format($category_row->price,2); ?></h6></li>
                        <li class="list-group-item list-group-item-light "><b>THIS PACKAGE INCLUDES:</b></li>
       <?php $feature = Features::find_by_feature_all($category_row->id); ?>
        <?php foreach ($feature as $feature_item) : ?>
                    <li class="list-group-item"><?= $feature_item->title; ?></li>
                <?php endforeach; ?>
              </ul>
```

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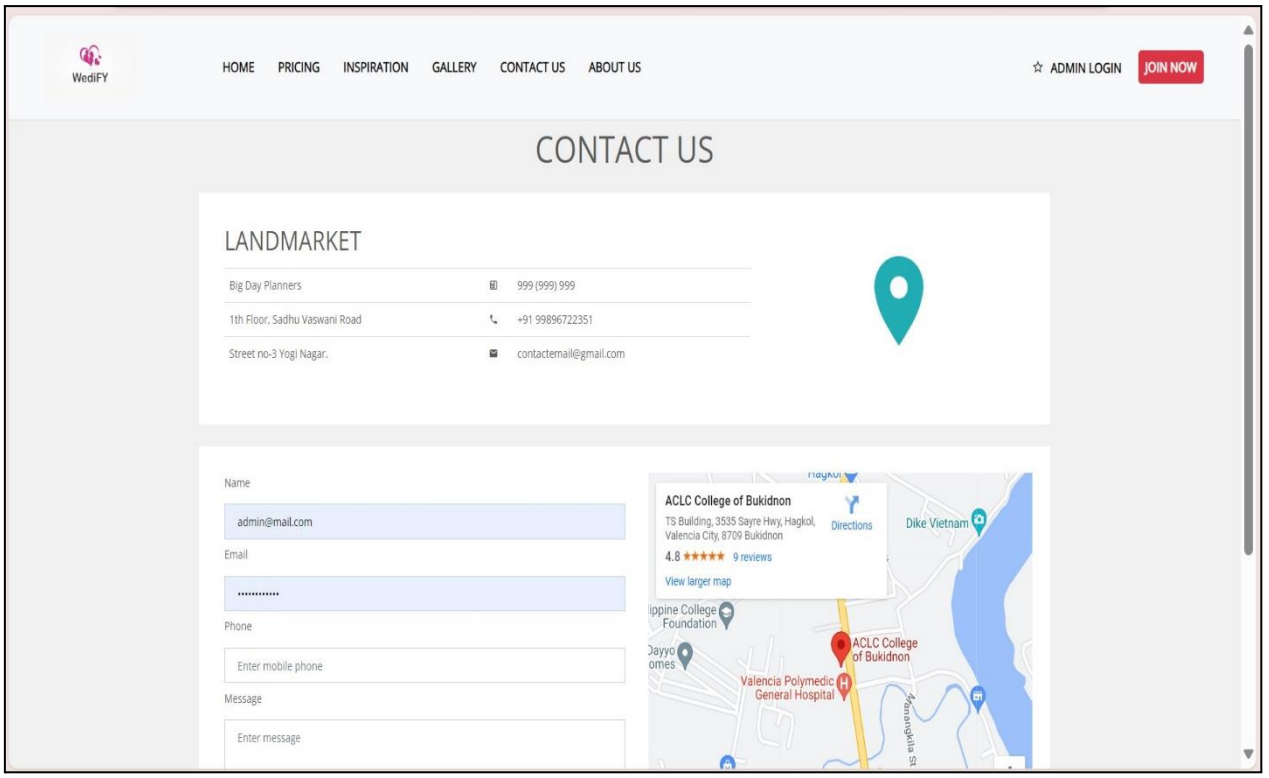
```
 <div class="float-right">
                <a href="package_detail.php?id=<?= $category_row->id; ?>" class="btn btn-sm
btn-success active" style="border-radius: 3px;margin-top: 9px;">Book Now</a>
                <a href="package_detail.php?id=<?= $category_row->id; ?>" class="btn btn-sm
btn-primary active" style="border-radius: 3px;margin-top: 9px;">More Detail</a>
            </div>
            </div>
            </div><!-- end of col-md-8 p-0 pl-3 -->
        </div>
        <?php endforeach; ?>
```

4) Contact Us:



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```
<?php include "include/nav.php"; ?>
<div class="container">
   <div class="row">
      <div class="col-lg-12">
         <h3 class="text-center mb-3">CONTACT US</h3>
         <div class="bg-white p-4">
            <div class="contact-information">
               <h5>LANDMARKET</h5>
               <div class="row">
                  <div class="col-md-8">
                     <table class="table table-sm" style="font-size: 12px;">
                        <tr>
                           <td>Big Day Planners</td>
                           <td><i class="mdi mdi-deskphone mr-3"></i> 999 (999) 999</td>
                        </tr>
                        <tr>
                           <td>1th Floor, Sadhu Vaswani Road</td>
                           <td><i class="mdi mdi-phone mr-3"></i> +91 99896722351</td>
                        </tr>
                        <tr>
                           <td>Street no-3 Yogi Nagar. </td>
                                                <td><i class="mdi mdi-email mr-3"></i>
contactemail@gmail.com</td>
                        </tr>
                     </table>
                  </div>
                  <div class="col-md-4">
                     <div class="text-center mt-3">
                                 <i class="mdi mdi-map-marker" style="font-size: 110px;color:
#22ADB5;"></i>
                     </div>
                  </div>
               </div>
            </div>
         </div>
```

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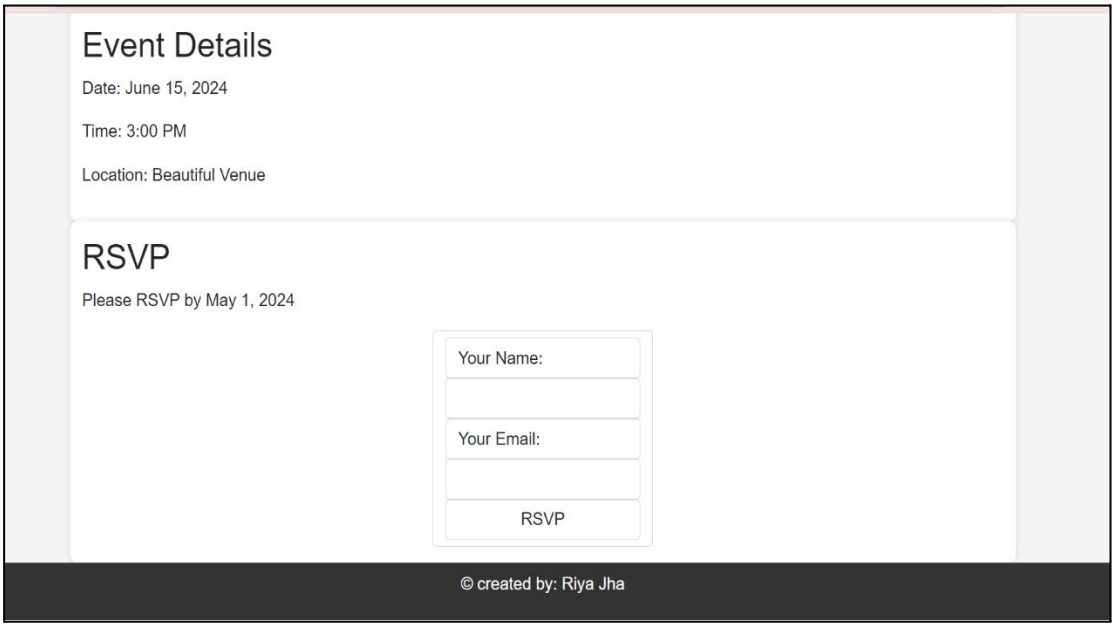
5) About Us:




```
<header>
      <div class="container">
        <h1>wedify</h1>
        <p>Welcome to our special day!</p>
      </div>
   </header
 <section id="event-details" class="container">
      <h2>Event Details</h2>
      <p>Date: June 15, 2024</p>
      <p>Time: 3:00 PM</p>
      <p>Location: Beautiful Venue</p>
   </section>
<section id="rsvp" class="container">
      <h2>RSVP</h2>
      <p>Please RSVP by May 1, 2024</p>
      <form class="form-control" action="rsvp.php" method="post">
        <label class="form-control" for="name">Your Name:</label>
        <input class="form-control" type="text" id="name" name="name" required>
        <label class="form-control" for="email">Your Email:</label>
        <input class="form-control" type="email" id="email" name="email" required>
        <button class="form-control" type="submit">RSVP</button>
      </form>
   </section>
```

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5.2 Testing Approach

What is testing :

Testing is the systematic process of evaluating and verifying a website's functionality, performance, security, and usability to ensure that it meets its intended goals and provides a positive experience for users. Testing is essential for your website for several important

1. Functional Testing:

- Verify individual components, integration, and end-to-end functionality.

2. Usability Testing:

- Evaluate overall user experience and validate acceptance with end-users.

3. Compatibility Testing:

- Check browser and device compatibility for a seamless user experience**.**

4. Performance and Security Testing:

- Assess system performance under load and identify and address potential security risks.

5. Regression and Post-Deployment Monitoring:

-Ensure new updates don't introduce issues and monitor system performancepost-deployment.

6.Document test cases, data, and results.

-Generate and share test summary reports with stakeholders.

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General Test Cases:

Sr. No.	Test Case	Expected Result	Passed / Failed
1	Create a New Wedding Plan	The system should create a new wedding plan successfully.	Passed
2	Create a Wedding Plan with Invalid Date	The system should reject the plan creation and display an error	Failed
3	Edit the details of an existing wedding plan	The system should update the plan details successfully	Passed
4	Attempt to view the details of an existing wedding plan	The system should display the details of the selected plan	Passed
5	Attempt to delete an existing wedding plan	The system should remove the plan and associated details	Passed
6	Search for Available Venues	The system should display a list of available venues matching the criteria	Passed
7	Create a Wedding Plan with Duplicate Date	The system should reject the plan creation, display an error, and prevent the creation of duplicate dates	Failed

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8	Log in with valid credentials	The system should grant access to the user dashboard	Passed
9	Add a new vendor to the system	The system should save vendor details successfully	Passed
10	Edit Vendor Information	The system should update vendor details successfully	Passed
11	Login into the application by giving valid Username and Password. Then logout from the application. Then click on the Back button of the browser	The Login page should be displayed and user should not be allowed to view the previous page	Passed
12	Check the size of buttons in all windows	All the buttons should be of same size	Passed
13	In the site, check if there any link appears, if there is any, right click on that link and select 'Open in a New Window'	The corresponding link should be displayed in new window	Passed
14	Assign deadlines to specific tasks within a wedding plan	The system should enforce deadlines and send reminders	Passed
15	Check the functionalities in all the browsers like different versions of	In all the versions of the browsers the functionalities, fonts and images should be the same.	passed

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	IE, different versions of Netscape etc…		
16	Simulate heavy concurrent usage by multiple users	The system should handle the load without significant performance degradation.	Passed
17	Add expenses to a wedding plan and check if it exceeds the budget limit	The system should notify if the expenses exceed the budget	Passed
18	Add guests to a wedding plan	The system should update the guest list for the wedding	Passed
19	Access and view details of assigned wedding organizers	The system should display accurate details of the assigned organizers	Passed
20	Collaborate with stakeholders (e.g., clients, vendors, organizers) through the system.	The system should facilitate smooth communication and collaboration between stakeholders involved in a wedding plan.	Passed

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Chapter 6: System Security and Measurement

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Role-Based Access Control (RBAC)

In 'Wedify.com-Wedding Planner Management System,' we implement a role-based access control (RBAC) mechanism to ensure secure and controlled access to the system. RBAC allows us to define distinct roles for different categories of users, primarily Admins and Users, each with specific access rights and privileges.

Admin Access:

Upon successful authentication, administrators are granted elevated access to the 'Wedify.com' Wedding Planner Management System.
Administrators wield comprehensive control over system settings, user management, event planning features, vendor interactions, and other administrative functions.
They can modify, add, or delete user accounts, customize event details, manage vendor partnerships, and oversee various aspects of the system's operation.

User Access:

In contrast, users access the system with tailored privileges designed to cater to their specific needs. Users can seamlessly browse and plan events, reserve venues, and select catering services, enhancing their wedding planning experience.Importantly, users do not have access to administrative functions or settings, ensuring the integrity and security of the 'Wedify.com' system.

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Chapter 7: Future scope and Enhancement

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Future Scope for 'Wedify.com' Wedding Planner Management System:

1. Innovative Features:

Explore virtual tools for event visualization and loyalty programs.

2. Mobile Application:

Develop a mobile app for on-the-go planning with push notifications.

3. External Service Integration:

Partner with vendors and integrate social media for a comprehensive planning ecosystem.

4. Accessibility and Localization:

Prioritize accessibility and localize for diverse user bases and traditions.

5. Data Analytics:

Implement advanced analytics for industry insights and predictive analytics.

6. Security Measures:

Proactive security with multi-factor authentication and encryption.

7. Cloud Migration:

Consider migrating to the cloud for improved performance.

8. AI and Chatbots:

Integrate AI-driven chatbots for instant support and recommendations.

9. User Personalization:

Introduce advanced personalization features and machine learning algorithms.

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Chapter 8: Conclusion and Limitations

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8.1. Conclusion:

Summary of Achievements:

The journey of 'Wedify.com' Wedding Planner Management System has been marked by significant accomplishments, turning ambitious concepts into a tangible and advanced solution for seamless wedding planning.

Project Objectives:

The core objectives of the 'Wedify.com' Wedding Planner Management System have been not only met but surpassed, reflecting a commitment to elevating the wedding planning experience, optimizing operations, and embracing cutting-edge technology.

Future Outlook:

Wedify.com' is poised for future growth, designed with scalability and adaptability. Opportunities for expansion include feature enrichment, mobile app development, and integration of AI and data analytics. Regular updates will maintain its leadership in the hospitality industry, meeting evolving user needs.

Gratitude:

We express our gratitude to the individuals who contributed to the success of 'Wedify.com,' our Wedding Planner Management System. We acknowledge our educational institution's support and encouragement, providing the knowledge and skills crucial for this system's development. Your commitment to fostering a culture of learning and innovation has played a vital role in our project. In closing, 'Wedify.com' stands as a testament to innovation and dedication in wedding planning technology. Its journey reflects achievements, lessons learned, and an unwavering commitment to excellence. As we envision the future, we are excited about endless possibilities for improvement and advancement in the dynamic landscape of wedding management and technology.

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8.2 Limitations :

While 'Wedify.com' strives to provide an advanced and user-friendly wedding planning experience, it is important to recognize certain limitations within the system:

1. **Internet Connectivity Dependency:**

Relies on internet for seamless access.Network issues may temporarily limit access.

2. **Hardware and Software Requirements:**

Users need specific hardware and software. Compatibility issues may arise without updates.

3. **Scalability Considerations:**

Designed for scalability, but limits with large events. Additional resources may be needed.

4. **Data Privacy and Compliance:**

Complies with data privacy regulations. Adherence to local laws is crucial.

5. **Security Vulnerabilities:**

Robust security, but not immune. Continuous vigilance needed.

6. **External Service Integration Challenges:**

Enhances capabilities but depends on third-party stability. Disruptions in external services may impact functionality.

7. **Learning Curve for Advanced Features:**

Adoption may pose a learning curve. Adequate training resources are crucial.

8. **Dependency on Mobile Application Compatibility:**

Mobile app effectiveness depends on device compatibility. Users may face limitations without supported devices.

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Chapter 9: Bibliography

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Throughout the project development, key insights and knowledge were gleaned from reputable online sources, shaping and enriching our understanding.

1) GitHub provided valuable insights into coding practices and innovative problem-solving through its open-source projects.

2) Stack Overflow, a vibrant programmer community, played a crucial role in efficiently resolving technical challenges encountered during development.

3) W3Schools. (https://www.w3schools.com)

4) GeeksforGeeks. (https://www.geeksforgeeks.org)

5) Mozilla Developer Network (MDN) Web Docs. (https://developer.mozilla.org)

6) OpenAI GPT-3.5 (Chat GPT). (https://openai.com)

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THANK YOU

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Comparative study on effect of chemical additive in warm mix asphalt

By

Chavda Chetan

220041002

Supervised by

Mr. Asharaf Mathakiya

Civil Engineering Department, Atmiya University

A Thesis Submitted to

Atmiya University in Partial Fulfillment of the Requirements for

The Degree of Master of Technology in [Transportation Engineering]

May 2024

Civil Engineering Department,

Faculty of Engineering & Technology

ATMIYA University

Yogidham Gurukul, Kalawad Road, Rajkot.

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It is certified that the work contained in this dissertation thesis entitled '***Comparative study on effect of chemical additive in warm mix asphalt***' submitted by **CHAVDA CHETAN, 220041002.** Studying at Civil Engineering Department, Faculty of Engineering & Technology, for the award of M.Tech (Civil-Transportation Engineering) is absolutely based on his own work carried out under my supervision and that this thesis has not been submitted elsewhere for any degree/diploma.

Date: 29/5/2024

Place: AU Rajkot

29/5/'24

Signature and Name of internal supervisor

Mr. Ashraf Mathakiya

Signature and Name Head of Department

Dr. H. G. Sonkusare

29/5/24

Dr. D. D. Vyas

Signature and Name of Head of Institute

Atmiya University Rajkot

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It is certified that the work contained in this dissertation thesis entitled '***Comparative study on effect of chemical additive in warm mix asphalt***' submitted by **CHAVDA CHETAN, 220041002,** Studying at Civil Engineering Department, Faculty of Engineering & Technology for partial fulfilment of M.Tech degree to be awarded by ATMIYA University. He has complied the comments of the Dissertation Progress Review-I, Dissertation Part-I as well as Dissertation Progress Review-II with my satisfaction.

Date: 29/5/2024

Place: AU Rajkot

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Chavda Chetan

Signature and Name of Internal supervisor

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Mr. Ashwat Marthakiya

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Date: 29/5/2024

Place: AU Rajkot

Signature and Name of Student Signature

Chavda Chetan

Signature and Name of Internal supervisor

Mr. Ashraf Mathalaiya

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Date: 29/5/2024

Place: AU Rajkot.

External Examiners' Sign and Name:

1) JAY KALARIA

2) _____

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Mr. Chavda Chetan

Enrolment No: 220041002

Dedicated

My Beloved

Parents

To,

Who always supporting me, always standing by my side,

Your unwavering support has given me strength and courage

throughout my life.

No words can ever be strong enough to express my gratitude to

my parents for their unconditional love and support.

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TABLE OF CONTENTS

CERTIFICATE ii

COMPLIANCE CERTIFICATE iii

PAPER PUBLICATION CERTIFICATE..... iv

THESIS APPROVAL CERTIFICATE.....v

UNDERTAKING OF ORIGINALITY OF WORK vi

ACKNOWLEDGEMENT viii

LIST OF FIGURES..... xiii

LIST OF TABLE xiv

ABSTRACT.....xvi

INTRODUCTION.....1

1.1 GENERAL.....1

1.2 FLEXIBLE PAVEMENT.....1

1.3 HOT MIX ASPHALT 3

1.4 WARM MIX ASPHALT.....5

1.4.1 NANOMATERIALS IN WARM MIX ASPHALT (NANO-WMA).....7

1.4.2 PRODUCTION OF NANO-WMA.....8

1.5 NEED OF STUDY.....8

1.6 PROBLEM IDENTIFICATION.....10

1.7 OBJECTIVE OF STUDY.....11

1.8 SCOPE OF STUDY 12

Registrar
Atmiya University
Rajkot

Atmiya University Rajkot

CHAPTER 2 13

LITERATURE REVIEW 13

2.1 GENERAL 13

2.2 RESEARCH STUDIES 13

2.2.1 SUMMARY OF RESEARCH PAPER 30

2.3 GUIDELINE 30

2.3.1 GUIDELINE OF POLYMER MODIFIED BITUMEN (PMB) AS PER MORTH SPECIFICATION 30

2.3.2 GUIDELINE FOR WARM MIX ASPHALT (WMA) AS PER MORTH SPECIFICATION 32

CHAPTER 3 34

MATERIALS AND METHODOLOGY 34

3.1 MATERIAL COLLECTION 34

3.1.1 AGGREGATE 34

3.1.2 BITUMEN 36

3.1.3 ZYCOTHERM 38

3.1.4 WETBOND 40

3.2 METHODOLOGY 42

CHAPTER 4 43

EXPERIMENTAL WORK 43

4.1 MODIFIED BITUMEN 43

4.2 PHYSICAL PROPERTIES OF POLYMER MODIFIED BITUMEN GRADE 40 43

4.2.1 PHYSICAL PROPERTIES OF PMB-40 WITH ZYCOTHERM 45

4.2.2 PHYSICAL PROPERTIES OF PMB-40 WITH WETBOND 46

4.3 PHYSICAL PROPERTIES OF AGGREGATE 47

4.4 GRADATION FOR BITUMINOUS MIX DESIGN (BC GRADE-II) 49

4.5 SAMPLE PREPARATION 51

4.5.1 MOULD CASTING 51

4.5.2 DETERMINATION OF OPTIMUM BITUMEN CONTENT 52

4.5.3 VOLUMETRIC PROPERTIES OF MARSHALL MIX DESIGN 53

4.5.4 OBC VOLUMETRIC PROPERTIES OF MARSHALL MIX DESIGN 55

4.6 PREPARATION OF BITUMEN MIX WITH ZYCOTHERM.....55

4.7 PREPARATION OF BITUMEN MIX WITH WETBOND 56

CHAPTER 5 57

RESULT AND ANALYSIS 57

5.1 VOLUMETRIC PROPERTIES OF MARSHALL MIX WITH VARIOUS DOSES OF ZYCOTHERM AT VARIOUS TEMPERATURE 57

5.1.1 MARSHALL STABILITY AND FLOW VALUE TEST 57

5.1.2 MARSHALL VOLUMETRIC PARAMETERS 61

5.2 VOLUMETRIC PROPERTIES OF MARSHALL MIX WITH VARIOUS DOSES OF WETBOND AT VARIOUS TEMPERATURE 68

5.2.1 MARSHALL STABILITY AND FLOW VALUE TEST 68

5.2.2MARSHALL VOLUMETRIC PARAMETERS 72

5.3 COMPARISON OF VOLUMETRIC PROPERTIES OF MARSHALL MIX WITH VARIOUS DOSES OF ZYCOTHERM AND WETBOND AT VARIOUS TEMPERATURES 78

5.3 CONCLUSION 85

5.3.1 ZYCOTHERM CHEMICAL ADDITIVE 85

5.3.2 WETBOND CHEMICAL ADDITIVE 86

CHAPTER 6 87

ECONOMIC ANALYSIS 87

6.1 ECONOMIC ANALYSIS OF HOT MIX ASPHALT AND WARM MIX ASPHALT 87

6.2 ECONOMIC ANALYSIS OF HOT MIX ASPHALT AND WARM MIX ASPHALT USING ZYCOTHERM AND WETBOND CHEMICAL ADDITIVE....88

6.3 COST ANALYSIS FOR ONE TON ASPHALT MIX 88

CHAPTER 7 90

REFERENCE.....90

ANNEXTURE – A.....93

RESEARCH PAPER CERTIFICATE 93

ANNEXTURE – B.....94

REVIEW CARD.....94

ANNEXTURE – C.....100

PRICE LIST OF POLYMER MODIFIED BITUMEN 100

ANNEXTURE – D.....101

PLAGIARISM REPORT 101

LIST OF FIGURES

SR. NO.	FIGURE NAME	PAGE NO.
1.1	Flexible Pavement	3
1.2	HMA & WMA	7
3.1	Aggregate	34
3.2	Bitumen	36
3.3	Zycotherm	38
3.4	Wetbond	40
4.1	Bituminous Mix Design	51
4.2	Determination of Optimum Bitumen Content	52
5.1	Temperature Vs Air Voids	58
5.2	Temperature Vs VMA	60
5.3	Temperature Vs VFB	61
5.4	Temperature Vs Marshall Stability	62
5.5	Temperature Vs Marshall Flow	63
5.6	Temperature Vs Marshall Quotient	65
5.7	Temperature Vs Gmb	66
5.8	Temperature Vs Air Voids	69
5.9	Temperature Vs VMA	70
5.10	Temperature Vs VFB	71
5.11	Temperature Vs Marshall Stability	73
5.12	Temperature Vs Marshall Flow	74
5.13	Temperature Vs Marshall Quotient	75
5.14	Temperature Vs Gmb	76
5.15	Volumetric Properties of Marshall mix Comparison	83

LIST OF TABLE

SR. NO.	TABLE NAME	PAGE NO.
4.1	Physical Properties of Polymer Modified Bitumen (PMB-40)	44
4.2	Physical Properties of Polymer Modified Bitumen (PMB-40) with Zycotherm additive	45
4.3	Physical Properties of Polymer Modified Bitumen (PMB-40) with Wetbond additive	46
4.4	Physical Properties of Aggregate	49
4.5	Gradation for bituminous mix design grade-II	50
4.6	Volumetric Properties of Marshall Mix Design	53
4.7	Volumetric Properties of Marshall Mix Design	54
4.8	Volumetric Properties of Marshall Mix Design at OBC	55
5.1	Temperature Vs Marshall Stability	58
5.2	Temperature Vs Marshall Flow	59
5.3	Temperature Vs Marshall Quotient	60
5.4	Temperature Vs Gmb	62
5.5	Temperature Vs Air Voids	63
5.6	Temperature Vs VMA	64
5.7	Temperature Vs VFB	65
5.8	Temperature Vs Marshall Volumetric Parameters	66
5.9	Temperature Vs Marshall Stability	68
5.10	Temperature Vs Marshall Flow	70
5.11	Temperature Vs Marshall Quotient	71
5.12	Temperature Vs Gmb	72
5.12	Temperature Vs Air Voids	73
5.14	Temperature Vs VMA	74
5.15	Temperature Vs VFB	75

5.16	Temperature Vs Marshall Volumetric Parameters	77
5.17	Comparison of Volumetric Properties of Marshall Mix	78
6.1	Cost Comparison of HMA & WMA	88

COMPARATIVE STUDY ON EFFECT OF CHEMICAL ADDITIVE IN WARM MIX ASPHALT

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ABSTRACT

Warm mix asphalt (WMA) is gaining popularity because it uses lower temperatures during production and paving. This means less fuel used, less harmful fumes and potentially a longer laying period. WMA offers similar performance to traditional asphalt while being more environmentally and worker friendly. Generally in WMA technology is used as a filler materials is traditional bitumen but in this experimental work use polymer modified bitumen grade-40 that is improve mechanical properties in several ways, PMB is more resistance to cracking, rutting and fatigue than traditional bitumen.

The purpose of this research work is to investigate effect of warm mix additive in asphalt mixture, using warm mix additive chemical in percentage by total weight of bitumen in asphalt mixture. Using zycotherm 0.05%, 0.1%, 0.15% and wetbond 0.2%, 0.4%, 0.6% at various temperatures ranges like 165℃, 135℃, 125℃ and 115℃, it used to reduces mixing temperature of bituminous mix that is helps in reduce environment pollution and sustainable development also that is improve performance of Marshall Stability, Flow Value, Quotient and Marshall volumetric parameters.

The outcomes shows that addition of zycotherm chemical dose 0.1% at 135℃ temperature and addition of wetbond chemical dose 0.4% at 125℃ temperature that is improve their performance and getting best results in Marshall volumetric parameters.

Key words: Hot Mix Asphalt, Warm Mix Asphalt, Polymer Modified Bitumen, Marshall Stability, Marshall Quotient.

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Transportation engineering pavement, a cornerstone of civil engineering, represents the convergence of science, technology, and innovation to create durable, safe, and efficient surfaces for vehicular movement. As the arteries of modern civilization, roadways serve as conduits for economic activity, social interaction, and cultural exchange. Within this intricate network, the pavement forms the very foundation upon which the smooth flow of traffic relies.

This report delves into the intricate world of transportation engineering pavement, exploring its diverse facets, from design and construction to maintenance and rehabilitation. By delving into the principles, materials, and methodologies that underpin pavement engineering, we aim to provide a comprehensive understanding of how these elements converge to create resilient and sustainable transportation infrastructure.

Throughout history, pavement engineering has evolved in response to changing societal needs, technological advancements, and environmental considerations. From ancient Roman roads to modern asphalt and concrete highways, the quest for smoother, safer, and more durable surfaces has driven innovation and progress in the field.

1.2 FLEXIBLE PAVEMENT

Flexible pavement is a type of road construction that consists of multiple layers of materials designed to distribute traffic loads and provide a smooth driving surface. Unlike rigid pavements, which are made of thick concrete slabs, flexible pavements are composed of several layers that work together to accommodate varying traffic volumes, environmental conditions, and sub-grade characteristics.

Here is a detailed explanation of the components and characteristics of flexible pavement:

Sub-grade: The lowest layer of the pavement system is the sub-grade, which is the natural soil or compacted fill material that serves as the foundation for the pavement. The sub-grade provides support for the entire pavement structure and must have adequate strength and stability to withstand traffic loads without excessive deformation.

Sub-base: Above the sub-grade is the sub-base layer, which consists of granular materials such as crushed stone, gravel, or sand. The sub-base layer helps to distribute the load from the pavement surface and provides additional support to the overlying layers. It also helps to improve drainage and prevent the infiltration of water into the sub-grade.

Base Course: The base course is the layer directly above the sub-base and serves as a transition between the sub-base and the surface layer. It is typically composed of high-quality aggregate materials, such as crushed stone or gravel, bound together with bituminous materials or cement. The base course contributes to the structural strength of the pavement and helps to distribute traffic loads evenly.

Surface Course: The top layer of the flexible pavement is the surface course, which is designed to provide a smooth and durable driving surface. The surface course is usually made of asphalt concrete (AC) or bituminous materials, which are flexible and resistant to cracking. Asphalt concrete consists of aggregate (such as crushed stone or sand) bound together with asphalt binder. The surface course protects the underlying layers from moisture and traffic abrasion while providing skid resistance and ride comfort for vehicles.

Pavement Structure: The combination of the sub-grade, sub-base, base course, and surface course forms the pavement structure, which is designed to distribute traffic loads and provide sufficient strength and durability to withstand the anticipated traffic volume and environmental conditions. The thickness and composition of each layer are determined based on factors such as traffic volume, soil properties, climate, and pavement design standards.

Construction and Maintenance: Flexible pavements are constructed using a series of construction processes, including grading and compacting the sub-grade, placing and compacting the sub-base and base courses, and applying the surface course. Regular maintenance is essential to ensure the long-term performance of flexible pavements and

may include routine inspections, crack sealing, patching, and resurfacing to address signs of distress and deterioration.

Fig-1.1 Flexible Pavement

In summary, flexible pavements are versatile and cost-effective road construction solutions that utilize multiple layers of materials to provide a durable and smooth driving surface. They are commonly used in highways, urban roads, and residential streets and require regular maintenance to ensure optimal performance and longevity.

1.3 HOT MIX ASPHALT

Hot mix asphalt (HMA) is a versatile and widely used paving material in road construction that consists of aggregate (such as crushed stone, gravel, or sand) and asphalt binder. It is produced at high temperatures and mixed at asphalt plants before being transported to the construction site for placement and compaction. Here's a detailed explanation of hot mix asphalt:

Aggregate: The aggregate component of HMA forms the bulk of the pavement structure and provides strength, stability, and durability. The aggregate is sourced from natural deposits or quarries and is carefully selected and graded to meet specific size and quality requirements. The aggregate particles are coated with asphalt binder during the mixing process to create a cohesive mixture.

Asphalt Binder: Asphalt binder, also known as asphalt cement, is a sticky, black, bituminous material derived from crude oil refining. It serves as the binding agent that

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holds the aggregate particles together and provides cohesion and flexibility to the pavement mixture. Asphalt binder is typically heated to high temperatures (around 300-350°F or 150-175°C) to achieve proper viscosity and workability during mixing and placement.

Mixing Process: The production of HMA involves heating the aggregate and asphalt binder separately to the specified temperatures before combining them in a mixing chamber at the asphalt plant. The hot aggregate is transferred to the mixing drum, where it is blended with the heated asphalt binder to form a uniform mixture. The mixing process ensures thorough coating of the aggregate particles with asphalt binder, resulting in a cohesive and workable asphalt mix.

Transportation and Placement: Once the HMA mixture is produced, it is loaded into trucks and transported to the construction site while still hot to maintain workability and prevent premature cooling. At the site, the HMA is deposited onto the prepared sub-grade or existing pavement surface using paving equipment such as asphalt pavers. The mixture is spread and compacted to achieve the desired density and surface smoothness.

Compaction: Compaction is a critical step in the construction of HMA pavements, as it helps to achieve the required density and stability of the pavement structure. Compaction equipment, such as vibratory rollers or pneumatic rollers, is used to compact the hot asphalt mixture while it is still pliable and workable. Proper compaction ensures uniform density and minimizes the risk of future pavement distresses such as rutting, cracking, and moisture damage.

Cooling and Traffic Opening: After compaction, the HMA pavement cools and hardens over time, gradually gaining strength and durability. Depending on the ambient temperature and weather conditions, the pavement may be opened to traffic shortly after construction or may require a period of curing before opening to full traffic loads.

In summary, hot mix asphalt is a versatile and durable paving material that combines aggregate and asphalt binder at high temperatures to produce a cohesive mixture suitable for road construction. Its excellent performance characteristics, including strength, flexibility, and resistance to fatigue and rutting, make it a preferred choice for a wide range of pavement applications, from highways and urban roads to parking lots

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and driveways. Proper design, production, placement, and compaction are essential to ensure the long-term success and performance of HMA pavements.

1.4 WARM MIX ASPHALT

Warm mix asphalt (WMA) is an innovative and environmentally friendly alternative to traditional hot mix asphalt (HMA) in road construction and pavement applications. It is designed to provide a more sustainable and cost-effective solution while maintaining the high-quality performance and durability expected from asphalt pavements.

WMA is produced and placed at lower temperatures compared to HMA, typically at temperatures between 30°C (86°F) and 140°C (284°F), whereas HMA is typically manufactured and placed at much higher temperatures, often exceeding 150°C (302°F). This reduction in production and application temperatures has several significant advantages, which include:

Environmental Benefits: WMA reduces greenhouse gas emissions and energy consumption because it requires less energy to heat the asphalt mix. Lower production temperatures also lead to reduced emissions of volatile organic compounds (VOCs), making it a more environmentally friendly choice.

Energy Savings: The lower production temperatures not only reduce energy consumption but also extend the lifespan of asphalt plants by reducing wear and tear on equipment. This can result in cost savings for the asphalt industry.

Improved Worker Safety: Reduced exposure to extremely high temperatures during production and placement of WMA enhances worker safety and comfort.

Extended Construction Season: WMA can be produced and placed at lower temperatures, which means that road construction can often occur in cooler weather, extending the construction season.

Better Compaction: WMA often has improved workability and compaction characteristics, resulting in a more uniform and durable pavement structure.

Enhanced Mix Design: The lower temperatures can allow for the use of alternative materials and modified asphalt binders, leading to improved pavement performance.

There are various methods to produce warm mix asphalt, such as foaming techniques, chemical additives, and wax-based additives, each designed to achieve the desired temperature reduction. The specific WMA technology used may vary based on project requirements and local conditions.

Foaming Techniques: Foaming techniques involve introducing air into the asphalt binder to create a foam-like consistency, which reduces viscosity and enables lower mixing and compaction temperatures.

Chemical Additives: Chemical additives modify the properties of the asphalt binder to achieve lower production temperatures.

Wax-based Additives: Wax-based additives contain waxes or fatty acids that lower the viscosity of the asphalt binder at lower temperatures. These additives work by coating the aggregate particles, reducing the surface tension between the binder and aggregate. This improves workability and facilitates proper coating of the aggregate with the binder, even at reduced temperatures. Wax-based additives can enhance the flexibility and moisture resistance of the asphalt mixture, leading to improved pavement performance.

Each of these warm mix additive types offers unique advantages and can be tailored to specific project requirements, climate conditions, and performance criteria. Their application can contribute to more sustainable and cost-effective asphalt pavement construction practices.

In summary, warm mix asphalt is a significant advancement in the field of road construction and pavement engineering. It offers a more sustainable, cost-effective, and environmentally friendly alternative to traditional hot mix asphalt, making it a valuable option for both public and private infrastructure projects.

Warm mix asphalt (WMA) technology has already proven to be an eco-friendly and cost-effective alternative to traditional hot mix asphalt (HMA). However, advancements in materials science have led to the incorporation of nanomaterials into WMA, creating a cutting-edge solution that further enhances the performance and sustainability of asphalt pavements. Here's an introduction to Warm Mix Asphalt using nanomaterials:

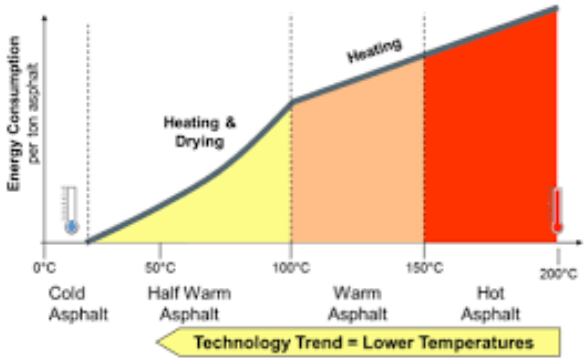

Fig-1.2 HMA & WMA

1.4.1 NANOMATERIALS IN WARM MIX ASPHALT (NANO-WMA)

Nanomaterials, which are materials with structures or properties at the nanoscale (typically at the scale of 1-100 nanometers), have opened up new possibilities in various fields, including construction and infrastructure. Nano-WMA is an innovative approach that integrates these tiny materials into the production and performance of warm mix asphalt. It offers several advantages over traditional WMA and HMA:

Improved Strength and Durability: Nanomaterials, such as nanoclays, nanosilica, and carbon nanotubes, can enhance the mechanical properties of asphalt mixes. They improve the strength and fatigue resistance of pavements, leading to longer-lasting road surfaces that require less frequent maintenance.

Reduced Rutting and Cracking: Nano-WMA can mitigate common pavement distresses like rutting and cracking, making it a more reliable and robust solution for roads subjected to heavy traffic and varying weather conditions.

Enhanced Thermal Stability: The addition of nanomaterials can improve the thermal stability of asphalt mixes, allowing them to withstand a broader range of temperatures without significant deformation or damage.

Reduced Aging and Oxidation: Nano-WMA is less prone to aging and oxidation, which can help maintain the asphalt's flexibility and extend its service life.

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Lower Production Temperatures: The use of nanomaterials can further reduce the production and placement temperatures of WMA. This contributes to energy savings, reduced emissions, and a more sustainable construction process.

Enhanced Workability and Compaction: Nano-WMA often exhibits improved workability, making it easier to handle during construction. This leads to better compaction and a more uniform pavement structure.

Eco-Friendly Solution: By lowering energy consumption and emissions during production, Nano-WMA contributes to a greener and more environmentally responsible approach to road construction.

1.4.2 PRODUCTION OF NANO-WMA

The production of Nano-WMA typically involves the dispersion of nanomaterials into the asphalt binder or the asphalt mixture. The specific nanomaterial used and the method of dispersion can vary based on the desired properties and project requirements. Common nanomaterials used in Nano-WMA include nanoparticles of various minerals, polymers, and carbon-based materials.

In conclusion, the integration of nanomaterials into warm mix asphalt (Nano-WMA) is a groundbreaking development in the field of road construction. It leverages nanotechnology to improve the performance, durability, and sustainability of asphalt pavements while maintaining the benefits of lower production temperatures associated with traditional WMA. This cutting-edge technology holds great promise for the future of infrastructure development and transportation networks.

1.5 NEED OF STUDY

The study of warm mix asphalt (WMA) is important for several reasons, encompassing technical, environmental, economic, and sustainability considerations. Here are some key reasons why need of studying warm mix asphalt:

Energy Efficiency: WMA technology allows for the production and placement of asphalt mixtures at lower temperatures compared to traditional hot mix asphalt (HMA). Understanding the energy savings associated with WMA is crucial for promoting more sustainable and energy-efficient practices in the construction industry.

Environmental Impact: Lower production temperatures for WMA lead to reduced emissions of greenhouse gases and other pollutants. Studying WMA helps assess its environmental benefits, supporting efforts to minimize the carbon footprint and environmental impact of asphalt production and construction activities.

Regulatory Compliance: As environmental regulations become more stringent, studying WMA helps industry professionals and researchers stay abreast of compliance requirements. It provides insights into how WMA can align with or contribute to regulatory goals related to air quality and sustainability.

Pavement Performance: Research on the performance characteristics of warm mix asphalt is essential for understanding how these mixtures behave under various conditions. This includes considerations such as durability, resistance to rutting and cracking, and overall long-term performance. Such studies inform the development of specifications and guidelines for using WMA in different applications.

Materials Engineering: The study of warm mix asphalt involves investigating the properties of the materials used in the mixtures, including the asphalt binder and additives. This research contributes to advancements in materials engineering, helping optimize the composition of WMA for improved performance and longevity.

Construction Practices: Understanding the construction and compaction aspects of warm mix asphalt is crucial for ensuring proper installation and achieving the desired pavement characteristics. Research in this area helps identify best practices and addresses any challenges associated with the use of WMA in the field.

Economic Considerations: Evaluating the economic feasibility of warm mix asphalt is important for decision-makers in the construction industry. While the initial costs of WMA technology may differ from traditional methods, studies help assess the overall economic benefits, considering factors such as energy savings, extended paving seasons, and long-term pavement performance.

Innovation and Technology Development: Ongoing research in warm mix asphalt contributes to innovation in asphalt technology. New additives, mix designs, and construction techniques may emerge through these studies, leading to continuous improvement in the industry.

In summary, the study of warm mix asphalt is essential for advancing sustainable and efficient practices in asphalt construction, meeting environmental regulations, optimizing materials and construction processes, and ensuring the long-term performance of asphalt pavements.

1.6 PROBLEM IDENTIFICATION

While warm mix asphalt (WMA) has shown various benefits, ongoing research in this field continues to address several challenges and areas of improvement. Here are some problem areas and challenges associated with current studies on warm mix asphalt:

Performance under Various Conditions: Understanding how WMA performs under different climatic conditions, traffic loads, and soil types is an ongoing challenge. Research needs to assess the long-term performance of WMA in diverse environments to ensure its suitability in various regions.

Binder aging and Durability: Despite the lower production temperatures of WMA, the aging of asphalt binders remains a concern. Researchers are investigating ways to enhance the durability of WMA and mitigate potential issues related to aging, such as cracking and rutting.

Standardization and Specifications: The standardization of warm mix asphalt materials and construction procedures is still evolving. Developing uniform specifications and standards for WMA is crucial for widespread adoption and ensuring consistency in performance across different projects.

Moisture Sensitivity: The susceptibility of WMA to moisture-related damage is an area of concern. Studying how WMA interacts with water and developing strategies to improve its resistance to moisture-induced distress is an ongoing research focus.

Mix Design Optimization: Achieving an optimal mix design for WMA that balances performance, workability, and durability remains a challenge. Researchers are exploring different combinations of additives, aggregates, and asphalt binders to enhance the overall performance of WMA mixtures.

Construction and Compaction Practices: Proper construction and compaction practices are crucial for the performance of any asphalt mixture, including WMA.

Research aims to identify the most effective construction techniques and compaction temperatures to ensure the successful implementation of WMA in the field.

Compatibility with Recycled Materials: Understanding how WMA interacts with recycled asphalt materials is important for sustainable pavement construction. Research is ongoing to assess the compatibility of WMA with high percentages of recycled asphalt pavement (RAP) and other recycled materials.

Life Cycle Assessment (LCA): While WMA is generally considered more environmentally friendly, comprehensive life cycle assessments are needed to quantify its environmental benefits accurately. This includes considering the entire life cycle of the pavement, from material extraction to construction, maintenance, and end-of-life recycling.

Economics and Cost-Effectiveness: Evaluating the economic aspects of WMA, including the initial costs, energy savings, and long-term maintenance requirements, is critical for decision-makers. Research aims to provide a comprehensive understanding of the cost-effectiveness of WMA compared to traditional hot mix asphalt.

Public Perception and Acceptance: The successful implementation of any new technology, including WMA, depends on public perception and acceptance. Research may focus on understanding stakeholder attitudes, addressing misconceptions, and promoting the benefits of WMA to encourage its widespread use.

Continued research in these areas will contribute to the ongoing improvement and adoption of warm mix asphalt in the construction industry. Addressing these challenges will help ensure that WMA remains a sustainable and effective alternative to traditional hot mix asphalt.

1.7 OBJECTIVE OF STUDY

- To determine physical properties of polymer modified bitumen (PMB) with zycotherm & wetbond.
- To determine marshal stability and flow value of polymer modified bitumen mixed without zycotherm as additive at various temperature.

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- To determine marshal stability and flow value of polymer modified bitumen with and without wetbond as additive at various temperature.

- To comparative analysis of economic evaluation and performance of polymer modified bituminous mix using zycotherm and wetbond.

1.8 SCOPE OF STUDY

Warm mix additives are materials or chemicals that can be added to bitumen (asphalt) to lower the production and placement temperatures of asphalt mixtures compared to traditional hot mix asphalt. This technology offers several benefits, including environmental advantages, energy savings, and improved working conditions, but there are some limitations to consider.

In this work following experiments have been covered only.

- To determine physical properties of aggregate.

- To determine physical properties of polymer modified bitumen (PMB) with 0.05%, 0.10%, 0.15% dose of zycotherm and 0.2%, 0.4%, 0.6% dose of wetbond.

- To design of bitumen concrete grade-II for bitumen mix and find optimum binder content (OBC).

- To determine marshal stability and flow value of bitumen mix at temperature of 165℃, 135℃, 125℃ and 115℃ having various dose of zycotherm 0.05%, 0.10%, 0.15%.

- To determine marshal stability and flow value of bitumen mix at temperature of 165℃, 135℃, 125℃ and 115℃ having various dose of wetbond 0.2%, 0.4%, 0.6%.

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CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

A literature review is a critical and comprehensive summary of existing knowledge on a particular topic. It serves several important purposes in academic and research contexts.

2.2 RESEARCH STUDIES

Hawraa J. Aljbouri, Amjad H. Albayati, "Effect of nanomaterials on the durability of hot mix asphalt" ***science direct*** **2023.**

This paper investigated the effect of adding nanomaterials as a modifier to the bitumen on the Marshall properties, resilient modulus as well as the durability of the asphalt concrete mixture. The nanomaterials used were nano silica (NS), nano carbonate calcium (NCC), nano clay (NC), and nano platelet hydroxyapatite (NP).

The results showed that the nanomaterials improved the Marshall stability, resilient modulus, and durability of the asphalt concrete mixture compared to the control mix (CM). The highest improvement rate belonged to NS, followed by NC, NP, and NCC.

The nanomaterials also improved the resistance to permanent deformation of the asphalt concrete mixture. The highest improvement belonged to NC, followed by NS, NP, and NCC.

The use of nanomaterials in the construction of asphalt concrete wearing course extended the service life of pavement structure. The modification of asphalt concrete by one of the nanomaterials; NS, NC, NP and NCC resulted in improvement in design life by 56.6, 35.7, 20 and 8.3% as compared to CM, respectively.

Overall, the results of this study suggest that nanomaterials can be used as effective modifiers to improve the performance of asphalt concrete.

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Diyar Khan, Rawid Khan, Muhammad Tariq Khan, Muhammad Alam, Tanveer Hassan, "Performance of hot-mix asphalt using polymer-modified bitumen and marble dust as a filler" ***science direct*** **2023.**

The paper evaluated the use of marble dust (MD) as a mineral filler substitute in hot mixed asphalt (HMA). The Marshall mix design was used to determine the optimum bitumen content (OBC) for all of the mixtures. The performance of HMA prepared in the laboratory using different types of minerals (all passing No. 200 sieves), namely SD and MD, was investigated.

The results showed that the addition of MD improved the Marshall stability and rutting resistance of HMA. The highest improvement was observed at 4% MD content. The dynamic modulus of HMA also increased with the addition of MD, indicating that MD-modified HMA is more fatigue resistant.

The authors concluded that MD can be used as a partial filler replacement in HMA to improve its performance properties. However, more research is needed on the influence of MD as a filler substitute in asphalt concrete with a proportion of more than 6% and various bitumen grades.

Shahab HasaniNasaba, Mohsen Arastb , Mohsen Zahedi, "Investigating the healing capability of asphalt modified with nano-zycotherm and Forta fibers" ***science direct*** **2019.**

This study investigated the healing ability of asphalt modified with Forta fibers and Nano-zycotherm, and non-additive asphalt. Four types of asphalt mixes were prepared: asphalt without additives, asphalt with nano-zycotherm, asphalt with Forta fibers, and asphalt with both nano-zycotherm and Forta fibers. The healing ability of the asphalt mixes was evaluated using a three-point bending test.

The results showed that the asphalt modified with both nano-zycotherm and Forta fibers concurrently exhibited the highest initial resistance, while ordinary asphalt without additives had the least resistance. However, the asphalt with no additive seemed to have greater healing capability. According to Table for the second bending resistance, the asphalt made with two additives (Forta fibers and nano-zycotherm) presented the highest secondary resistance of 114 kg.

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The authors concluded that the asphalt modified with both nano-zycotherm and Forta fibers has the potential to improve both the initial resistance and healing capability of asphalt. However, more research is needed to optimize the dosage of additives and to investigate the long-term performance of modified asphalt.

Ankit Sharma, Praveen Kumar, Ashish Walia, "Use of Recycled Material in WMA- Future of Greener Road Construction" ***science direct*** **2019.**

The paper discusses the use of warm mix asphalt (WMA) technology, including its classification, mix design guidelines, and the use of reclaimed asphalt pavement (RAP) and reclaimed asphalt shingles (RAS) in WMA.

The authors also discuss the role of rejuvenators in WMA, and the environmental and economic benefits of using RAP and RAS in WMA.

Some of the key points from the paper include:

RAP and RAS can be used in WMA to reduce the need for virgin materials and energy, and to improve the performance of the asphalt mix.

Rejuvenators can be used to improve the workability and durability of RAP- and RAS-containing WMA mixes.

The optimum percentage of RAP and RAS to use in WMA depends on a number of factors, including the type and quality of the RAP and RAS, the type of WMA additive used, and the desired performance of the mix.

WMA technology has the potential to enable the 100% recycling of RAP.

Overall, the paper provides a comprehensive overview of the use of RAP and RAS in WMA, and highlights the potential benefits of this technology.

Teng Wang, Wei Jiang, Jingjing Xiao, Dedong Guo, Dongdong Yuan, Wangjie Wu, Wentong Wang. "Study on the blending behavior of asphalt binder in mixing process of hot recycling" ***science direct*** **2022.**

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WMA technology has the potential to enable the 100% recycling of RAP.

Overall, the paper provides a comprehensive overview of the use of RAP and RAS in WMA, and highlights the potential benefits of this technology.

Ali Mansourkhaki, Amir Aghasi. "Performance of rubberized asphalt containing liquid nanomaterial anti-strip agent" ***science direct*** **2019.**

The study investigated the effect of a liquid nano material anti stripping agent, namely Zycotherm, on the performance of rubberized asphalt binders and mixtures. Zycotherm at the dosage range used in this study (0.08-0.12%) did not have a significant effect on the rheological properties at high, intermediate, and low temperature properties of rubberized binder.

Zycotherm significantly improved the moisture damage resistance of the mixtures. It can be used as a WMA additive for rubberized asphalt. However, it was not found to be an effective anti-stripping agent. In general, Zycotherm did not have a considerable effect on the performance properties of asphalt mixtures.

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Erisa Mirzaaghaeian, Amir Modarres "Rheological properties of bituminous mastics containing chemical warm additive at medium temperatures and its relationship to warm mix asphalt fatigue behavior" ***science direct*** **2019.**

This research paper investigates the long-term performance of bituminous mastic and asphalt mix containing Zycotherm, a chemical warm additive, in terms of fatigue behavior.

The main findings of the study are as follows:

Zycotherm up to 0.14% by weight of bitumen does not have a detrimental effect on mastic fatigue resistance.

The shear modulus of Zycotherm containing bitumen is higher than the base bitumen after both RTFO and PAV aging. However, for mastics the addition of Zycotherm results in lower shear modulus than the base bitumen.

The Nph fatigue criterion results in higher fatigue lives than the Nf50 criterion.

By increasing the filler/bitumen ratio the fatigue law trend line showed a lower absolute slope value, indicating that the fatigue resistance of mastics is improved at low strain levels, but reduced at high initial strain levels.

The effect of Zycotherm content on fatigue life of mastics is negligible. The micro-structural analysis performed by AFM showed to high extent similar topographical behavior for Zycotherm containing binders/mastics and the reference bitumen/mastic.

The results of indirect tensile fatigue test accomplished on both HMA and WMAs proved the similar behavior of the WMA containing proper dosages of Zycotherm to that of HMA.

The study concludes that Zycotherm can be used as a WMA additive without sacrificing the fatigue resistance of asphalt mastics and mixtures.

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Afshar Yousefi , Ali Behnood, Ata Nowruzi, Hamzeh Haghshenas.“Performance evaluation of asphalt mixtures containing warm mix asphalt (WMA) additives and reclaimed asphalt pavement (RAP)” *science direct* 2020.

The research paper investigates the mechanical and durability performance of WMA mixtures containing 0% and 50% reclaimed asphalt pavement (RAP) made with different types of WMA additives including Sasobit, Kaowax, Zeolite, and PAWMA.

The main findings of the study are as follows:

The incorporation of 50% RAP into asphalt mixtures increases the flow number, resilient modulus, and resistance to moisture damage. However, it decreases the flexibility and cracking resistance indices and increases the fracture energy at intermediate temperatures.

The type of WMA additive significantly affects the performance of the mixtures. Sasobit, Zeolite, and Kaowax resulted in decreased resistance to moisture damage while PAWMA increased that.

WMA additives can increase the MR value of asphalt mixtures. Sasobit was found to result in the highest increase in the MR value.

Sasobit, Kaowax, and PAWMA increased the FN value of the WMA mixtures made with no RAP while Zeolite decreased that. Similar effects were observed in the mixtures containing RAP with the exception that Sasobit slightly decreased the FN value compared to the mixture containing RAP and no Sasobit.

WMA additives increase the fracture energy, Jc, FI, and CRI of mixtures. Kaowax resulted in the highest increase in fracture energy and Jc of both types of mixtures (i.e., with and without RAP) while PAWMA resulted in the highest increase in FI and CRI.

In SCB tests, for both types of mixtures (i.e., with and without RAP), irrespective of the notch size, the strain energy of the mixtures containing WMA additive is higher than that of the mixture without WMA additive. In both types of mixtures, the highest strain energy values are associated with the mixtures containing Zeolite or PAWMA.

The use of WMA additives allows for the incorporation of high amount of RAP without compromising the mechanical performance.

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Overall, the study concludes that WMA additives can be used to improve the performance of asphalt mixtures containing RAP. The type of WMA additive used will have a significant impact on the performance of the mixture, so it is important to select the right additive for the specific application.

Md Naquib Alam, Praveen Aggarwal "Effectiveness of anti stripping agents on moisture susceptibility of bituminous mix" ***science direct*** **2020.**

In this research paper, the authors investigated the effect of two types of liquid anti-stripping agents (ASAs) on the performance of bituminous concrete mix against moisture damage. The two types of ASAs used were silicon-based (ZycoTherm, WETBOND-S, and WETBOND-ES) and amine-based (Super Bond A-99 and Bitubuild).

The performance of the bituminous mix against moisture damage was evaluated using the Modified Lottman test (AASHTO T283), surface free energy (SFE) using the sessile drop method, and Texas boiling test (ASTM D3625).

The following conclusions were drawn from the study:

Optimum bitumen content for BC (G-II) was observed as 5.4%. WETBOND-S (0.05%) and WETBOND-ES (0.05%) resulted in the highest indirect tensile strength (ITS) values under un-conditioned and conditioned specimens, respectively. Although all the specimens fulfilled the requirement of 80% TSR value, specimens with ZycoTherm (0.05%) resulted in the highest TSR value of 94.9%. Results of Texas boiling tests also indicated better resistance against stripping with the use of ASAs. Best results were observed with ZycoTherm (0.05%). Based on results of surface free energy, use of ASAs increased the resistance of bituminous mixtures against moisture damage compared to control mix. Best performance in terms of total SFE was also observed using 0.05% ZycoTherm according to both theories used. Overall, the study found that the use of ASAs, especially ZycoTherm (0.05%), can significantly improve the resistance of bituminous concrete mix against moisture damage.

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Mohammad Javad Amirkhani, Mansour Fakhri, Abdollah Amirkhani "Evaluating the use of different fillers and Kaowax additive in warm mix asphalt mixtures" ***science direct*** **2023.**

This research paper investigates the effect of Kaowax additive and different fillers (fly ash, calcium carbonate, cement) on the mechanical performance of warm mix asphalt (WMA) mixes.

The following key findings were obtained from the study:

Kaowax additive increased the rutting resistance, resilient modulus, and indirect tensile strength of the asphalt mix. However, it decreased the fatigue life by 33%. Calcium carbonate filler significantly increased the fatigue life and flow number (53% and 139%, respectively). It also enhanced the ability to resist moisture, indirect tensile strength, fracture toughness (KIC), and resilient modulus of the WMA mixtures. Calcium carbonate reduced the optimum bitumen content of WMA mixes and was the only filler that could increase the fatigue life of the WMA mixes.

Cement filler increased rutting resistance by about 25% and the amount of the optimum bitumen used in WMA mixtures. However, it decreased the fatigue life, indirect tensile strength, ability to withstand low-temperature cracking, and resilient modulus of the WMA samples. The moisture resistance was not acceptable because the tensile strength ratio (TSR) value decreased to 70%.

The utilization of the fly ash filler increased the optimum bitumen consumption and decreased the fatigue life, indirect tensile strength, rutting resistance, KIC, and resilient modulus. The moisture resistance of WMA was relatively good (the TSR value was 80%).

Overall, the study found that calcium carbonate filler had the best performance among the various fillers examined. It improved the performance of WMA mixtures at high, medium, and low-temperatures.

The authors concluded that calcium carbonate can be used to produce WMA mixtures that perform well in all temperature conditions.

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Ronald Fabrice Pouokam Kamdem, Jacob Adedayo Adedeji, Mohamed M. Hassan mostafa "A Study on Indirect Tensile Strength for the Determination of Resilient Modulus of Warm Mix Asphalt" ***science direct*** **2022.**

This research study investigates the use of the indirect tensile strength (ITS) test together with the correlation formula method (CFM) to determine the resilient modules of asphalt mixes (WMA15% RAP, WMA30% RAP and HMA) and compares them against the resilient module found through the dynamic modulus test method (DMTM).

The study found that the resilient module determined with CFM is very close to the resilient module determined with DMTM for the HMA and WMA15% RAP pavements. This indicates that the response data of the ITS test can be adequately used as parameters in correlation formula to determine reliable resilient module of asphalt mixes. Moreover, the determination of resilient module through CFM can be used as a less expensive and quicker alternative technique to determine the resilient module of asphalt mixes.

However, the WMA30% RAP pavement showed a large difference in tensile strain between the CFM and DMTM resilient modules. This may have been caused by the inadequate mix and poor quality of the WMA30% RAP mix samples. Therefore, the authors recommend that adequate mix and quality production of the WMA30% RAP specimens be used to improve the resilient modulus of the WMA30% RAP mix.

Overall, the study found that the CFM method is a promising alternative to the DMTM method for determining the resilient modules of asphalt mixes, especially for HMA and WMA15% RAP pavements. However, further research is needed to improve the accuracy of the CFM method for WMA30% RAP pavements.

Ali Almusawi, Sarmad Shoman, Andrei P. Lupanov "Assessment of the effectiveness and the initial cost efficiency of hot recycled asphalt using polymer modified bitumen" ***science direct*** **2023.**

The first study investigated the effect of elastomeric polymer on the performance of asphalt mixtures using reclaimed asphalt pavement (RAP) following Russian standards (GOST). The study found that using 30% RAP with polymer-modified bitumen (PMB) can improve the performance of asphalt concrete, especially at high temperatures.

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However, the addition of RAP reduced the moisture resistance of the mixture, which can be overcome by using PMB. The study also found that using RAP can significantly decrease the initial cost of the asphalt concrete mixture.

The second study investigated the combined use of re-recycled RAP on the performance properties of Warm Mix Asphalt (WMA) at both binder and mixture scales. The study found that the softening action of the fresh 160/220 binder can substantially restore the rheological behavior of the aged asphalt binder to achieve the target performance property of a virgin unmodified 50/70 binder. Similar fatigue and low temperature behavior were observed for reference HMA and two WMA mixtures prepared with different generations of RAP. Better low temperature fracture performances were found for WMA mixtures prepared with recycled materials. Similar rheological characteristics, including fatigue and high temperature properties, can be achieved for the extracted binder in both WMA mixtures when compared with the reference virgin binder; this is especially true for the WMA-2 mixture extracted binder.

Overall, both studies found that using RAP in asphalt mixtures can improve the performance and reduce the cost of the mixture. However, it is important to use RAP in combination with other materials, such as PMB or WMA, to overcome the reduction in moisture resistance caused by RAP.

Gourav Goel, S.N. Sachdeva "Effect of hydrated lime and organosilane based adhesion promoters on performance of bituminous concrete mixes" ***science direct*** **2020.**

The study investigated the effect of bitumen grade and antis tripping agents (ASAs) on the tensile strength ratio (TSR) of bituminous concrete (BC) mixes subjected to multiple freeze-thaw cycles. The main conclusions are:

BC mixes prepared with CRMB55 bitumen binder exhibited superior moisture resistance compared to BC mixes prepared with VG30 bitumen.

ITS and TSR values of BC mixes decreased with the increase in the number of freeze-thaw cycles.

BC mixes prepared with VG30 failed to meet the minimum TSR requirement of 80% when used without ASAs.

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Using ASAs with VG30 bitumen increased the TSR value to meet the minimum requirement of 80%, except for hydrated lime with 3 freeze-thaw cycles (TSR value 79.2%).

BC mixes prepared with CRMB55 met the TSR requirement of 80% for 1st, 2nd, and 3rd freeze-thaw cycles with and without ASAs.

The increase in TSR value with OSAP dosage was not significant for BC mixes prepared with both bitumen binders, indicating that the effect of OSAP decreases with increasing dosage from 0.05% to 0.075%. OSAP was found to be more effective than hydrated lime in resisting moisture susceptibility of BC mixes. ASAs were effective in increasing the resistance of BC mixes against moisture susceptibility, even when subjected to multiple freeze-thaw cycles.

The regression model generated for TSR was in conformity with the pattern of results obtained from laboratory tests. Overall, the study found that using CRMB55 bitumen and OSAP can improve the moisture resistance of BC mixes, even in adverse conditions.

My own thoughts on the study

The study is well-designed and conducted, and the results are clear and concise. The authors have done a good job of explaining the significance of their findings and providing recommendations for future research.

One of the most interesting findings of the study is that OSAP is more effective than hydrated lime in resisting moisture susceptibility of BC mixes. This is important because OSAP is a relatively new material, and there is not yet a lot of data on its performance in the long term. However, the results of this study suggest that OSAP could be a promising new way to improve the durability of BC mixes in areas that are exposed to harsh weather conditions.

Another important finding of the study is that ASAs were effective in increasing the resistance of BC mixes against moisture susceptibility, even when subjected to multiple freeze-thaw cycles. This is important because it suggests that ASAs can be used to improve the performance of BC mixes in climates with cold winters.

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Overall, the study provides valuable information on the use of CRMB55 bitumen and OSAP to improve the moisture resistance of BC mixes. The findings of the study could be used to develop new guidelines for the design and construction of BC pavements in areas that are exposed to adverse weather conditions.

Mansour Fakhri, Sajad Javadi, Reza Sedghi, Danial Arzjani, Yousef Zarrinpour "Effects of deicing agents on moisture susceptibility of the WMA containing recycled crumb rubber" ***science direct*** **2019.**

The study evaluated the effects of deicing salts on the moisture susceptibility of warm mix asphalt (WMA) mixtures incorporating recycled crumb rubber (RCR). The study found that:

Deicing process by a solution of Calcium Chloride had a better influence on the asphalt specimens compared with those saturated in Magnesium Chloride and Sodium Chloride.

Asphalt specimens containing RCR as a partial replacement of aggregate (i.e., Dry Process) led to a decrease in load-bearing capacity and the moisture resistance of asphalt specimens.

Most of the specimens containing RCR without anti-stripping agent could not meet the minimum requirement of TSR (i.e., 80%) which is recommended by conventional standards.

Asphalt specimens containing RCR particles had lower TSR values than those that had not RCR particles, which revealed the lower strength of asphalt specimens incorporating RCR particle exposed to moisture.

The presence of the anti-stripping agent in WMA asphalt mixture (with or without RCR) caused better bonding between the bitumen and aggregate that led to the enhancement of both load-bearing and moisture resistant of asphalt mixtures.

Overall, the study found that using RCR in WMA mixtures can reduce the load-bearing capacity and moisture resistance of the asphalt specimens. However, using an anti-stripping agent can improve the moisture resistance of the asphalt specimens, even when RCR is used.

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Mahmoud Ameri, Mostafa Vamegh, Seyed Farhad Chavoshian Naeni, Mohammad Molayem "Moisture susceptibility evaluation of asphalt mixtures containing Evonik, Zycotherm and hydrated lime" ***science direct*** **2017.**

This research paper investigated the effects of Evonik, Zycotherm, and hydrated lime on the moisture susceptibility and other performance characteristics of asphalt mixtures. The study found that:

Adding Evonik and Zycotherm to the asphalt binder can improve the moisture resistance and dynamic response of the mixture. Zycotherm is a more effective anti-stripping agent than Evonik and hydrated lime.Hydrated lime is more effective in improving the rutting resistance of asphalt mixtures. Texas boiling test can be used as an accelerated procedure to evaluate the moisture susceptibility of modified asphalt mixtures. The optimum amounts of Zycotherm and Evonik are 0.1% and 0.3% by the weight of the bitumen, respectively. The optimum amount of hydrated lime is 2% by the weight of the aggregates.

Overall, the study found that Zycotherm and hydrated lime are effective additives for improving the moisture susceptibility and rutting resistance of asphalt mixtures, respectively.

Masoud Faramarzi, Behnam Golestani, K. Wayne Lee. "Improving moisture sensitivity and mechanical properties of sulfur extended asphalt mixture by nano-antistripping agent" ***science direct*** **2017.**

The study evaluated the effectiveness of using a new generation of modified-sulfur and ASA additives in the production of warm-mix asphalt. The researchers found that the modification of asphalt mixture with Googas (modified sulfur) and the use of nanotechnology Zycotherm as the anti stripping agent resulted in an efficient additives combination which improved the mechanical properties of SEAs.

Specifically, they found that:

Extending a portion of asphalt by Googas led to a mixture with a higher resilient modulus which was more resistant to permanent deformation.

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Obtained results by Lottman test demonstrated the reduction of ITS and TSR by Googas implementation in approximately 8% and 12%, respectively; nevertheless, ASA improved ITS and TSR significantly by about 42% and 28%, respectively. Therefore, moisture susceptibility of ASA-modified SEA (ASWMA) was significantly improved compared to unmodified SEA.

SEA mixtures showed the least fatigue life. However, the greater modulus of SEA mixtures reduced the magnitude of strain induced in the sample (about 20%). Furthermore, anti stripping agent increased fatigue life (about 25%) by developing adhesion between asphalt and aggregates.

As a result of higher stiffness, the rut depth of SEA mixtures decreased by about 300% at the last cycle of the loading process in comparison with conventional asphalt mixture. Using ASA attenuated this improvement slightly, but the reduction was negligible (about 25%).

Overall, the conclusions of this research indicate that sulfur modification has the potential to improve mechanical characteristics of asphaltic mixtures essentially in rutting phenomenon. Moreover, nanotechnology Zycotherm as an anti stripping agent could improve adhesion between aggregates and SEA; therefore, improved the deteriorated parameters caused by sulfur modification, such as moisture susceptibility and fatigue resistance.

Lokesh Gupta, and Ashik Bellary "Comparative study on The Behavior of Bituminous Concrete Mix and Warm Mix Asphalt Prepared Using Lime and Zycotherm as Additive" ***science direct*** **2018.**

The study compared the behavior of bituminous concrete mix and warm mix asphalt (WMA), both prepared with lime (1% and 2%) as filler material and zycotherm (0.1% by weight of binder) as chemical additive.

The following conclusions were drawn:

Bituminous concrete mix has a substantially higher Marshall Stability value than WMA.

The optimum bitumen content of the bituminous mix increases as the filler content increases, irrespective of mix type.

As the filler content increases, the percentage air voids reduces.

Bituminous concrete mix has marginally higher percentage air voids, VMA, and VFB than WMA. Bituminous concrete mixes possess better indirect tensile strength but marginally higher resistance against moisture susceptibility as compared to WMA. Warm mix asphalt exhibits lower ordinary results than bituminous concrete mix, but it still fabulously satisfies the minimum requirements defined by MORT&H specifications. Therefore, it can also be used as an alternative bituminous mix type.

Overall, the study concluded that bituminous concrete mix is a better mix type than warm mix asphalt in terms of Marshall Properties, indirect tensile strength, and tensile strength ratio. However, since WMA also fabulously satisfies the minimum requirements, it can also be accepted as an alternative bituminous mix type as and when required.

It is important to note that this study was limited in scope and only considered a few factors. More research is needed to compare the performance of bituminous concrete mix and warm mix asphalt in different field conditions.

Aniket V. Kataware, Dharamveer Singh "Evaluating effectiveness of WMA additives for SBS modified binder based on viscosity, Superpave PG, rutting and fatigue performance" ***science direct*** **2017.**

The study investigated the rheological characterization of a control SBS polymer modified binder (PMB) with and without WMA additives through different tests such as viscosity, Superpave high performance grade (PG), multiple stress creep recovery (MSCR), and linear amplitude sweep (LAS). Three WMA additives namely Sasobit (wax based) (Wax-S), Rediset (chemical/surfactant based) (Che-R), and Advera (water based/ zeolite) (Zeo-A) were used in the present study.

The following conclusions can be drawn based on the results and discussion presented above:

Addition of Wax-S and Che-R decreased viscosity of PMB, hence they may be considered as WMA additives. However, inclusion of Zeo-A increased viscosity of PMB, hence its applicability, as a WMA additive needs further verification.

Addition of Wax-S not only reduced viscosity of binder, but also bumped high PG of PMB by one grade interval (i.e., change from 76C to 82C), increased rutting and fatigue resistance of binder.

Though addition of Che-R reduced viscosity, it adversely impacted other rheological parameters of the PMB. The addition of Che-R, reduced rutting and fatigue performance, and also degraded high PG of PMB.

Addition of Zeo-A showed increased viscosity of PMB, however, it found have negligible effect on rutting and fatigue performance of binder. The high PG of PMB degraded with addition of Zeo-A.

Considering viscosity and other rheological parameters, only Wax-S could satisfy criteria to ascertain optimum amount. 2% of Wax-S could be considered optimum dosage for PMB. However, optimum dosage of Che-R and Zeo-A could not be determined because they adversely impacted rutting and fatigue performance of binders.

The study's conclusions are limited to the PMB and three selected WMA additives. Further research is needed to investigate the performance of asphalt mixes with different WMAs and the behavior of WMA additives for binders with higher dosages of polymer additive.

Md Naquib Alam, Praveen Aggarwal "Effectiveness of anti stripping agents on moisture susceptibility of bituminous mix" ***science direct*** **2020.**

The study investigated the effect of two liquid anti-stripping agents (ASAs), silicon-based and amine-based, on bituminous concrete mix. The performance of the mix against moisture damage was evaluated using modified Lottman test, surface free energy (SFE) using sessile drop method, and Texas boiling test.

The following conclusions were drawn from the study:

The optimum bitumen content for BC (G-II) was observed as 5.4%. WETBOND-S (0.05%) and WETBOND-ES (0.05%) resulted in the maximum indirect tensile strength (ITS) value under-unconditioned and conditioned specimens, respectively. Although all the specimens fulfilled the requirement of 80% tensile strength ratio (TSR) value, specimens with Zycotherm (0.05%) resulted in the maximum TSR value of 94.9%.

Results of Texas boiling tests also indicated better resistance against stripping with the use of ASAs. The best results were observed with ZycoTherm (0.05%). Based on the results of SFE, the use of ASAs increased the resistance of bituminous mixtures against moisture damage compared to the control mix. The best performance in terms of total SFE was also observed using 0.05% ZycoTherm according to both theories used.

Overall, the study concluded that the use of liquid ASAs, especially ZycoTherm (0.05%), can improve the moisture resistance of bituminous concrete mix.

Peyman Mirzababaei "Effect of zycotherm on moisture susceptibility of Warm Mix Asphalt mixtures prepared with different aggregate types and gradations" ***science direct*** **2016.**

The study investigated the effects of zycotherm, a liquid and nano-organosilane warm mix and anti-stripping additive, on the water susceptibility of warm mix asphalt (WMA) mixtures prepared with different aggregate types and gradations.

The study found that:

Siliceous aggregates have lower degree of alkalinity than calcareous aggregates and have greater affinity to water than bitumen, consequently, are more susceptible to water damage.

Zycotherm creates a Si-O-Si film structure (hydrophobic layer) over the surface of the aggregate, which prevents water penetration and formation of H-bonds at the binder-aggregate interface. Although gradation of aggregates affects the results of tests related to functional properties of both HMA and WMA, types of aggregates seems to have greater effect and it is highly recommended not to use siliceous aggregates without an anti-stripper because all HMA samples prepared with siliceous materials do not satisfy the minimum acceptable value to ensure good performance against stripping of the mixtures. Both HMA and WMA mixtures containing siliceous aggregates do not satisfy minimum amount of 80% TSR. The type and gradation of the materials have significant impact on functional properties of bituminous mixtures and, therefore, comparison between mixtures with the same gradation or between samples with different types of aggregates is not truthful. The study also suggested conducting further research to investigate the rutting performance and fatigue cracking properties of WMA modified

with zycotherm using siliceous, calcareous and other materials with different gradations, as well as to confirm the findings with other asphalt binders.

2.2.1 SUMMARY OF RESEARCH PAPER

Warm Mix Asphalt (WMA) encompasses various technologies that aim to reduce the production and placement temperatures of asphalt mixtures compared to traditional Hot Mix Asphalt (HMA). These technologies offer several benefits, including environmental sustainability, improved workability, and enhanced pavement performance. One approach involves the use of additives or modifiers that lower the viscosity of asphalt binders at lower temperatures, allowing for easier mixing and compaction. Another method utilizes foaming agents to generate tiny air bubbles within the asphalt mixture, reducing its viscosity and facilitating compaction. Additionally, chemical additives can modify the asphalt-aggregate bond, enhancing moisture resistance and overall durability. The adoption of WMA technologies results in reduced energy consumption, lower emissions of greenhouse gases and other pollutants, and decreased reliance on virgin materials. Furthermore, WMA allows for the incorporation of reclaimed asphalt pavement (RAP) and reclaimed asphalt shingles (RAS) into asphalt mixes, promoting recycling and reducing waste. Overall, the diverse array of WMA technologies provides flexibility in addressing specific project requirements while advancing sustainability and performance in asphalt pavement construction.

2.3 GUIDELINE

2.3.1 GUIDELINE OF POLYMER MODIFIED BITUMEN (PMB) AS PER MORTH SPECIFICATION

The Ministry of Road Transport and Highways (MoRTH) has issued guidelines for the use of polymer modified bitumen (PMB) in road construction. These guidelines are based on the Indian Roads Congress (IRC) SP: 53 "Guidelines on Use of Modified Bitumen in Road Construction".

General Guidelines

- PMB shall be used in the wearing course of all new national highways.

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- PMB shall be procured from approved sources.
- PMB shall be stored and handled properly to prevent contamination and degradation.
- PMB shall be mixed with aggregates using a suitable mixer.
- The mixing temperature of PMB shall be controlled to ensure proper coating of the aggregates.
- The laying temperature of PMB shall be controlled to ensure proper compaction of the bituminous mix.

Technical Requirements for PMB

- PMB shall comply with the requirements of IS: 15462 "Polymer Modified Bitumen (PMB)-Specification".
- PMB shall have a penetration grade of VG 40.
- PMB shall have a softening point of not less than 60°C.
- PMB shall have a ductility of not less than 30 cm.
- PMB shall have a Multiple Stress Creep Recovery (MSCR) test result of not less than 70%.

Testing and Quality Control

- PMB shall be tested for its physical properties as per IS: 15462.
- The bituminous mix shall be tested for its Marshall properties as per IS: 1206.
- The compacted bituminous mix shall be tested for its density and air voids as per IS: 1208.

Additional Guidelines

- The use of a shearing mill is mandatory for the mixing of PMB with crumbed rubber or natural rubber.

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- Stone Matrix Asphalt (SMA) shall be used in some projects, especially those related to expressways/ green-field projects and traffic more than 150 MSA.

2.3.2 GUIDELINE FOR WARM MIX ASPHALT (WMA) AS PER MORTH SPECIFICATION

The Ministry of Road Transport and Highways (MoRTH) has issued guidelines for the use of warm mix asphalt (WMA) in road construction. These guidelines are based on the Indian Roads Congress (IRC) SP: 101 "Interim Guidelines for Warm Mix Asphalt".

Guidelines for the Use of WMA

The MoRTH guidelines for the use of WMA are as follows:

WMA shall be used in all new national highways and expressways.

WMA shall be procured from approved sources.

WMA shall be stored and handled properly to prevent contamination and degradation.

WMA shall be mixed with aggregates using a suitable mixer.

The mixing temperature of WMA shall be controlled to ensure proper coating of the aggregates.

The laying temperature of WMA shall be controlled to ensure proper compaction of the bituminous mix.

Technical Requirements for WMA

WMA shall comply with the requirements of IRC: SP: 53 "Guidelines on Use of Modified Bitumen in Road Construction".

WMA shall have a penetration grade of VG 40.

WMA shall have a softening point of not less than 60°C.

WMA shall have a ductility of not less than 30 cm.

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WMA shall have a Multiple Stress Creep Recovery (MSCR) test result of not less than 70%.

Testing and Quality Control

WMA shall be tested for its physical properties as per IRC: SP: 53.

The bituminous mix shall be tested for its Marshall properties as per IS: 1206.

The compacted bituminous mix shall be tested for its density and air voids as per IS: 1208.

Additional Guidelines

The use of a shearing mill is mandatory for the mixing of WMA with crumbed rubber or natural rubber.

Stone Matrix Asphalt (SMA) shall be used in some projects, especially those related to expressways/ green-field projects and traffic more than 150 MSA.

CHAPTER 3

MATERIALS AND METHODOLOGY

3.1 MATERIAL COLLECTION

3.1.1 AGGREGATE

Aggregates are the most important ingredient in asphalt mixes, comprising 90-95% of the total weight. They provide the strength, durability, and stability of the pavement. Aggregates are typically crushed rock, gravel, or sand that is graded by size. The size and gradation of the aggregates have a significant impact on the performance of the asphalt mix.

Fig-3.1 Aggregate

Aggregates in Asphalt Mix

Types of Aggregates:

There are two main types of aggregates used in asphalt mixes: coarse aggregates and fine aggregates.

- Coarse aggregates are larger than 5 mm (0.2 inches) in diameter. They provide the bulk of the strength and durability of the pavement.
- Fine aggregates are smaller than 5 mm (0.2 inches) in diameter. They fill the voids between the coarse aggregates and help to bind the asphalt binder to the aggregates.

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The proportion of coarse aggregates to fine aggregates in an asphalt mix is called the aggregate gradation. The aggregate gradation is designed to create a dense, well-packed mix that is strong, durable, and flexible.

Functions of Aggregates in Asphalt Mixes:

Aggregates serve several important functions in asphalt mixes:

- Provide strength and durability: Aggregates provide the bulk of the strength and durability of the pavement. They resist cracking, rutting, and wear and tear.
- Fill the voids: Aggregates fill the voids between the asphalt binders to create a dense, well-packed mix. This helps to prevent water from infiltrating the pavement and causing damage.
- Bind the asphalt binder to the aggregates: Aggregates have a rough surface that helps to bind the asphalt binder to the aggregates. This is important for preventing the asphalt binder from stripping off the aggregates, which can lead to pavement failure.
- Provide flexibility: Aggregates help to provide flexibility to the pavement, which is important for resisting cracking under load.

Selection of Aggregates:

The selection of aggregates for asphalt mixes is critical to the performance of the pavement. The aggregates must meet certain specifications for size, gradation, shape, texture, and soundness. The specific requirements for aggregates will vary depending on the application and the traffic loading.

Aggregate Use in Asphalt Mixes:

Aggregates are used in a variety of asphalt mixes, including hot mix asphalt (HMA), warm mix asphalt (WMA), and cold mix asphalt (CMA). HMA is the most common type of asphalt mix, and it is typically used for high-traffic pavements. WMA is a newer type of asphalt mix that is produced at lower temperatures than HMA, which can save energy and reduce emissions. CMA is a type of asphalt mix that can be used without

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heating the aggregates, which makes it a more environmentally friendly option. Aggregates are taken from Pavan Construction Company, Rajkot. Gujarat.

The use of aggregates in asphalt mixes is essential for the construction of durable, long-lasting pavements.

3.1.2 BITUMEN

Bitumen, also known as asphalt cement, is the black or dark brown sticky substance that binds the aggregate particles together in asphalt concrete. It is a byproduct of petroleum refining, and it is the most important component of asphalt paving mixtures.

Fig-3.2 Bitumen

Bitumen in Asphalt Mix

Properties of Bitumen:

Bitumen is a highly viscous material that is solid at room temperature but becomes fluid when heated. It is also waterproof and adheres well to aggregate particles. These properties make it an ideal material for binding the aggregate particles together in asphalt concrete.

Types of Bitumen:

There are two main types of bitumen used in asphalt mixes: performance grade (PG) bitumen and modified bitumen.

PG bitumen is classified by its performance at different temperatures. The PG grade of bitumen indicates its ability to resist rutting at high temperatures and cracking at low temperatures.

Modified bitumen is bitumen that has been modified with polymers or other additives to improve its performance. Modified bitumen can have improved resistance to rutting, cracking, and fatigue.

Polymer modified bitumen:

Polymer modified bitumen (PMB) is bitumen (asphalt) that has been combined with one or more polymers to improve its properties. The most common type of polymer used in PMB is styrene-butadiene-styrene (SBS), which is a type of elastomer. Elastomers are materials that have high elasticity and can be stretched repeatedly without breaking. PMB-40 is taken from Maruti Bitumen, Mehsana, Gujarat.

The addition of polymers to bitumen improves its mechanical properties in several ways. PMB is more resistant to cracking, rutting, and fatigue than unmodified bitumen. It is also less temperature susceptible, meaning that it will not become too soft in hot weather or too brittle in cold weather. These improvements in performance make PMB a valuable material for a variety of applications, including:

- Road pavements: PMB is used extensively in road pavements, particularly those that are subjected to heavy traffic loads or extreme weather conditions.
- Roofing membranes: PMB is also used in roofing membranes, where it provides excellent waterproofing and weather resistance.
- Bridge decks: PMB can be used in bridge decks to improve their durability and resistance to cracking.
- Airport pavements: PMB is used in airport pavements to withstand the heavy loads imposed by aircraft.

Overall, polymer modified bitumen is a versatile and high-performance material that can be used in a wide variety of applications.

Bitumen Content in Asphalt Mixes:

The bitumen content in an asphalt mix is typically between 4% and 10%. The exact amount of bitumen required will depend on the type of aggregate, the desired performance of the pavement, and the traffic loading.

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Functions of Bitumen in Asphalt Mixes

Bitumen serves several important functions in asphalt mixes:

Binds the aggregate particles together: Bitumen is the glue that holds the aggregate particles together in asphalt concrete. It coats the aggregate particles and fills the voids between them, creating a dense, well-packed mix.

Waterproofs the pavement: Bitumen is impervious to water, which helps to protect the pavement from water damage.

Provides flexibility: Bitumen is a flexible material that allows the pavement to move slightly under load. This helps to prevent cracking.

Selection of Bitumen:

The selection of bitumen for asphalt mixes is critical to the performance of the pavement. The bitumen must meet certain specifications for viscosity, penetration, and ductility. The specific requirements for bitumen will vary depending on the application and the traffic loading.

3.1.3 ZYCOTHERM

Zycotherm is a warm mix additive (WMA) that is used to reduce the production temperature of asphalt pavements. It is an odorless, non-corrosive liquid that is compatible with all aggregate types. Zycotherm works by modifying the surface of the aggregate particles, making them more receptive to the asphalt binder. This allows for better coating and adhesion of the asphalt to the aggregate, even at lower temperatures.

Fig-3.3 Zycotherm

Benefits of using ZycoTherm:

Reduced production temperatures: ZycoTherm can reduce production temperatures by up to 50°F (28°C), which can save energy and reduce emissions.

Improved compaction: ZycoTherm can improve compaction by reducing viscosity of the asphalt binder, which makes it easier to work with.

Reduced pavement cracking: ZycoTherm can help to reduce pavement cracking by improving the adhesion between the asphalt binder and the aggregate.

Extended pavement life: ZycoTherm can help to extend the life of asphalt pavements by reducing wear and tear.

ZycoTherm is a versatile WMA that can be used in a variety of applications, including:

Hot mix asphalt (HMA)

Warm mix asphalt (WMA)

Cold mix asphalt (CMA)

Recycled asphalt pavement (RAP)

ZycoTherm is a proven technology that has been used in over 50 million tons of asphalt worldwide. It is a safe and effective way to reduce the environmental impact of asphalt pavements.

Here are some of the specifications of ZycoTherm:

Appearance: Clear liquid

Odor: Odorless

Specific gravity: 0.85-0.95

Flash point: >200°F (93°C)

Compatibility: All aggregate types

Dosage: 0.03-0.1% by weight of asphalt binder

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This material was introduced and produced by Zydex Company Baroda, Gujarat.

3.1.4 WETBOND

Overview:

Wetbond is a type of WMA additive that is used to reduce the production temperature of asphalt pavements. It is a non-hazardous, odorless, and brownish dark oily liquid that is compatible with all types of aggregates. Wetbond works by modifying the surface of the aggregate particles, making them more receptive to the asphalt binder. This allows for better coating and adhesion of the asphalt to the aggregate, even at lower temperatures.

Fig-3.4 Wetbond

Benefits of using Wetbond in WMA additives:

- Reduced production temperatures: Wetbond can reduce production temperatures by up to 50°F (28°C), which can save energy and reduce emissions.
- Improved compaction: Wetbond can improve compaction by reducing the viscosity of the asphalt binder, which makes it easier to work with.
- Reduced pavement cracking: Wetbond can help to reduce pavement cracking by improving the adhesion between the asphalt binder and the aggregate.

- Extended pavement life: Wetbond can help to extend the life of asphalt pavements by reducing wear and tear.

Dosage:

The dosage of Wetbond in WMA additives typically ranges from 0.1 to 0.5% by weight of asphalt binder. The specific dosage will depend on the type of aggregate, the desired performance of the pavement, and the traffic loading.

This material was introduced and produced by Petrochem Specialties Muzaffarnagar, Uttarpradesh.

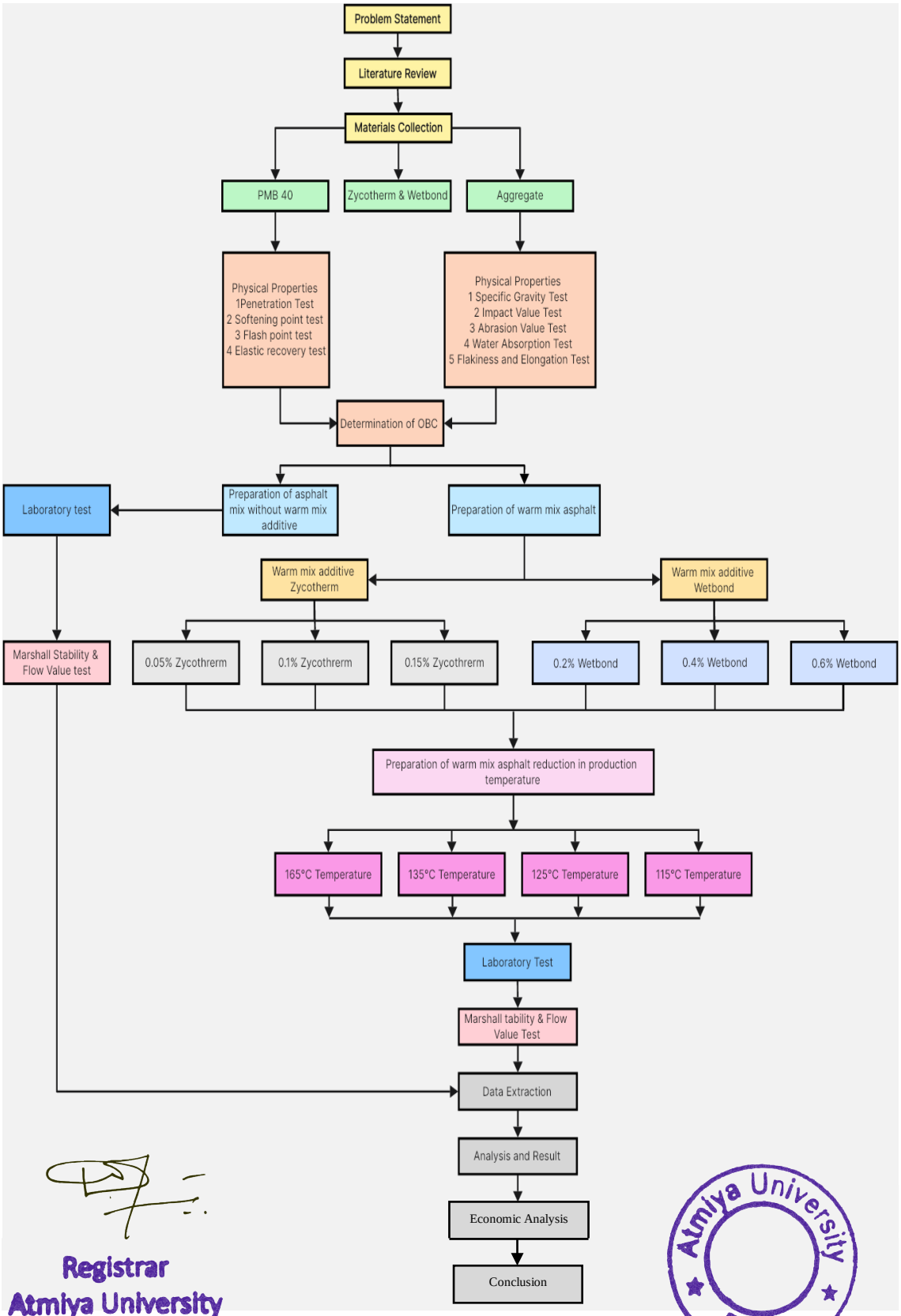
Applications:

Wetbond can be used in a variety of WMA applications, including:

- Hot mix asphalt (HMA)
- Warm mix asphalt (WMA)
- Cold mix asphalt (CMA)
- Recycled asphalt pavement (RAP)

3.2 METHODOLOGY

The following diagram shows the step by step process of research work.



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CHAPTER 4

EXPERIMENTAL WORK

4.1 MODIFIED BITUMEN

In this experimental worked on to reduce production temperature of asphalt mix used of modified bitumen in asphalt mix for creating modified bitumen used zycotherm and wetbond chemical as a warm mix additive, so that first of all weight of bitumen and decide requirement of warm mix additive, then after heat bitumen at 165℃ temperature when bitumen is on liquid state then mixed warm mix additive in bitumen using of stirrer for better mixture, requirement of various modified bitumen mix used various doses of warm mix asphalt chemical.

4.2 PHYSICAL PROPERTIES OF POLYMER MODIFIED BITUMEN GRADE-40

Determining the physical properties of bitumen involves a series of tests and analyses to assess its behavior under various conditions. One common method is the penetration test, where a standard needle is allowed to penetrate vertically into a sample of bitumen under specific conditions of temperature and load. The depth of penetration provides information about the consistency and softness of the bitumen. Another crucial test is the softening point test, which measures the temperature at which the bitumen becomes soft enough to allow a standard ball to sink a specified distance under controlled conditions. This parameter is essential for understanding the temperature susceptibility of bitumen. Additionally, the ductility test evaluates the bitumen's ability to stretch without breaking by measuring the length of a bitumen sample before it ruptures under tension. These tests help determine the deformation resistance and elasticity of bitumen, which are critical for its performance in road construction. These tests provide valuable insights into the flow behavior, stiffness, and fatigue resistance of bitumen, enabling engineers to select appropriate grades and formulations for specific applications. Overall, a comprehensive understanding of the physical properties of bitumen is essential for designing durable and sustainable asphalt pavements. Here are mentioned in table physical properties of polymer modified bitumen grade-40 with and without additive.

Table 4.1: Physical Properties of Polymer Modified Bitumen (PMB-40)

Sr. No.	Test Name	Unit	Result	Specification as per IS 15462-2004.
1	Penetration at 25°C, 100gm, 5 Sec.	mm/10	40	30-50
2	Softening Point	°C	68	60 Min.
3	Flash Point, COC, °C	°C	288	220 Min.
4	Elastic recovery of Half thread in Ductilometer at 15°C	%	75	70 Min. (70mm)
Thin film test and Tests Residue.				
5	Loss in mass	%	0.16	1 Max.
6	Increase in softening point	°C	3.2	5 Max.
7	Reduction in penetration of residue at 25°C	%	18	35 Max.
8	Elastic recovery of half thread in Ductilometer at 25°C	%	65	50 Min. (50mm)

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4.2.1 PHYSICAL PROPERTIES OF PMB-40 WITH ZYCOTHERM

Table 4.2: Physical Properties of Polymer Modified Bitumen (PMB-40) with zycotherm additive

Sr. No.	Test Name	Result				Specification as per MoRTH –V and (IRC 135:2022)
		Zycotherm Doses				
		0%	0.05%	0.1%	0.15%	
1	Penetration at 25°C, 100gm, 5 Sec.	33	31	38	45	30-50 (mm/10)
2	Softening Point	72	65	63.5	59	60°C min.
3	Flash Point, COC, °C	253	256	263	267	220°C min.
4	Elastic recovery of Half thread in Ductilometer at 15°C	70	65.5	60.5	51.5	70 % min. (70mm)
Thin film test and Tests Residue.						
5	Loss in mass	0.81	0.49	0.40	0.34	1 % max.
6	Increase in softening point	71	56	58	61	5°C max. (65°C)

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7	Reduction in penetration of residue at 25℃	6.06	3.22	15.78	24.44	35 % max.
8	Elastic recovery of half thread in Ductilometer at 25℃	69	54	57	58	50 % min. (50mm)

4.2.2 PHYSICAL PROPERTIES OF PMB-40 WITH WETBOND

Table 4.3: Physical Properties of Polymer Modified Bitumen (PMB-40) with wetbond additive

Sr. No.	**Test Name**	**Result**				**Specification as per MoRTH –V and (IRC 135:2022)**
		Wetbond Doses				
		0%	0.2%	0.4%	0.6%	
1	Penetration at 25℃, 100gm, 5 Sec.	33	37	32	31.5	30-50 (mm/10)
2	Softening Point	72	68	68	72	60C min.
3	Flash Point, COC, ℃	253	256	274	281	220C min.

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4	Elastic recovery of Half thread in Ductilometer at 15°C	70	70	71	72.5	70 % min. (70mm)
Thin film test and Tests Residue.						
5	Loss in mass	0.81	0.58	0.44	0.41	1 % max.
6	Increase in softening point	70	61	62	64	5°C max. (65°C)
7	Reduction in penetration of residue at 25°C	3.03	43.24	31.25	20.63	35 % max.
8	Elastic recovery of half thread in Ductilometer at 25°C	68	72	75	77	50 % min. (50mm)

4.3 PHYSICAL PROPERTIES OF AGGREGATE

Aggregates, the essential component of concrete and asphalt mixtures, possess a range of physical properties crucial for constructing durable and resilient infrastructure. One primary characteristic is particle size distribution, which determines the packing density and workability of the aggregate blend. The shape of aggregate particles, whether angular, rounded, or irregular, influences the interlocking and bonding within the mixture, affecting the strength and stability of the resulting pavement. Additionally, aggregate hardness, determined by factors like mineral composition and resistance to abrasion, impacts the overall durability and wear resistance of the pavement surface. Porosity and absorption capacity are also critical properties, as they affect the

susceptibility of the aggregate to moisture-induced damage and freeze-thaw cycles. Furthermore, the specific gravity and bulk density of aggregates play a role in determining the weight and volume of the pavement structure, influencing its structural design and performance. Moreover, aggregate gradation, characterized by the distribution of particle sizes within the mixture, directly affects the workability, stability, and drainage characteristics of concrete and asphalt pavements. Overall, understanding and optimizing these physical properties of aggregates are essential for designing and constructing high-quality and long-lasting infrastructure projects.

Determining the physical properties of aggregates involves a series of standardized tests and analyses aimed at evaluating their characteristics for use in construction materials. One fundamental test is the sieve analysis, where aggregates are separated into different size fractions using a series of sieves with progressively finer mesh sizes. This provides valuable information about the particle size distribution and grading of the aggregate, which influences the workability and strength of concrete and asphalt mixtures. Additionally, the specific gravity and absorption tests measure the density and porosity of the aggregate, respectively, helping to assess its ability to absorb moisture and resist freeze-thaw damage. The aggregate crushing value (ACV) and aggregate impact value (AIV) tests evaluate the strength and toughness of aggregates under compressive and impact loads, respectively, providing insights into their suitability for use in various construction applications. Furthermore, tests such as the Los Angeles abrasion test and the sodium sulfate soundness test assess the resistance of aggregates to abrasion and chemical deterioration, which are crucial for ensuring the long-term durability of pavements. Overall, these tests help engineers and researchers characterize the physical properties of aggregates and make informed decisions regarding their selection and use in construction projects. Aggregate physical properties mentioned in below table.

Table 4.4: Physical properties of aggregate

Sr. No.	Test Name	Result	Specification as per MoRTH –V and (IRC 135:2022)
1	Specific Gravity test	2.67	>2.5

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2	Impact Value test	11%	<24%
3	Abrasion Value test	26%	<30%
4	Water Absorption test	0.45%	2% max.
5	Flakiness and Elongation test	29.4 %	35% max.

4.4 GRADATION FOR BITUMINOUS MIX DESIGN (BC GRADE-II)

In Marshall Mix design for BC grade 2 asphalt mixtures, achieving the optimal gradation of aggregates is crucial for ensuring the desired performance characteristics of the pavement. The gradation refers to the distribution of particle sizes within the aggregate blend, and it plays a significant role in determining the workability, stability, and durability of the asphalt mixture. Typically, the gradation is designed to achieve a balance between void spaces in the mixture, which affect the ability of the asphalt binder to coat and bond with the aggregates, and aggregate interlock, which enhances the structural integrity of the pavement. BC grade 2 mixtures commonly utilize a combination of coarse and fine aggregates to achieve the desired gradation. The coarse aggregates provide structural strength and stability, while the fine aggregates fill void spaces and enhance the workability of the mixture. The specific gradation requirements for BC grade 2 mixtures may vary depending on factors such as traffic volume, climate conditions, and pavement performance criteria. However, in general, the gradation should be carefully optimized to ensure that the resulting asphalt mixture meets the specified requirements for density, stability, and durability, thereby ensuring the long-term performance of the pavement in service.

In the Marshall Mix design process for BC grade 2 asphalt mixtures, the gradation procedure involves carefully selecting and blending aggregates to achieve the desired particle size distribution. The procedure typically begins with determining the aggregate specifications required for BC grade 2 mixtures, including maximum and minimum particle sizes, gradation limits, and aggregate quality criteria. Once the aggregate specifications are established, suitable coarse and fine aggregates are selected and

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blended together in appropriate proportions to meet the gradation requirements. This blending process aims to achieve a well-graded aggregate blend that balances the distribution of particle sizes to optimize the packing density and void content of the mixture. The gradation of the aggregate blend is then verified through sieve analysis, where the aggregate sample is passed through a series of sieves with progressively smaller openings to determine the percentage of material retained on each sieve. The results of the sieve analysis are compared against the specified gradation limits for BC grade 2 mixtures to ensure compliance with the requirements. Adjustments may be made to the aggregate blend as needed to achieve the desired gradation, with the goal of producing an asphalt mixture that meets the specified performance criteria for density, stability, and durability. By following this gradation procedure, engineers can design BC grade 2 asphalt mixtures that exhibit optimal performance characteristics and meet the requirements for use in road construction projects. Gradation for bitumen mix design (BC grade-II) mentioned in table 4.5 also show in figure-4.1.

Table 4.5: Gradation for bituminous mix design grade-II

Proportion			**Combined**	**Gradation As Per MORTH**	
10MM	**6MM**	**Stone Dust**	**100%**	**Lower**	**Upper**
25%	**30%**	**45%**			
25.00	30.00	45.00	100.00	100	100
21.83	30.00	45.00	96.83	90	100
11.26	30.00	45.00	86.26	70	88
0.25	24.71	45.00	69.96	53	71
0.07	7.19	44.08	51.34	42	58
0.07	1.74	38.30	40.11	34	48

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0.07	1.07	30.22	31.36	26	38
0.07	0.90	21.62	22.60	18	28
0.07	0.78	12.56	13.41	12	20
0.07	0.65	4.21	4.93	4	10

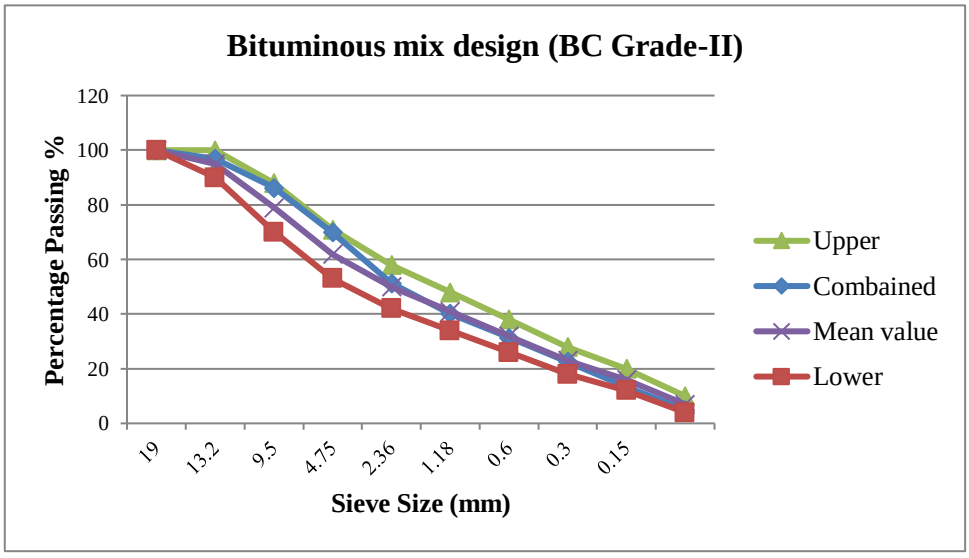


Fig-4.1 Bituminous mix design

4.5 SAMPLE PREPARATION

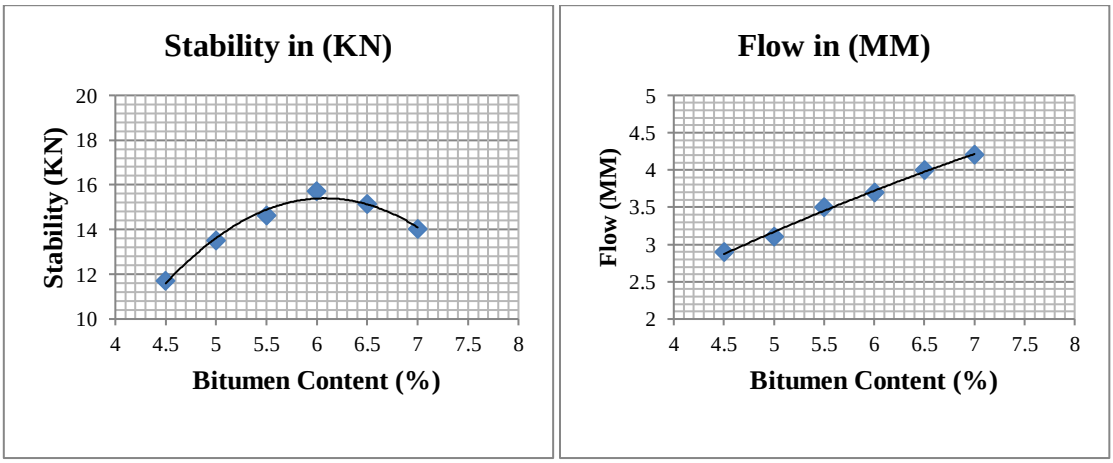
4.5.1 MOULD CASTING

The Marshall mould casting procedure is a critical step in evaluating the quality and performance of asphalt mixtures, particularly in road construction. This method involves preparing a cylindrical specimen of asphalt mixture under specific conditions to assess its properties and suitability for use. To begin, the asphalt mixture is carefully prepared according to the desired mix design, ensuring the proper combination of aggregates, asphalt binder, and any additives or modifiers. The mixture is then heated to the required temperature to achieve optimal workability. Next, the Marshall Mould assembly, consisting of a cylindrical mould with a base plate, is prepared for compaction. Layers of the hot asphalt mixture are then added to the mould and

compacted using a specified number of blows from a compaction hammer. Each layer is compacted until it slightly exceeds the top of the mould. After the final layer is compacted, any excess mixture is trimmed, and the surface is finished to ensure uniformity. Once cooled to room temperature, the compacted specimen is carefully removed from the mould for further testing and analysis. Various tests are conducted to evaluate properties such as density, stability, flow, and air voids content, providing valuable insights into the performance and suitability of the asphalt mixture for its intended application. Overall, the Marshall mould casting procedure offers a standardized and reliable method for assessing the quality and performance of asphalt mixtures, facilitating informed decisions in road construction projects.

4.5.2 DETERMINATION OF OPTIMUM BITUMEN CONTENT

For finding Optimum Bitumen Content, prepare Marshall Mould of various bitumen content like 4.5%, 5%, 5.5%, 6%, 6.5% and 7% of total mix and determined their volumetric parameter, Marshall Stability, Flow value and Marshall Quotient. Considered 4% air voids is used to determine OBC which is found 6.4% bitumen content. Fig-4.2 shows the result of various parameter of Marshall Mix design also show in table 4.6 and 4.7. Table 4.8 show physical properties of Marshall Mix at OBC.



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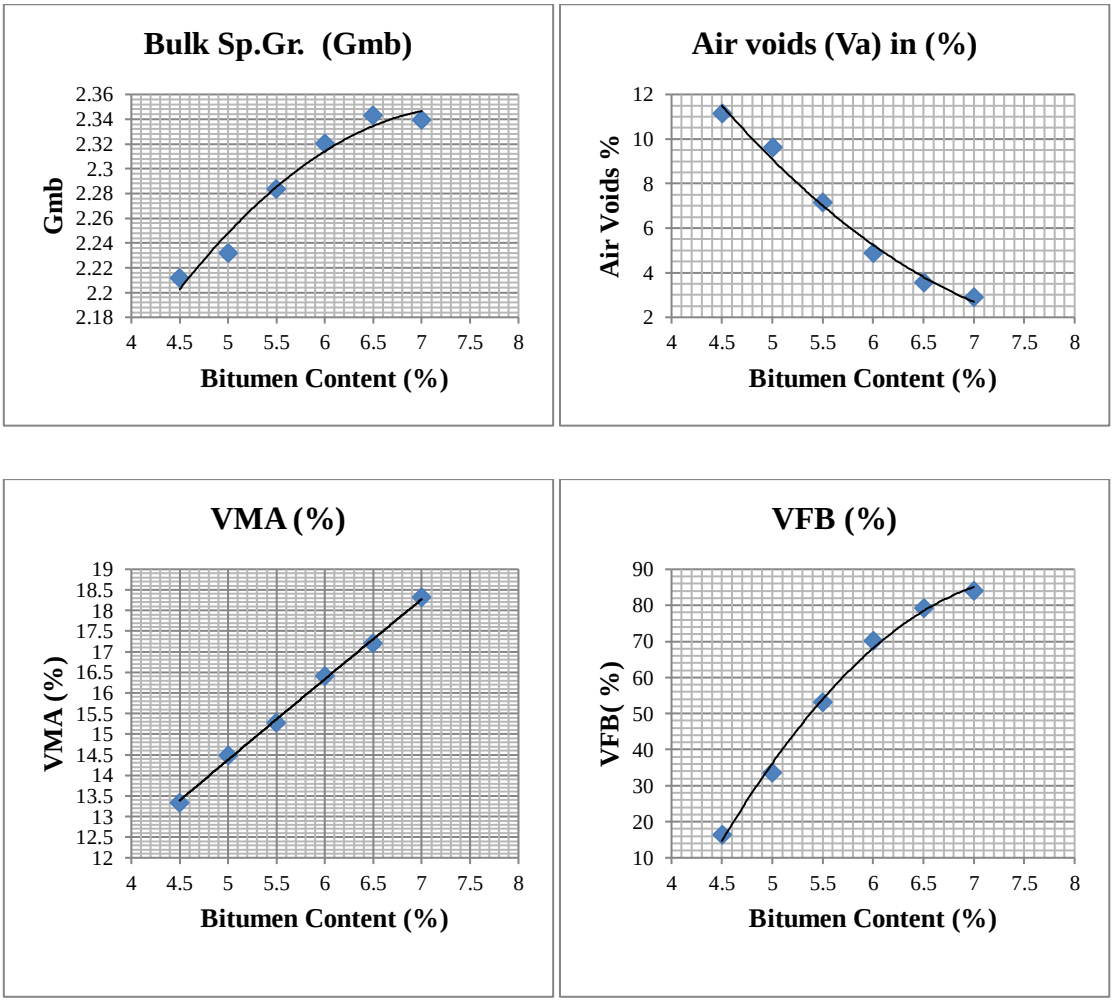

Fig-4.2 Determination of Optimum Bitumen Content

4.5.3 VOLUMETRIC PROPERTIES OF MARSHALL MIX DESIGN

Table 4.6: Volumetric properties of Marshall Mix design

Bitumen contain (%)	Bulk sp. Gr. (Gmb)	Air Voids (Va) in (%)	VMA (%)	VFB (%)	Stability (KN)	Flow in (mm)	MQ (mm)
4.5	2.2119	11.1653	13.34	16.301703	11.7	2.9	4.034482759
5	2.2322	9.6267	14.4862	33.5450924	13.514	3.1	4.359354839

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5.5	2.2835	7.1716	15.2806	53.0667762	14.638	3.5	4.182285714
6	2.3207	4.8888	16.413	70.2155129	15.7	3.7	4.243243243
6.5	2.3431	3.5755	17.1993	79.2113624	15.14	4	3.785
7	2.3395	2.9218	18.32	84.0511685	14.0235	4.2	3.338928571

Table 4.7: Volumetric properties of Marshall Mix design

Bitumen contain (%)	**Height of specimen (mm)**	**Weight of specimen**			**Specific Gravity**	
		weight in air (gm)	**weight in water (gm)**	**SSD weight (gm)**	**Bulk (Gmb)**	**Theoretical**
4.5	67	1207.3	663.8	1209.6	2.21198241	2.49
5	67	1255.4	695.3	1257.7	2.23221906	2.47
5.5	66	1236.1	696.5	1237.8	2.28357657	2.46
6	65	1250.4	712.2	1251	2.32071269	2.44
6.5	65	1245.6	714.5	1246.1	2.34311512	2.43
	67	1260.1	713.2	1251.8	2.3395841	2.41

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4.5.4 OBC VOLUMETRIC PROPERTIES OF MARSHALL MIX DESIGN

Table 4.8: Volumetric properties of Marshall Mix design at OBC 6.4% Bitumen Content

Requirement of dense graded bituminous mix		
Parameter	**Results**	**Specification as per IRC:135-2022**
Marshall stability in KN	15.2	12
Flow in mm	3.9	2.5 - 4
Marshall Quotient	3.897	2.5 - 5
% Air- voids	4	3.0 - 5.0
% VFB	75	65 - 75
%VMA	17.2	14%
OBC	6.4	%

4.6 PREPARATION OF BITUMEN MIX WITH ZYCOTHERM

In this experimental work to reduce production temperature of asphalt mix use of zycotherm chemical as a warm mix additive at various temperature with various doses of zycotherm and determined that Marshall Properties. For making bitumen mix with zycotherm first of all calculate weight of aggregates required for Marshall Specimen and put aggregates in oven for heating at temperature of 135℃ temperature. Then after weight of bitumen for requirements and heating that at 165℃ temperature and mixing zycotherm chemical at required different doses in stirrer. After that bitumen put in oven at required temperature and also aggregates are heating at required temperature when

that is heat properly after that mixing both at various temperature range and put mixture in Marshall specimen and compact properly using of hammer each side 75 blow for better compaction and after put in room temperature for cooling down, when they cool down specimen put in water bath at 60℃ temperature for 30 minutes after that determined their Marshall volumetric properties.

4.7 PREPARATION OF BITUMEN MIX WITH WETBOND

In this experimental work to reduce production temperature of asphalt mix use of wetbond chemical as a warm mix additive at various temperature with various doses of wetbond and determining that Marshall Properties. For making bitumen mix with wetbond first of all calculate weight of aggregates required for Marshall Specimen and put aggregates in oven for heating at temperature of 135℃ temperature. Then after weight of bitumen for requirements and heating that at 165℃ temperature and mixing wetbond chemical at required different doses in stirrer. After that bitumen put in oven at required temperature and also aggregates are heating at required temperature when that is heat properly after that mixing both at various temperature range and put mixture in Marshall specimen and compact properly using of hammer each side 75 blow for better compaction and after put in room temperature for cooling down, when they cool down specimen put in water bath at 60℃ temperature for 30 minutes after that determined their Marshall volumetric properties.

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CHAPTER 5

RESULT AND ANALYSIS

5.1 VOLUMETRIC PROPERTIES OF MARSHALL MIX WITH VARIOUS DOSES OF ZYCOTHERM AT VARIOUS TEMPERATURE

In this experimental work to reduce production temperature of asphalt mix use zycotherm chemical as a warm mix additive with various doses of zycotherm like 0.05%, 0.1% and 0.15% at various temperature ranges of 165℃, 135℃, 125℃ and 115℃.

5.1.1 MARSHALL STABILITY AND FLOW VALUE TEST

The Marshall Stability and flow value test is a common method used to evaluate the performance of bituminous mixes. In this test, a compacted cylindrical specimen of the asphalt mix is subjected to a compressive load at a specific deformation rate. The Marshall Stability value represents the maximum load sustained by the specimen before failure, indicating its strength and resistance to deformation under load. The flow value measures the deformation or flow of the specimen at the point of maximum load, indicating its ability to deform under load. These parameters are crucial in determining the suitability of the asphalt mix for various pavement applications, with higher stability and lower flow values generally indicating better performance.

Marshall Stability: Marshall Stability refers to the maximum load that a cylindrical asphalt concrete specimen can withstand before failure under specific test conditions. It is a key measurement in the Marshall Mix Design method used to assess the rutting resistance of asphalt mixtures. As the dose of zycotherm increase it also increases Marshall Stability and as temperature decreases it also decreases Marshall Stability. Show in fig-5.1.

Table 5.1: Temperature Vs Marshall Stability

Marshal Stability in (KN) **(Minimum requirement 12 KN as per IRC: 135-2022)**

Bitumen content in (%)	**Temperature (℃)**	**Conventional mix**	**Zycotherm**		
			0.05%	**0.10%**	**0.15%**
6.40%	165	19.216	20.154	24.558	24.561
	135	10.93	15.009	17.603	17.479
	125	10.082	13.527	14.542	14.453
	115	9.8413	10.562	11.16	10.95

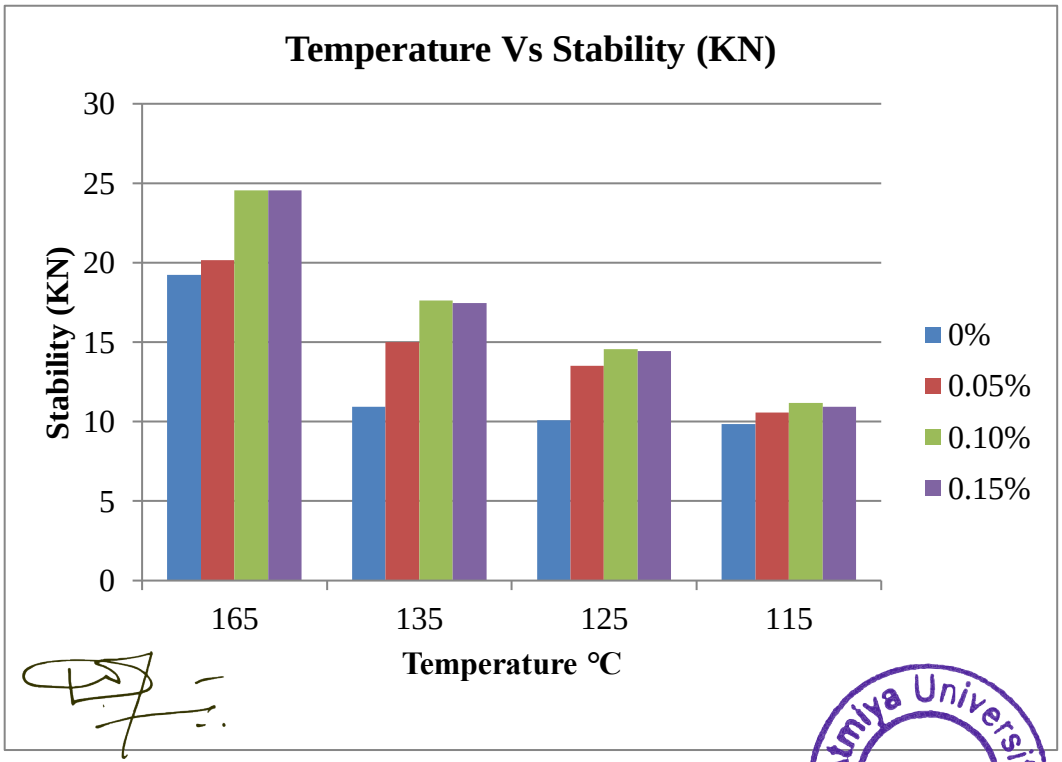

Fig-5.1 Temperature Vs Marshall Stability

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Marshall Flow: The Marshall Flow value in the Marshall Mix Design method represents the amount of plastic deformation that a cylindrical asphalt concrete specimen will undergo at the point of Marshall Stability (maximum load) during testing. Relation between temperature and flow is when the temperature decreases, flow also decreases and the increase in dose of zycotherm increases the flow in all temperature ranges. Show in fig-5.2.

Table 5.2: Temperature Vs Marshall Flow

Marshal Flow in (MM) **(Requirement 2.5-4 MM as per IRC: 135-2022)**

Bitumen content in (%)	**Temperature (℃)**	**Conventional mix**	**Zycotherm**		
			0.05%	**0.10%**	**0.15%**
6.40%	165	3.85	3.85	4.2	4.15
	135	2.95	3.35	3.75	3.725
	125	2.925	2.97	3.35	3.15
	115	2.65	2.8	2.8	2.45

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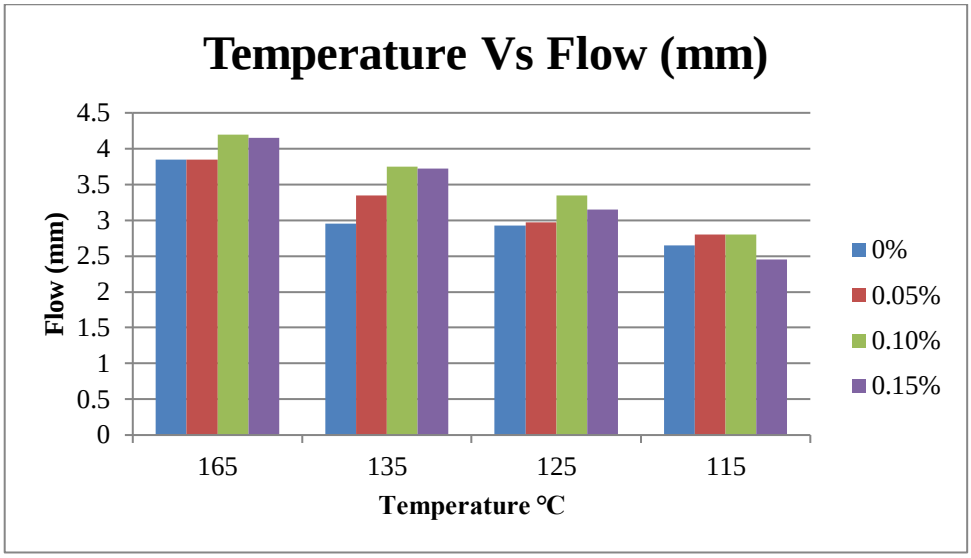

Fig-5.2 Temperature Vs Marshall Flow

Marshall Quotient: Marshall Quotient in Marshall Mix Design is the only value that combines information from Marshall Stability and Marshall Flow. Essentially, it provides a measure of the stiffness or stiffness of the mixture. Relation between temperature and quotient is when the temperature decreases, quotient also decreases at same rate but increases in dose of zycotherm increases quotient in all temperature ranges. Show in fig-5.3

Table 5.3: Temperature Vs Marshall Quotient

Marshal Quotient in (MM) **(Requirement 2.5-5 MM as per IRC: 135-2022)**

Bitumen content in (%)	**Temperature (℃)**	**Conventional mix**	**Zycotherm**		
			0.05%	**0.10%**	**0.15%**
6.40%	165	4.977	5.211	5.847	5.925
	135	3.7011	4.478	4.695	4.692

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	125	3.4458	4.546	4.337	4.585
	115	3.714	3.778	3.987	4.471

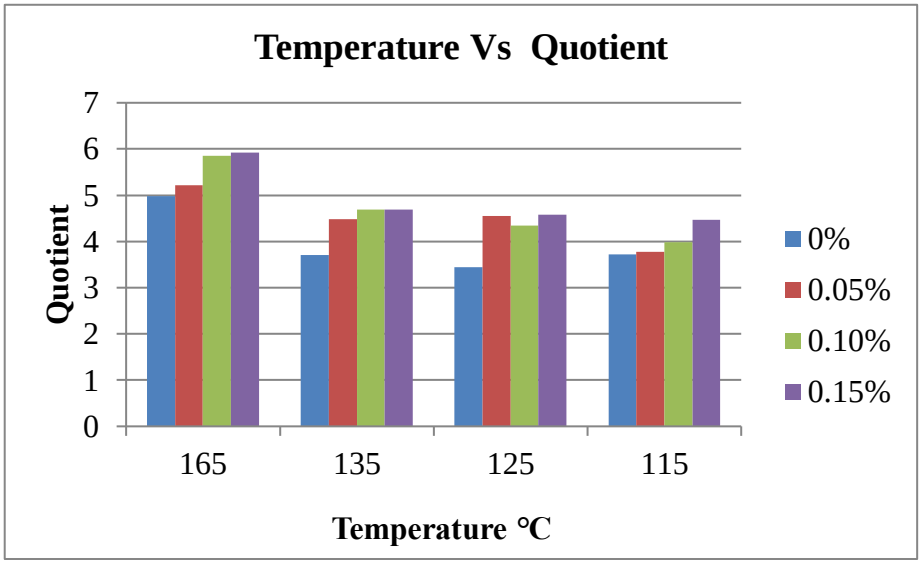

Fig-5.3 Temperature Vs Marshall Quotient

5.1.2 MARSHALL VOLUMETRIC PARAMETERS

Marshall volumetric parameters are crucial indicators used in assessing the quality and performance of asphalt mixes. They include Bulk Specific Gravity (Gmb), Maximum Specific Gravity (Gmm), Air Void Content (Va), Voids in Mineral Aggregate (VMA), and Voids Filled with Asphalt (VFA). Marshall Mix design includes an analysis of the air spaces in the asphalt mix. These spaces are key to balancing strength, durability and easy handling of the compound.

Bulk Specific Gravity (Gmb): Gmb (Bulk Specific Gravity) is a key measurement in Marshall Mix design and refers to the density of the compacted asphalt mix. It basically tells you how much space the mixture takes up compared to the same volume of non-porous material. Relation between temperature and bulk specific gravity is when the temperature decreases, bulk specific gravity also decreases and when dose of zycotherm increases, the bulk specific gravity is increases in all temperature ranges till 0.1%. Show in fig-5.4

Table 5.4: Temperature Vs Bulk Specific Gravity

Bulk Specific Gravity of the mixture (GMB) in (G/CC)					
Bitumen content in (%)	**Temperature (°C)**	**Conventional mix**	**Zycotherm**		
			0.05%	**0.10%**	**0.15%**
6.40%	165	2.18	2.183	2.186	2.193
	135	2.168	2.176	2.19	2.187
	125	2.163	2.176	2.192	2.176
	115	2.168	2.186	2.182	2.179

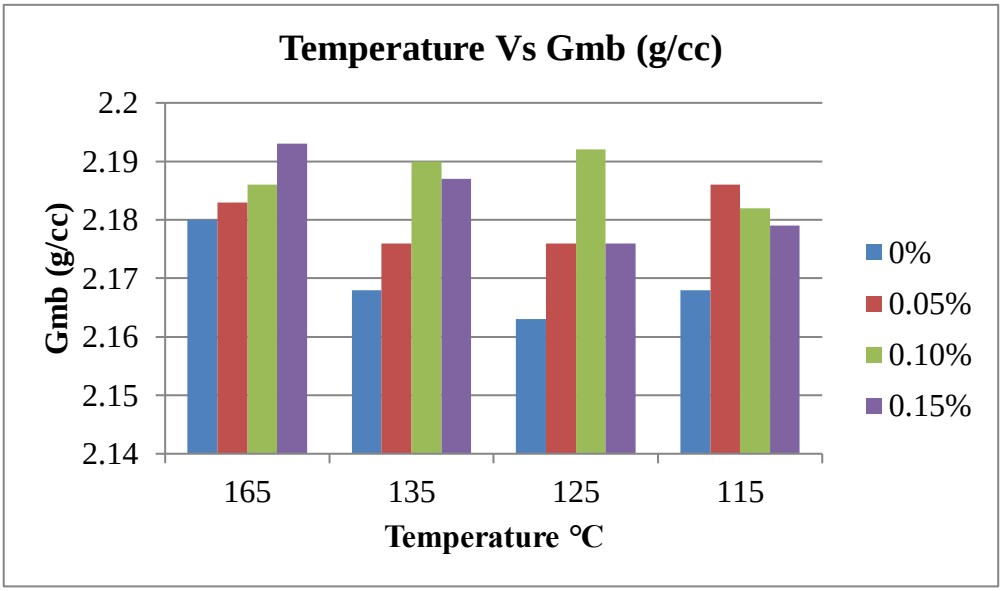

Fig-5.4 Temperature Vs Gmb

Air Voids (Va): The empty space between the aggregate and the asphalt. The right amount is needed to prevent water damage and give the tile a long life. Relation between temperature and air voids is when dose of zycotherm increases, air voids

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slightly decreases and there is fluctuation in dose of zycotherm at 115°C temperature. Show in fig-5.5.

Table 5.5: Temperature Vs Air Voids

Air Voids in (%) **(Requirement 3-5 % as per IRC: 135-2022)**					
Bitumen content in (%)	**Temperature (°C)**	**Conventional mix**	**Zycotherm**		
			0.05%	**0.10%**	**0.15%**
6.40%	165	4.7434	4.649	4.481	4.192
	135	5.2678	4.924	4.335	4.438
	125	5.5023	4.9516	4.249	4.922
	115	5.2854	4.509	4.667	4.806

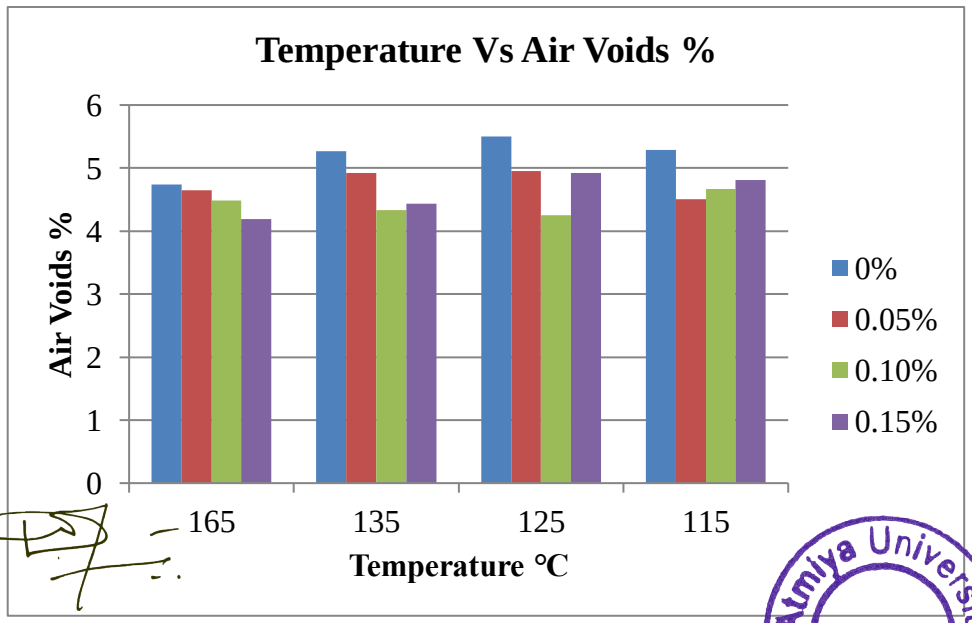

Fig-5.5 Temperature Vs Air Voids

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Voids in Mineral Aggregate (VMA): Air space closely spaced between aggregate particles, without binder. Sufficient VMA allows drainage and prevents the binder from separating from the rocks. Relation between temperature and VMA is when the dose of zycotherm increases, VMA decreases at same rate of various temperatures. Show in fig-5.6.

Table 5.6: Temperature Vs VMA

Voids in Mineral Aggregate (VMA) in (%) **(Minimum requirement 14 % as per IRC: 135-2022)**

Bitumen content in (%)	**Temperature (°C)**	**Conventional mix**	**Zycotherm**		
			0.05%	**0.10%**	**0.15%**
6.40%	165	18.815	18.735	16.297	16.346
	135	19.262	18.969	16.321	16.304
	125	19.462	18.992	16.336	16.221
	115	19.277	18.615	16.265	16.241

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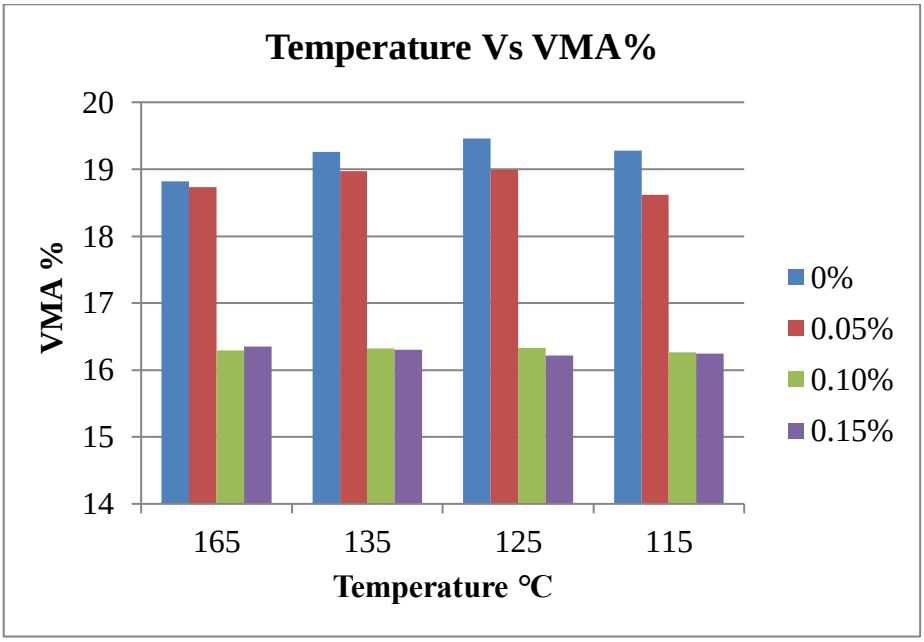

Fig-5.6 Temperature Vs VMA

Void spaces filled with asphalt (VFA):

Table 5.7: Temperature Vs VFB

Volume Field with Bitumen (VFB) in (%) **(Requirement 65-75 % as per IRC: 135-2022)**					
Bitumen content in (%)	**Temperature (°C)**	**Conventional mix**	**Zycotherm**		
			0.05%	**0.10%**	**0.15%**
6.40%	165	74.796	75.19	72.496	74.351
	135	72.659	74.057	73.429	72.772
	125	71.747	73.948	73988	69.655
	115	72.583	75.73	71.306	70.405

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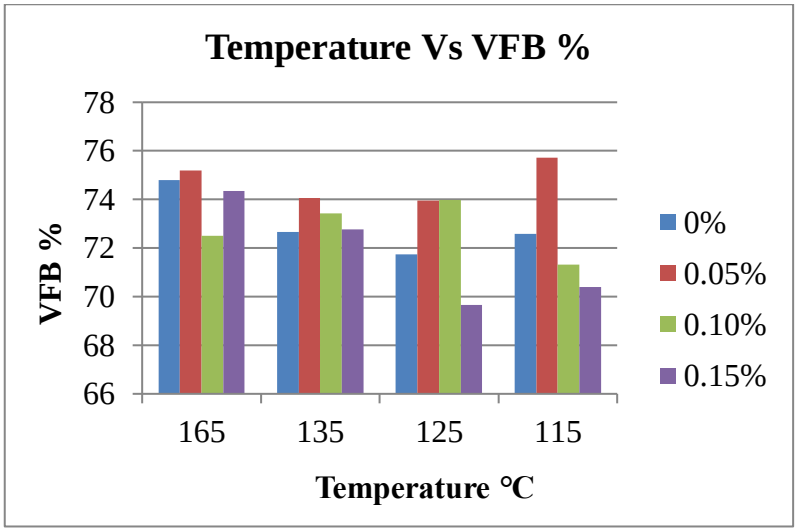

Fig-5.7 Temperature Vs VFB

The part of the VMA filled with an asphalt binder. A good VFA makes for a strong mix, but too much can cause drainage problems. Relation between temperature and VFA is when temperature decreases, VFA decreases. As the dose of zycotherm increases there is a fluctuation in VFA. Show in fig-5.7.

These parameters, determined through laboratory testing for strength, durability, and resistance to deformation, ensuring high-quality asphalt pavement construction.

Table 5.8: Temperature Vs Marshall volumetric parameters

Bitumen (%)	Temperature (°C)	Zycotherm (%)	Air voids (Va) in (%) (3-5)	VMA (%) (>14)	VFB (%) (65-75)	Stability in (KN) (>12)	Flow in (mm) (2.5-4)	MQ (2.5-5)	Bulk specific gravity of the mixture (Gmb) (g/cc)
6.4	165	0	4.7434	18.815	74.796	19.216	3.85	4.977	2.18

	135		5.2678	19.262	72.659	10.93	2.95	3.7011	2.168
	125		5.5023	19.462	71.747	10.082	2.925	3.4458	2.163
	115		5.2854	19.277	72.583	9.8413	2.65	3.714	2.168
	165	0.05	4.649	18.735	75.19	20.153	3.85	5.211	2.183
	135		4.924	18.969	74.057	15.009	3.35	4.478	2.176
	125		4.9516	18.992	73.948	13.527	2.97	4.546	2.176
	115		4.509	18.615	75.73	10.562	2.8	3.778	2.186
	165	0.1	4.481	16.297	72.496	24.558	4.2	5.847	2.186
	135		4.335	16.321	73.429	17.603	3.75	4.695	2.19
	125		4.249	16.336	73.988	14.542	3.35	4.337	2.192
	115		4.667	16.265	71.306	11.159	2.8	3.987	2.182
	165	0.15	4.192	16.346	74.351	24.561	4.15	5.925	2.193
	135		4.438	16.304	72.772	17.479	3.725	4.692	2.187
	125		4.922	16.221	69.655	14.453	3.15	4.585	2.176
	115		4.806	16.241	70.405	10.95	2.45	4.471	2.179

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5.2 VOLUMETRIC PROPERTIES OF MARSHALL MIX WITH VARIOUS DOSES OF WETBOND AT VARIOUS TEMPERATURE

In this experimental work to reduce production temperature of asphalt mix use wetbond chemical as a warm mix additive with various doses of wetbond like 0.2%, 0.4% and 0.6% at various temperature ranges of 165°C, 135°C, 125°C and 115°C.

5.2.1 MARSHALL STABILITY AND FLOW VALUE TEST

The Marshall Stability and flow value test is a common method used to evaluate the performance of bituminous mixes. In this test, a compacted cylindrical specimen of the asphalt mix is subjected to a compressive load at a specific deformation rate. The Marshall Stability value represents the maximum load sustained by the specimen before failure, indicating its strength and resistance to deformation under load. The flow value measures the deformation or flow of the specimen at the point of maximum load, indicating its ability to deform under load. These parameters are crucial in determining the suitability of the asphalt mix for various pavement applications, with higher stability and lower flow values generally indicating better performance.

Marshall Stability: Marshall Stability refers to the maximum load that a cylindrical asphalt concrete specimen can withstand before failure under specific test conditions. It is a key measurement in the Marshall Mix Design method used to assess the rutting resistance of asphalt mixtures. Relation between temperature and Marshall Stability is when dose of wetbond increases it also increases in Marshall Stability and temperature decreases it also decreases Marshall Stability. Show in fig-5.8.

Table 5.9: Temperature Vs Marshall Stability

Marshal Stability in (KN) **(Minimum requirement 12 KN as per IRC: 135-2022)**					
Bitumen content in (%)	**Temperature (°C)**	**Conventional mix**	**Wetbond**		
			0.20%	**0.40%**	**0.60%**

6.40%	165	19.216	20.861	24.486	19.564
	135	10.93	15.405	17.808	13.191
	125	10.082	13.403	13.902	12.818
	115	9.8413	11.07	10.759	10.928

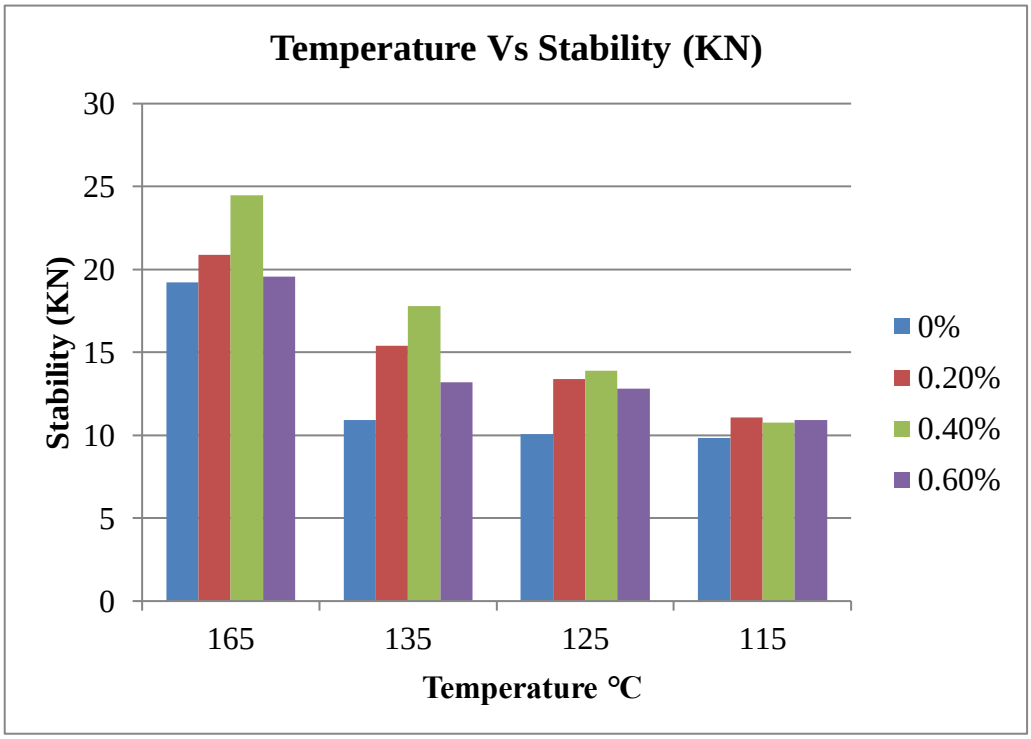

Fig-5.8 Temperature Vs Marshall Stability

Marshall Flow: The Marshall Flow value in the Marshall Mix Design method represents the amount of plastic deformation that a cylindrical asphalt concrete specimen will undergo at the point of Marshall Stability (maximum load) during testing. Relation between temperature and flow is when the temperature decreases, flow also decreases and the increase in dose of wetbond Flow value fluctuation in all temperature ranges. Show in fig-5.9.

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Table 5.10: Temperature Vs Marshall Flow

Marshal Flow in (MM) **(Requirement 2.5-4 MM as per IRC: 135-2022)**

Bitumen content in (%)	**Temperature (°C)**	**Conventional mix**	**Wetbond**		
			0.20%	**0.40%**	**0.60%**
6.40%	165	3.85	3.95	4.2	3.7
	135	2.95	3.5	3.85	3.25
	125	2.925	3.425	3.25	3.15
	115	2.65	3.05	2.9	2.875

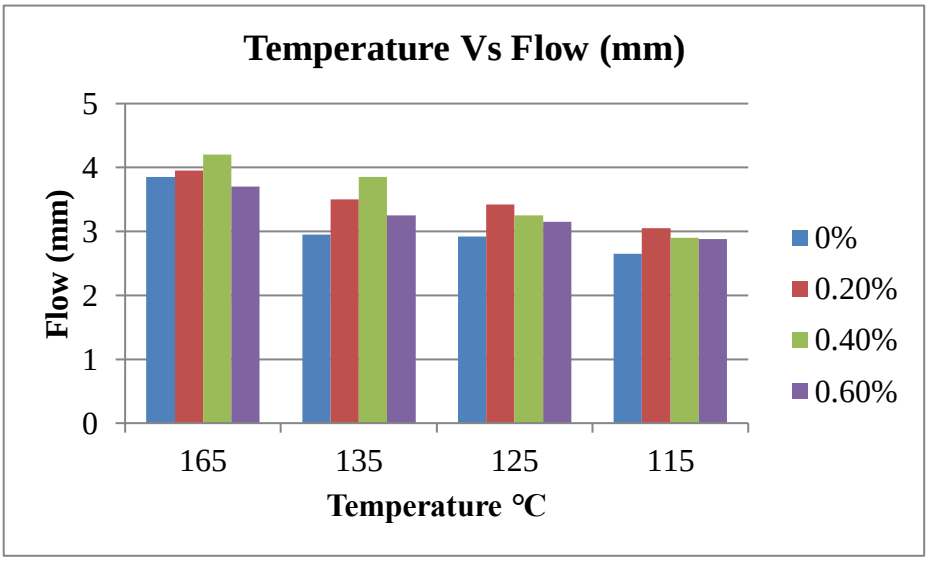

Fig-5.9 Temperature Vs Marshall Flow

Marshall Quotient: Marshall Quotient in Marshall Mix Design is the only value that combines information from Marshall Stability and Marshall Flow. Essentially, it provides a measure of the stiffness or stiffness of the mixture. Relation between

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temperature and quotient is when the temperature decreases, quotient also decreases at same rate but increases in dose of wetbond, Quotient fluctuation in all temperature ranges. Show in fig-5.10.

Table 5.11: Temperature Vs Marshall Quotient

Marshal Quotient in (MM) **(Requirement 2.5-5 MM as per IRC: 135-2022)**					
Bitumen content in %	**Temperature ℃**	**Conventional mix**	**Wetbond**		
			0.20%	**0.40%**	**0.60%**
6.40%	165	4.977	5.26	5.824	5.029
	135	3.7011	4.394	4.627	4.064
	125	3.4458	4.19	4.28	4.077
	115	3.714	3.612	3.882	3.787

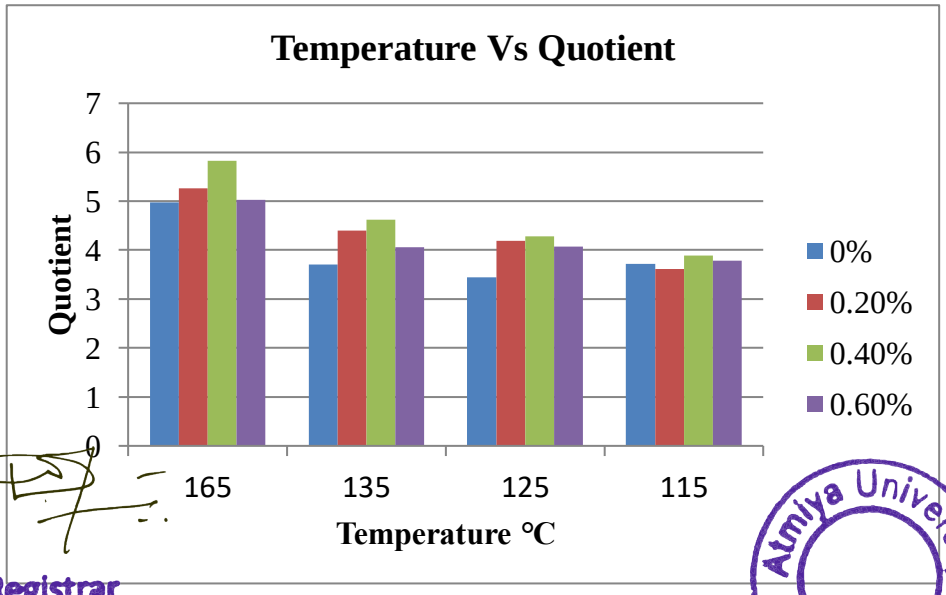

Table-5.10 Temperature Vs Marshall Quotient

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5.2.2MARSHALL VOLUMETRIC PARAMETERS

Marshall volumetric parameters are crucial indicators used in assessing the quality and performance of asphalt mixes. They include Bulk Specific Gravity (Gmb), Maximum Specific Gravity (Gmm), Air Void Content (Va), Voids in Mineral Aggregate (VMA), and Voids Filled with Asphalt (VFA). Marshall Mix design includes an analysis of the air spaces in the asphalt mix. These spaces are key to balancing strength, durability and easy handling of the compound.

Bulk Specific Gravity (Gmb): Gmb (Bulk Specific Gravity) is a key measurement in Marshall Mix design and refers to the density of the compacted asphalt mix. It basically tells you how much space the mixture takes up compared to the same volume of non-porous material. Relation between temperature and bulk specific gravity is when the temperature decreases, bulk specific gravity also decreases and when dose of wetbond increases, bulk specific gravity varying in all temperature ranges. Show in fig-5.11.

Table 5.12: Temperature Vs Gmb

Bulk Specific Gravity of the mixture (GMB) in (G/CC)					
Bitumen content in (%)	**Temperature (°C)**	**Conventional mix**	**Wetbond**		
			0.20%	**0.40%**	**0.60%**
6.40%	165	2.18	2.188	2.196	2.171
	135	2.168	2.201	2.189	2.159
	125	2.163	2.186	2.189	2.175
	115	2.168	2.156	2.187	2.161

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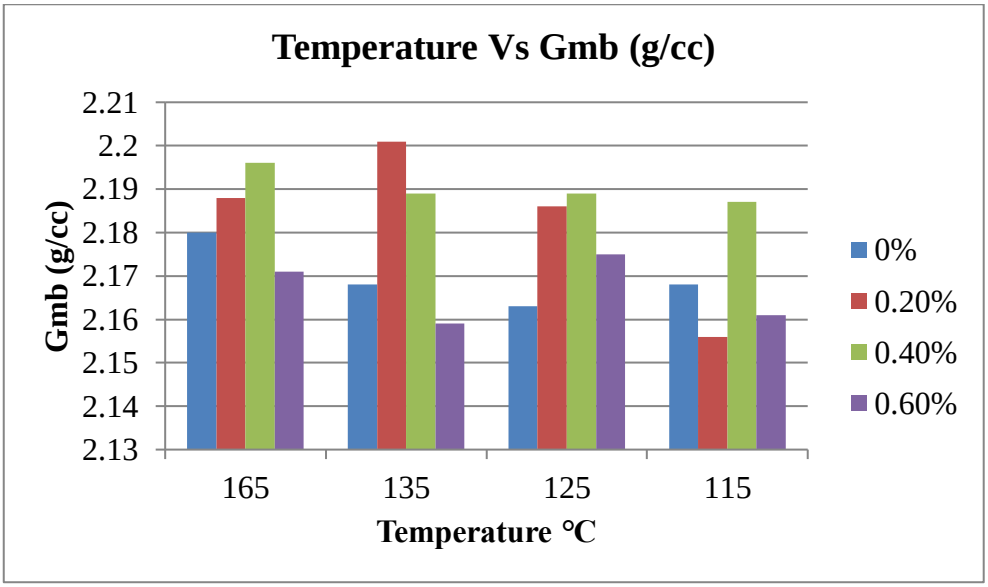

Fig-5.11 Temperature Vs Gmb

Air Voids (Va): The empty space between the aggregate and the asphalt. The right amount is needed to prevent water damage and give the tile a long life. Relation between temperature and air voids is when dose of wetbond increases, Air voids slightly decreases in 165℃ temperature till 0.4% dose of wetbond, in other temperature ranges, temperature decreases air voids is slightly increases and dose of wetbond increases air voids is varying. Show in fig-5.12.

Table 5.13: Temperature Vs Air Voids

Air Voids in (%) **(Requirement 3-5 % as per IRC: 135-2022)**					
Bitumen content in (%)	**Temperature (℃)**	**Conventional mix**	**Wetbond**		
			0.20%	**0.40%**	**0.60%**
6.40%	165	4.7434	4.4071	4.0789	5.1477
	135	5.2678	3.8285	4.384	5.6594

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	125	5.5023	4.4962	4.39	4.9628
	115	5.2854	5.8209	4.4683	5.6063

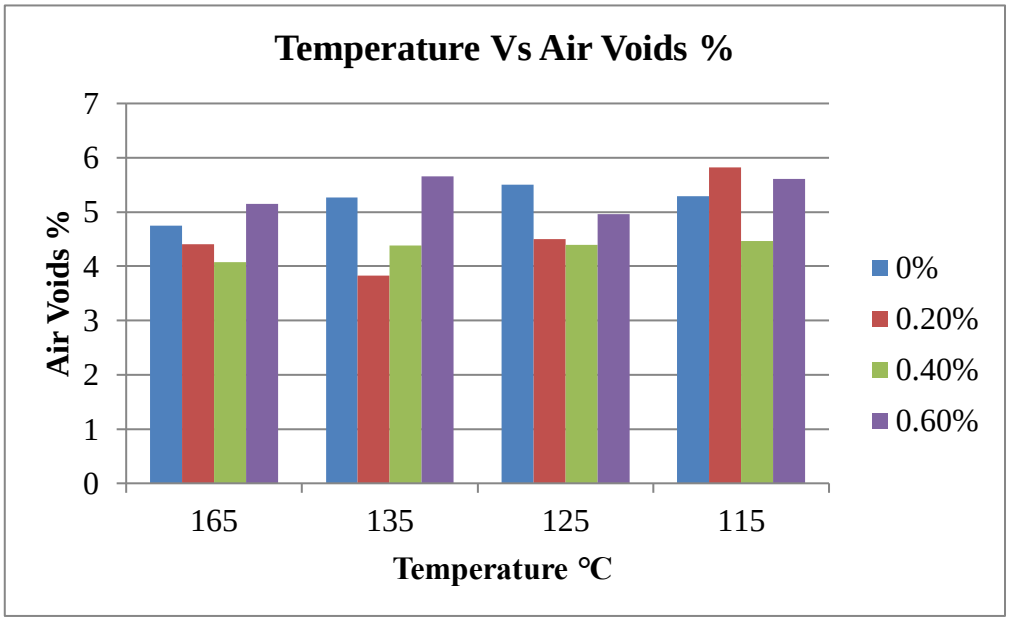

Fig-5.12 Temperature Vs Air Voids

Voids in Mineral Aggregate (VMA): Air space closely spaced between aggregate particles, without binder. Sufficient VMA allows drainage and prevents the binder from separating from the rocks. Relation between temperature and VMA is when temperature decreases, VMA is not affected and when dose of wetbond increases, VMA is slightly. Show in fig-5.13.

Table 5.14: Temperature Vs VMA

Voids in Mineral Aggregate (VMA) in (%) **(Minimum requirement 14 % as per IRC: 135-2022)**					
Bitumen content in (%)	**Temperature (℃)**	**Conventional mix**	**Wetbond**		
			0.20%	**0.40%**	**0.60%**

6.40%	165	18.815	18.528	16.366	19.16
	135	19.262	18.035	16.314	19.596
	125	19.462	18.604	16.313	19.002
	115	19.277	19.733	16.299	19.55

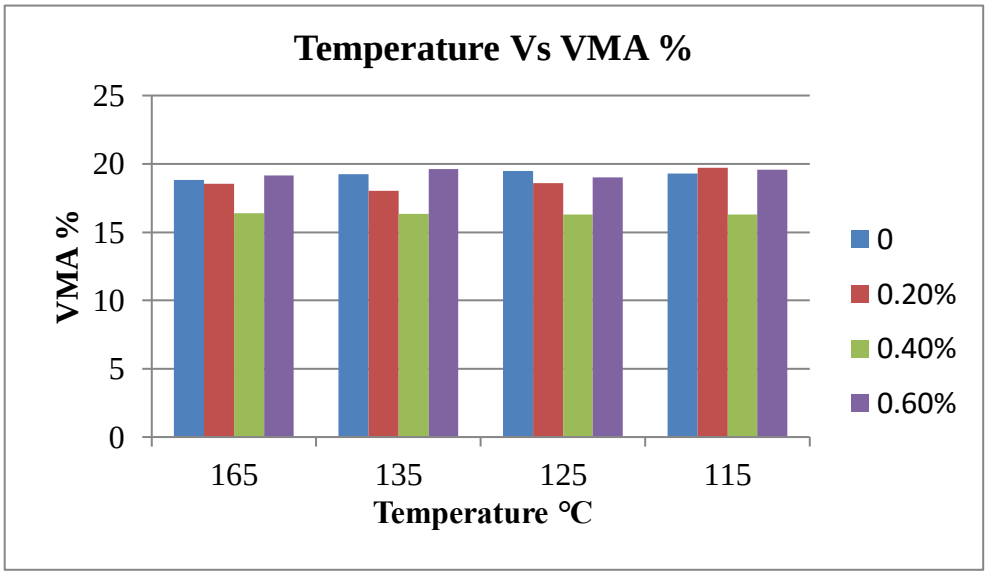

Fig-5.13 Temperature Vs VMA

Void spaces filled with asphalt (VFA): The part of the VMA filled with an asphalt binder. A good VFA makes for a strong mix, but too much can cause drainage problems. Relation between temperature and VFA is when temperature decreases, VFA decreases in all temperature ranges and dose of wetbond increases there is a fluctuation in VFA. Show in fig-5.14.

Table 5.15: Temperature Vs Volume field with bitumen

Volume Field with Bitumen (VFB) in (%) (Requirement 65-75 % as per IRC: 135-2022)

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Bitumen content in %	Temperature ℃	Conventional mix	Wetbond		
			0.20%	0.40%	0.60%
6.40%	165	74.796	76.218	75.068	73.209
	135	72.659	78.875	73.113	73.156
	125	71.747	77.637	73.083	74.119
	115	72.583	70.703	72.586	71.526

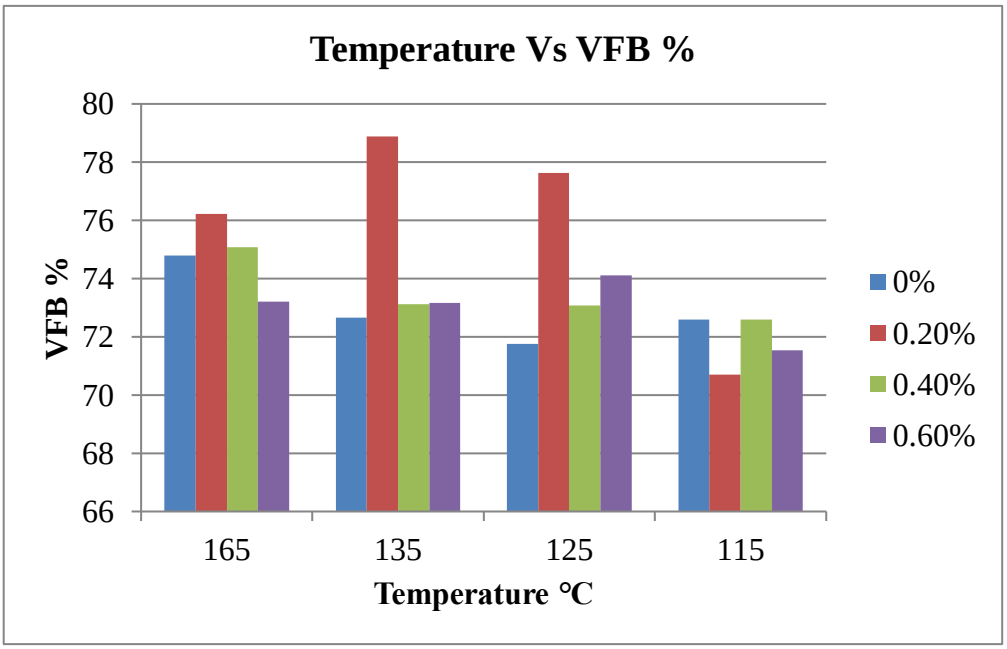

Fig-5.14 Temperature Vs VFB

These parameters, determined through laboratory testing, guide engineers in optimizing mix designs for strength, durability, and resistance to deformation, ensuring high-quality asphalt pavement construction.

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Table 5.16: Temperature Vs Marshall Volumetric Parameters

Bitumen (%)	Mixing Temperature (°C)	Wetbond (%)	Air voids (Va) in (%) (3-5)	VMA (%) (>14)	VFB (%) (65-75)	Stability in (KN) (>12)	Flow in (mm) (2.5-4)	MQ (2.5-5)	Bulk specific gravity of the mixture (Gmb) (g/cc)
6.4	165	0	4.7434	18.815	74.796	19.216	3.85	4.977	2.18
	135		5.2678	19.262	72.659	10.93	2.95	3.7011	2.168
	125		5.5023	19.462	71.747	10.082	2.925	3.4458	2.163
	115		5.2854	19.277	72.583	9.8413	2.65	3.714	2.168
	165	0.2	4.4071	18.528	76.218	20.861	3.95	5.26	2.188
	135		3.8285	18.035	78.875	15.405	3.5	4.394	2.201
	125		4.4962	18.604	77.637	13.403	3.425	4.19	2.186
	115		5.8209	19.733	70.703	11.07	3.05	3.612	2.156
	165	0.4	4.0789	16.366	75.068	24.486	4.2	5.824	2.196
	135		4.384	16.314	73.113	17.808	3.85	6.627	2.189

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	125		4.39	16.313	73.083	13.902	3.25	4.28	2.189
	115		4.4683	16.299	72.586	10.759	2.9	3.882	2.187
	165		5.1477	19.16	73.209	19.564	3.7	5.029	2.171
	135		5.6594	19.596	73.156	13.191	3.25	4.064	2.159
	125	0.6	4.9628	19.002	74.119	12.818	3.15	4.077	2.175
	115		5.6063	19.55	71.526	10.928	2.875	3.787	2.161

5.3 COMPARISON OF VOLUMETRIC PROPERTIES OF MARSHALL MIX WITH VARIOUS DOSES OF ZYCOTHERM AND WETBOND AT VARIOUS TEMPERATURES

In this experimental work finding volumetric properties of Marshall mix with various doses warm mix chemical additive zycotherm 0.05%, 0.1%, 0.15% at 165℃, 135℃, 125℃, 115℃ temperature and wetbond 0.2%, 0.4%, 0.6% at 165℃, 135℃, 125℃, 115℃ temperature. Mention in table 5.17 and Figure-5.15.

Table 5.17: Volumetric Properties of Marshall mix Comparison

Marshal Stability in (KN) (Minimum requirement 12 KN as per IRC:135-2022)								
Bitumen content in %	**Temperature ℃**	**Conventional mix**	**Zycotherm**			**Wetbond**		
			0.05%	**0.10%**	**0.15%**	**0.20%**	**0.40%**	**0.60%**

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6.40%	165	19.216	20.154	24.558	24.561	20.861	24.486	19.564
	135	10.93	15.009	17.603	17.479	15.405	17.808	13.191
	125	10.082	13.527	14.542	14.453	13.403	13.902	12.818
	115	9.8413	10.562	11.16	10.95	11.07	10.759	10.928

Marshal Flow in (MM)
(Requirement 2.5-4 MM as per IRC:135-2022)

Bitumen content in %	**Temperature ℃**	**Conventional mix**	**Zycotherm**			**Wetbond**		
			0.05 %	**0.10 %**	**0.15 %**	**0.20 %**	**0.40 %**	**0.60 %**
6.40%	165	3.85	3.85	4.2	4.15	3.95	4.2	3.7
	135	2.95	3.35	3.75	3.725	3.5	3.85	3.25
	125	2.925	2.97	3.35	3.15	3.425	3.25	3.15
	115	2.65	2.8	2.8	2.45	3.05	2.9	2.875

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Marshal Quotient in (MM) (Requirement 2.5-5 MM as per IRC:135-2022)								
Bitumen content in %	**Temperature ℃**	**Conventional mix**	**Zycotherm**			**Wetbond**		
			0.05 %	**0.10 %**	**0.15 %**	**0.20 %**	**0.40 %**	**0.60 %**
6.40%	165	4.977	5.211	5.847	5.925	5.26	5.824	5.029
	135	3.7011	4.478	4.695	4.692	4.394	4.627	4.064
	125	3.4458	4.546	4.337	4.585	4.19	4.28	4.077
	115	3.714	3.778	3.987	4.471	3.612	3.882	3.787

Air Voids in (%) (Requirement 3-5 % as per IRC:135-2022)								
Bitumen content in %	**Temperature ℃**	**Conventional mix**	**Zycotherm**			**Wetbond**		
			0.05%	**0.10 %**	**0.15 %**	**0.20%**	**0.40%**	**0.60%**
6.40%	165	4.7434	4.649	4.481	4.192	4.4071	4.0789	5.1477
	135	5.2678	4.924	4.335	4.438	3.8285	4.384	4.6594

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	125	5.5023	4.9516	4.249	4.922	4.4962	4.39	4.9628
	115	5.2854	4.509	4.667	4.806	5.8209	4.4683	5.6063

Voids in Mineral Aggregate (VMA) in (%) (Minimum requirement 14 % as per IRC:135-2022)								
Bitumen content in %	**Temperature °C**	**Conventional mix**	**Zycotherm**			**Wetbond**		
			0.05%	**0.10%**	**0.15%**	**0.20%**	**0.40%**	**0.60%**
6.40 %	165	18.815	18.735	16.297	16.346	18.528	16.366	19.16
	135	19.262	18.969	16.321	16.304	18.035	16.314	19.596
	125	19.462	18.992	16.336	16.221	18.604	16.313	19.002
	115	19.277	18.615	16.265	16.241	19.733	16.299	19.55

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Volume Field with Bitumen (VFB) in (%) (Requirement 65-75 % as per IRC:135-2022)								
Bitumen content in %	**Temperature ℃**	**Conventional mix**	**Zycotherm**			**Wetbond**		
			0.05%	**0.10%**	**0.15%**	**0.20%**	**0.40%**	**0.60%**
6.40 %	165	74.796	75.19	72.496	74.351	76.218	75.068	73.209
	135	72.659	74.057	73.429	72.772	78.875	73.113	73.156
	125	71.747	73.948	73.988	69.655	77.637	73.083	74.119
	115	72.583	75.73	71.306	70.405	70.703	72.586	71.526

Bulk Specific Gravity of the mixture (GMB) in (G/CC)								
Bitumen content in %	**Temperature ℃**	**Conventional mix**	**Zycotherm**			**Wetbond**		
			0.05 %	**0.10 %**	**0.15 %**	**0.20 %**	**0.40 %**	**0.60 %**
6.40%	165	2.18	2.183	2.186	2.193	2.188	2.196	2.171
	135	2.168	2.176	2.19	2.187	2.20	2.189	2.159

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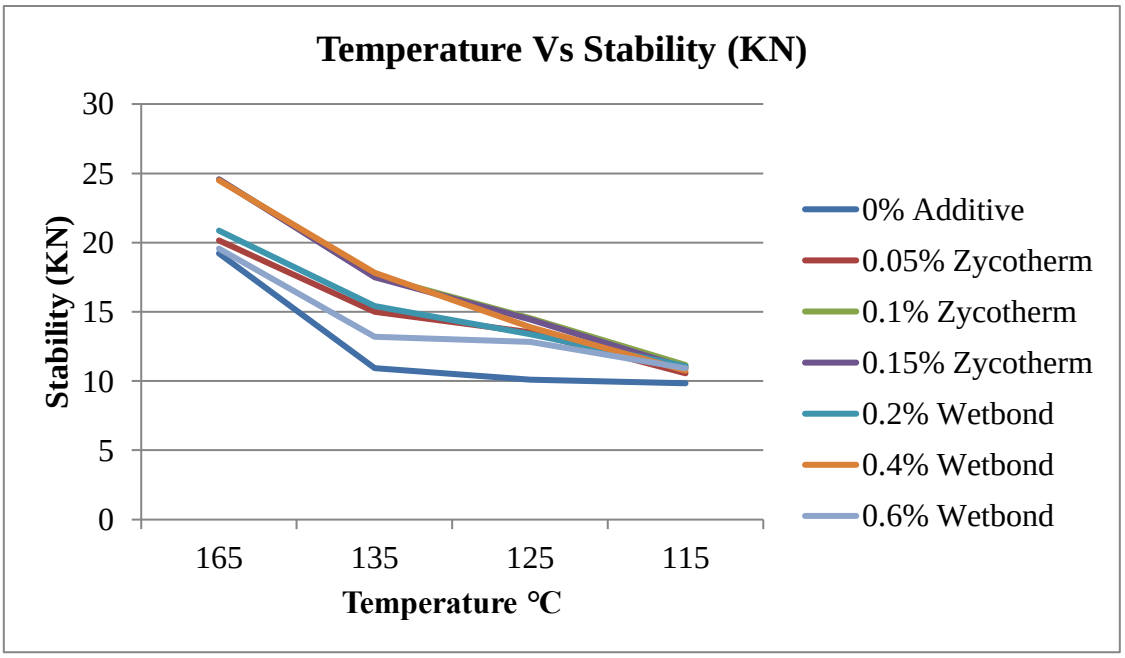
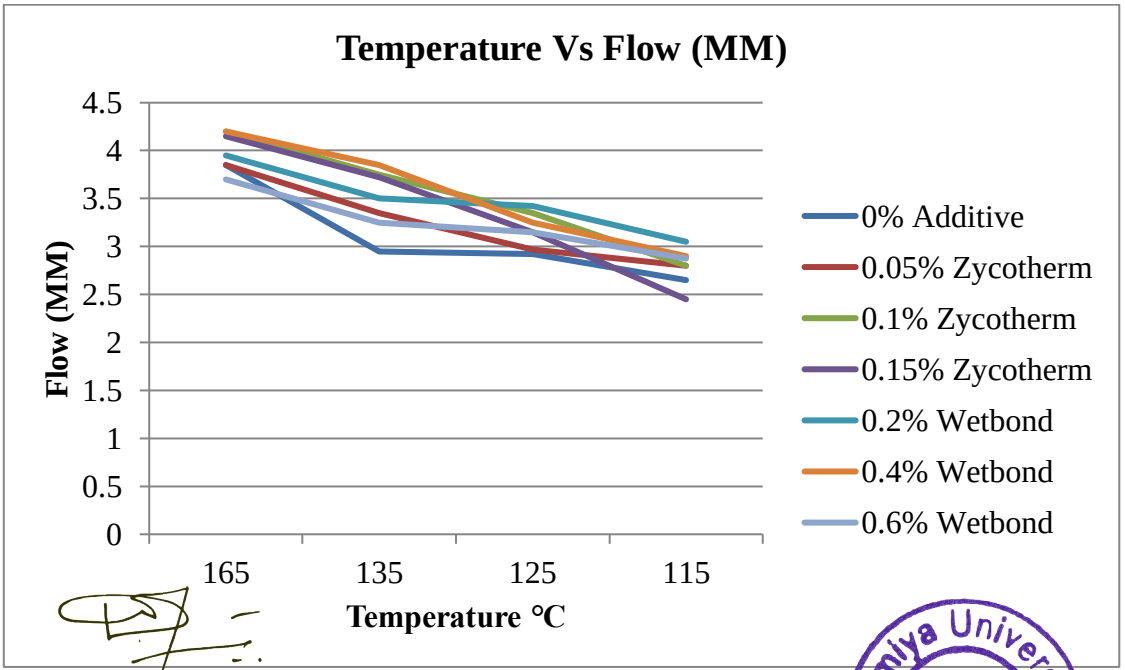
	125	2.163	2.176	2.192	2.176	2.186	2.189	2.175
	115	2.168	2.186	2.182	2.179	2.156	2.187	2.161





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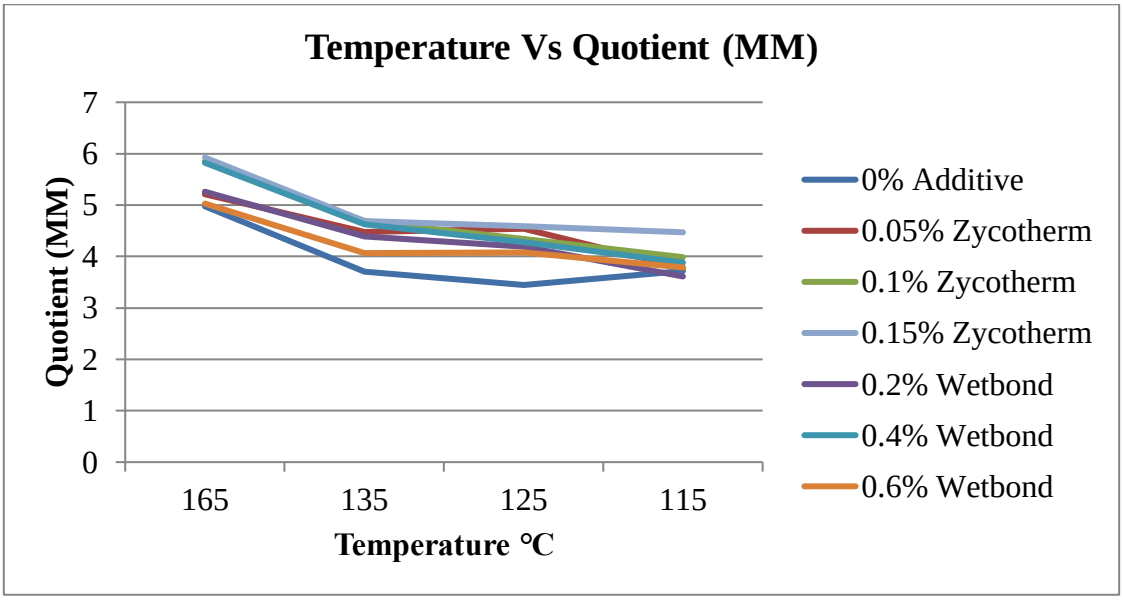

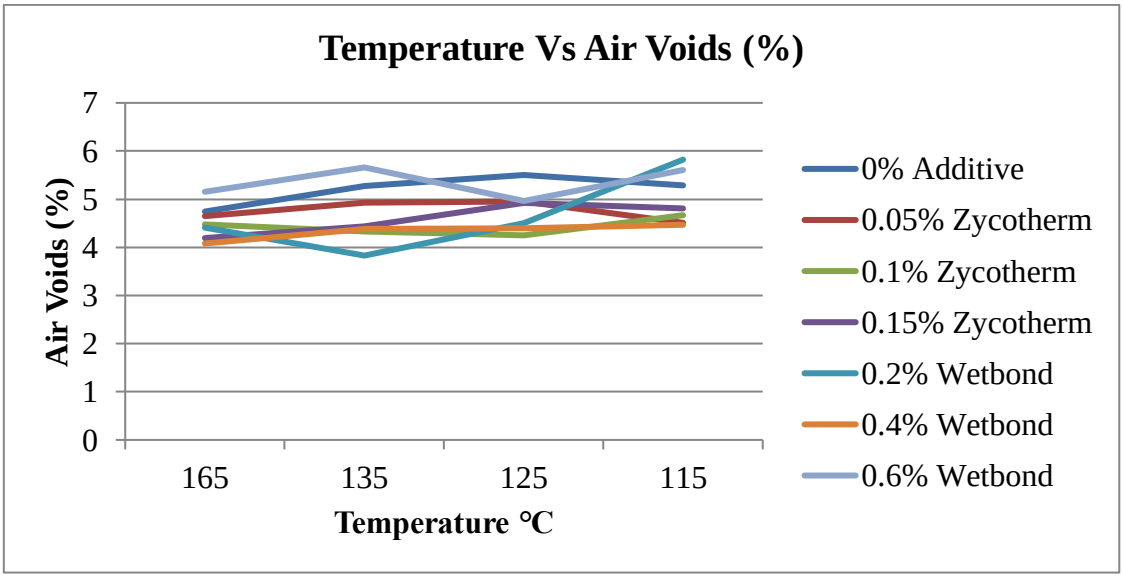

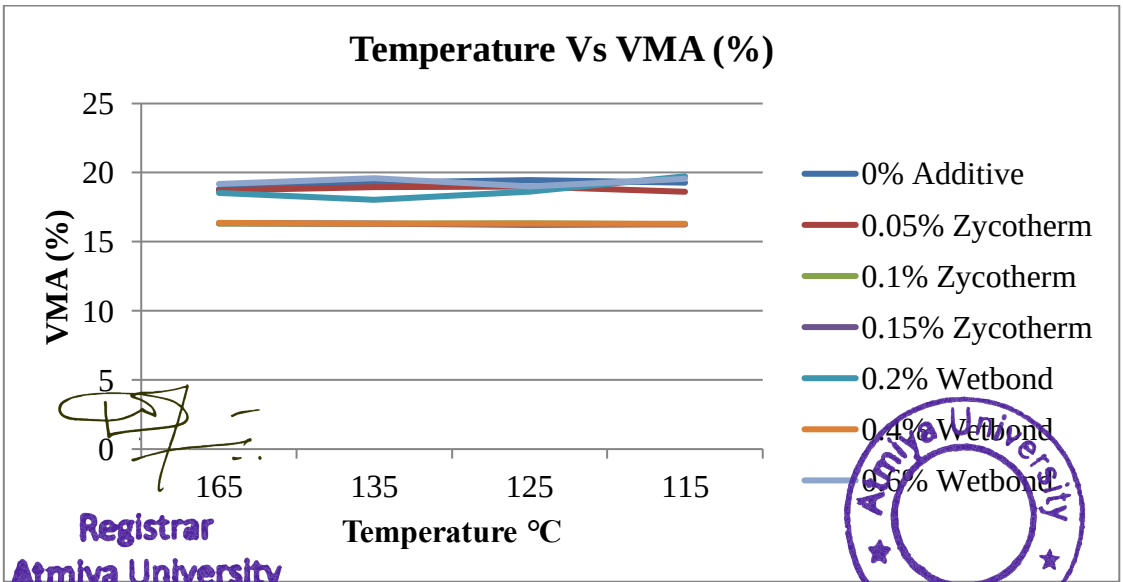

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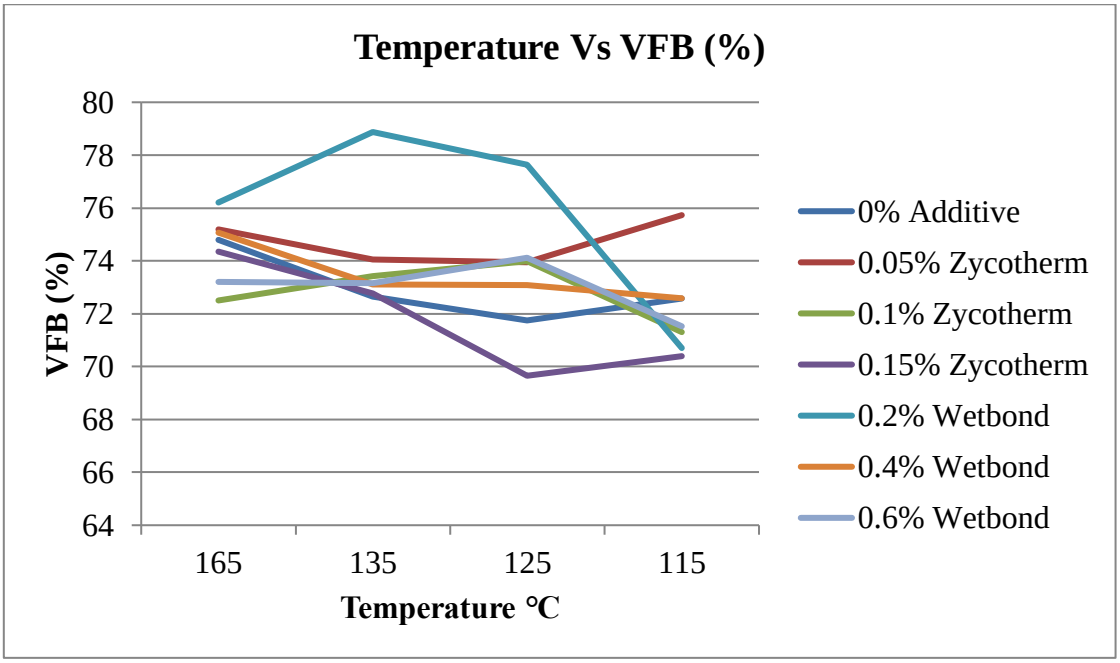

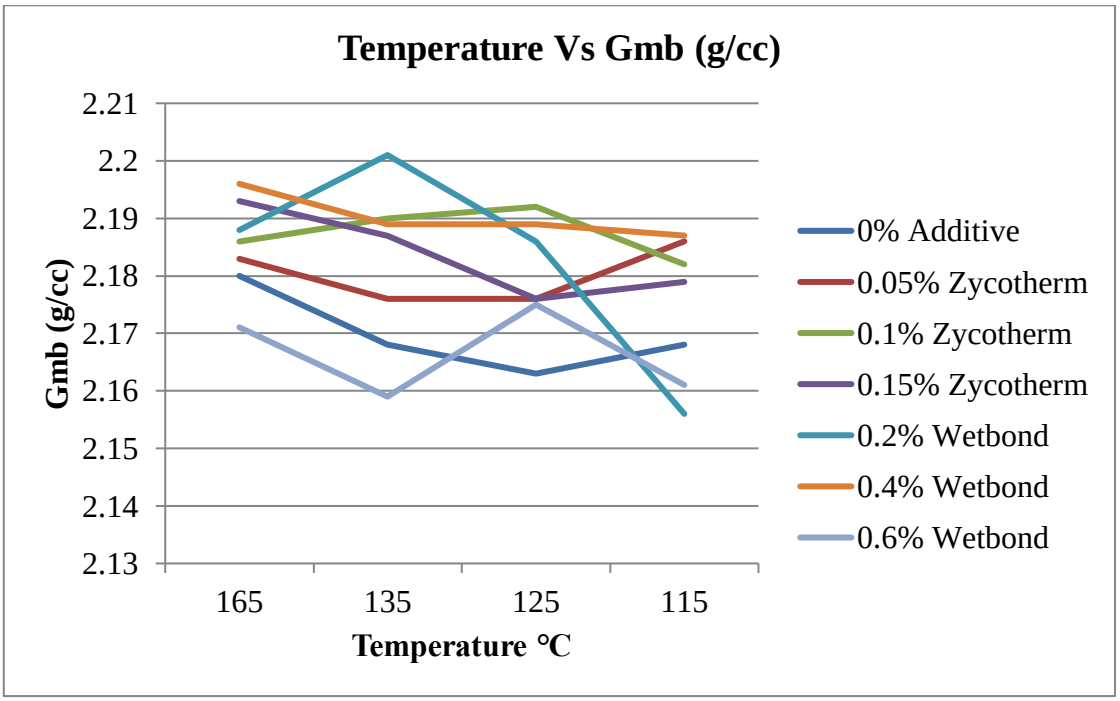

Fig-5.15 Volumetric Properties of Marshall mix Comparison

5.3 CONCLUSION

5.3.1 ZYCOTHERM CHEMICAL ADDITIVE

Warm mix additive can reduces production temperature of asphalt mixtures and that is not affect on their performance on Marshall Stability, Flow and Quotient also volumetric parameters are within range limit. In this research work conclude, in

conventional mix at 165℃ temperature achieved best result their Marshall properties all are within their range limit, at 0.05% dose of zycotherm by weight of total bitumen content in asphalt mix best results are achieved at 135℃ temperature their all Marshall properties are within range limit, at 0.1% dose of zycotherm by weight of total bitumen content in asphalt mix best results are achieved at 135℃ temperature their all Marshall properties are within range limit, at 0.15% dose of zycotherm by weight of total bitumen content in asphalt mix best results are achieved at 135℃ temperature their all Marshall properties are within range limit.

Overall conclude 0.1% dose of zycotherm by total bitumen content in asphalt mix at 135℃ temperature shows best results in Marshall Stability 17.603 KN, Flow value 3.75 MM, Quotient 4.695 and Marshall Volumetric parameters are within their range limit.

5.3.2 WETBOND CHEMICAL ADDITIVE

Warm mix additive can reduces production temperature of asphalt mixtures and that is not affect on their performance on Marshall Stability, Flow and Quotient also volumetric parameters are within range limit. In this research work conclude, in conventional mix at 165℃ temperature achieved best result their Marshall properties all are within their range limit, at 0.2% dose of wetbond by weight of total bitumen content in asphalt mix best results are achieved at 125℃ temperature their all Marshall properties are within range limit, at 0.4% dose of wetbond by weight of total bitumen content in asphalt mix best results are achieved at 125℃ temperature their all Marshall properties are within range limit, at 0.6% dose of wetbond by weight of total bitumen content in asphalt mix best results are achieved at 125℃ temperature their all Marshall properties are within range limit.

Overall conclude 0.4% dose of wetbond by total bitumen content in asphalt mix at 125℃ temperature shows best results in Marshall Stability 13.902 KN, Flow value 3.25 MM, Quotient 4.28 and Marshall Volumetric parameters are within their range limit.

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CHAPTER 6

ECONOMIC ANALYSIS

6.1 ECONOMIC ANALYSIS OF HOT MIX ASPHALT AND WARM MIX ASPHALT

According to Zydex Innovating for Sustainability Hot mix asphalt (HMA) is heated up to around 300 degrees Fahrenheit in a special oven to help reduce the curing time on the road. Warm mix asphalt (WMA) uses a process called “adhesive bonding” to create an even, strong bond between the aggregate and binder that allows it to be put down at about 180 degrees Fahrenheit without cooling. HMA is produced and transported at a higher cost than WMA because of the higher temperatures needed to prevent it from solidifying. Warm mix asphalt is more environmentally friendly than hot mix because it uses less fuel. The typical amount of fuel used to produce 1 ton of hot mix asphalt is 8 gallons, while with warm mix only 3.2 gallons is needed. Fuel consumption during WMA manufacturing is typically reduced by 20%.It also has a lower carbon footprint than hot mix, which means that not as much carbon dioxide is released into the air during production. The reason warm mix asphalt can be placed at a lower temperature is because it is less viscous or thick than hot mix asphalt and therefore easier to apply at a lower temperature. Construction crews can pave at lower temperatures, which allows opening the pavement for traffic sooner and lessens traffic gridlocks. The window for paving is widened and this results in the extension of the paving season, especially in colder climatic geographies. On certain days when the air quality is bad, paving activities are halted, thereby delaying the process of paving. WMA also produces lesser emissions, making it a possibility to construct pavements on such non-attainment days. Also, working conditions are a lot better with WMA. Both at the production plant and on the building site, crews inhale lesser smoke and dust. This decrease is especially significant in tunnels where ventilation is lesser. It has been utilized effectively in a wide scope of pavements with varying thicknesses. It is sufficiently strong to withstand high traffic demands. Warm Mix Asphalt has been utilized in a wide range of asphalt layers: dense-graded, stone matrix, porous, and mastic asphalt. Numerous WMA advances are available in the market, so the decision on the type of WMA can be adjusted according to the temperatures and materials required.

WMA has been utilized effectively in Europe for over 10 years. In the United States, WMA projects are presently in excess of 40 States [21].

6.2 ECONOMIC ANALYSIS OF HOT MIX ASPHALT AND WARM MIX ASPHALT USING ZYCOTHERM AND WETBOND CHEMICAL ADDITIVE

According to this experimental work conclude cost of using WMA technology is less than HMA technology. Using zycotherm and wetbond chemical as a warm mix additive in asphalt mix that is reduce production temperature of asphalt mix and reduce 20% energy consumption than traditional hot mix asphalt. WMA is reduced energy consumption during production. By requiring lower mixing and compaction temperatures, WMA production consumes less energy, leading to decreased emissions of greenhouse gases and other pollutants. This reduction in energy use contributes to mitigating the environmental impact of asphalt production while promoting energy efficiency. Additionally, WMA's lower temperatures result in decreased emissions of harmful gases and particulate matter, including carbon dioxide, nitrogen oxides, sulfur oxides, and volatile organic compounds. These emissions reductions help improve air quality and reduce the negative health effects associated with air pollution. Considering this experimental work result best dose of Zycotherm 0.1% and Wetbond 0.4% Rate analysis mentioned in table 6.1.

6.3 COST ANALYSIS FOR ONE TON ASPHALT MIX

Table 6.1: Cost comparison of HMA & WMA

Sr. No.	Item Description	Unit	Required Quantity	Rate per unit Rs.	Cost of Conventional mix in Rs.	Cost of Bituminous Mix with 0.1% Zycotherm in Rs.	Cost of Bituminous Mix with 0.4% Wetbond in Rs.

1	Bitumen (PMB-40)	Kg	64	60	3840	3840	3840
2	Aggregate 10 mm	Ton	0.250	400	100	100	100
3	Aggregate 6 mm	Ton	0.300	400	120	120	120
4	Stone Dust	Ton	0.450	400	180	180	180
5	Zycotherm	Kg	64	1000	-	64	-
6	Wetbond	Kg	54	850	-	-	54
7	Fuel Diesel [21]	Liter	30.3	90	2727	-	-
8	Fuel Diesel [21]	Liter	12.12	90	-	1091	1091
9	Total Cost				6967	5395	5385

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CHAPTER 7

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ANNEXTURE – A

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ANNEXTURE – B

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College Name : Atmiya University.

College Code : 051

Branch Name : Civil Eng. (Transportation)

Theme of Title : Highway Material.

Title of Thesis : Comparative study on Effect of chemical additive in warm mix Asphalt.

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Name : Ms. Ashrut Matheliya
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Institute :
Institute Code :
Mail Id :
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❖ Comments For Internal Review ( ) (Semester 3)

Exam Date : 20/10/2023 & 06/11/2023

Sr. No.	Comments given by Internal review panel (Please write specific comments)	Modification done based on Comments
1.	modify objective	done
2.	Add more literature regarding to objective.	
3	modify methodology Chart	
4.	Improve knowledge regarding your topic.	
		(Guide Sign.)

Particulars	Internal Review Panel	
	Expert 1	Expert 2
Name :	Ms. Asheret Mevthukiya	Ms. Mayursinh Jadeja
Institute :	A.U.	AU
Institute Code :		
Mobile No. :	9974107583 77	7874800084
Sign :		

Particulars	Internal Guide Details	
	Expert 1	Expert 2
Name :	Ms. Asheret Mevthukiya	
Institute :	A.U.	
Institute Code :		
Mobile No. :	9974107583 77	
Sign :		

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❖ **Comments of Dissertation Phase-1 ( )** **(Semester 3)**

Exam Date : 30 / 11 / 2023

Title : Comparative study on effect of chemical additive in warm mix asphalt.

1. Appropriateness of title with proposal. (Yes/ ~~No~~) YES
2. Whether the selected theme is appropriate according to the title ? (Yes / ~~No~~) YES
3. Justify rational of proposed research. (Yes/ ~~No~~) YES
4. Clarity of objectives. (Yes/ ~~No~~) YES

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Exam Date : 30/11/2023

Sr. No.	Comments given by External Examiners (DP-I) : (Please write specific comments)	Modification done based on Comments
1)	Modify Objectives	done
2)	Add Summary of all literature paper	
3)	Modify Methodology	
4)	Arrange Reference alphabetically.	

(Internal Guide Sign.)

- *Approved* ☐
- *Approved with suggested recommended changes* ☑
- *Not Approved* ☐

Please tick on any on. If approved/approved with suggession then put marks ≥ 50 %.

➢ ***Details of External Examiners :***

Particulars	*Full Name*	*University / College Name & Code*	*Mobile No.*	*Sign.*
Expert 1	JAY KALARIA	MARWADI UNIVERSITY	9879470878	
Expert 2				

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❖ Comments of Mid Sem Review ( ) (Semester 4)

Exam Date : 15/03/2024

Sr. No.	Comments given by External Examiners : i) The appropriateness of the major highlights of work done; State here itself if work can be approved with some additional changes. ii) Main reasons for approving the work. iii) Main reasons if work is not approved.	Modification done based on Comments
1]	Modify Methodology chart	
2]	Put graphical Representation in line diagram for volumetric parameters	
3]	Redesting the physical properties of Aggregates	
4]	Add Cost Analysis for further scope of work	
5]	Improve the concept of work regarding the field work	
6]	Work progress is very slow.	
		Internal Guide Sign.

- *Approved* ☐
- *Approved with suggested recommended changes* ☑
- *Not Approved* ☐

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Expert 2				

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❖ Comments of DP-II Review ( ) (Semester 4)

Exam Date : / /

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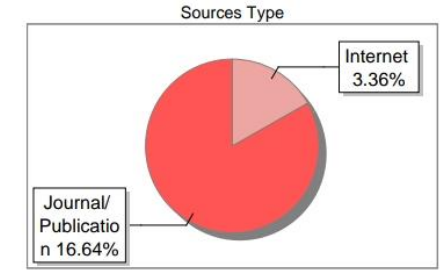

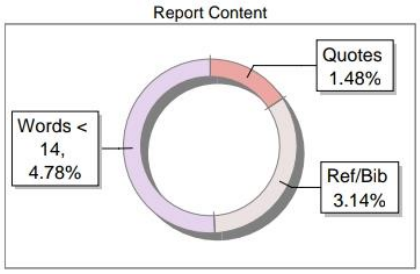

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SOLUBILITY ENHANCEMENT OF POORLY SOLUBLE DRUGS BY FORMULATION OF SOLID DISPERSION USING SOLUPLUS® AS A CARRIER

By

SHEIKH MOHAMMED FARHAN MOHAMMED MUSTAFA

Enrollment Number: 220521003

Research guide

Ms. REENA UGHREJA

Research Co-guide

Ms. HANI JANI

Dr. KEVINKUMAR C. GARALA

A Thesis Submitted to Atmiya University in Partial Fulfillment of the Requirements for the Master of Pharmacy in Pharmaceutics

JULY-2024

Department of Pharmaceutics

School of Pharmaceutical Sciences, Faculty of Health Sciences

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LIST OF CONTENTS

Elements	Page No.
Acknowledgment	**I**
List of contents	**II**
List of Tables	**IV**
List of Figures	**VI**
Abbreviations	**IX**
Abstract	**X**
1. Introduction 1.1 BCS Classification of Drugs 1.2 Classification of Solid Dispersion 1.3 Mechanism of Solid dispersion 1.4 Mechanism of Bioavailability Enhancement 1.5 Advantages and Disadvantages 1.6 Common techniques used for the formulation of Solid dispersion 1.7 Type of Carriers 1.8 Current Trends in Solid Dispersion 1.9 Introduction to Diseases • Introduction to tuberculosis • Introduction to Major Depressive Disorder • Introduction to Prostate Cancer	**1**
2. Review of literature	**29**
3. Aim and Objective 3.1 Aim 3.2 Objectives	**41**
4. Profiles 4.1 Drug profiles 4.2 Polymer profile	**43**
5. Materials and Methods 5.1 Materials 5.2 Equipments 5.3 Methods	**55**
6. Results and Discussion 6.1 Preliminary trails 6.2 Results 6.2.1 Rifampicin 6.2.2 Duloxetine HCl 6.2.3 Abiraterone Acetate	**61**
7. Summary and Conclusion	**97**

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8. References	**99**
9. Annexure	**109**

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LIST OF TABLES

No.	Name	Page No.
1.1	BCS classification of drugs	2
5.1	List of Chemicals	55
5.2	List of Equipments	55
5.3	Composition batches of Rifampicin formulations	56
5.4	Composition batches of Duloxetine HCL formulations	57
5.5	Composition batches of Abiraterone Acetate formulations	57
6.1	Characterization of Rifampicin, its physical mixture, and its SDs	63
6.2	Dissolution profile of Rifampicin and its SDs	64
6.3	Comparison of FTIR wavelengths of Rifampicin, its physical mixture, its SDs	67
6.4	Characterization of Duloxetine Hydrochloride and its SDs	74
6.5	Dissolution profile of Duloxetine HCl, its physical mixture, and its SDs	75
6.6	Comparison of FTIR wavelengths of Rifampicin and its physical mixture	78
6.7	Characterization of Abiraterone Acetate, its physical mixture, and its SDs	85
6.8	Dissolution profile of Abiraterone Acetate, its physical mixture and its SDs	87
6.9	Comparison of FTIR wavelengths of Abiraterone Acetate, its physical mixture, its SDs	92
6.10	XRD peak intensity comparison of Abiraterone Acetate and its SDs	96
9.1	Standard curve of Rifampicin with water	110
9.2	Standard curve of Rifampicin with methanol	111
9.3	Standard curve of Rifampicin with Phosphate buffer (7.4)	112
9.4	Standard curve of Duloxetine Hydrochloride with water	115
9.5	Standard curve of Duloxetine Hydrochloride with methanol	116

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9.6	Standard curve of Duloxetine Hydrochloride with phosphate buffer (6.8)	117
9.7	Standard curve of Abiraterone Acetate with methanol	119
9.8	Standard curve of Abiraterone Acetate with distilled water	120
9.9	Standard curve of Abiraterone Acetate with Phosphate buffer (4.5)	121

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LIST OF FIGURES

No.	Name	Page No.
1.1	Schematic diagram of Melt Extrusion	7
1.2	Schematic diagram of Spray Drying	10
4.1	Chemical structure of Rifampicin	43
4.2	Chemical structure of Duloxetine Hydrochloride	47
4.3	Chemical structure of Abiraterone Acetate	50
4.4	Chemical structure of Soluplus®	53
6.1	Solubility study of Rifampicin pure drug, its physical mixture & its solid dispersions	63
6.2	Cumulative % release studies of Rifampicin pure drug, its physical mixture & its solid dispersions	65
6.3	Release studies of Rifampicin pure drug vs formulation (SE-SD 1:3)	65
6.4	Release studies of Rifampicin pure drug vs formulation (ME-SD 1:3)	66
6.5	%Drug release of Rifampicin pure drug, physical mixture, and its solid dispersion	66
6.6	FTIR spectra of Rifampicin	67
6.7	FTIR spectra of Soluplus®	67
6.8	FTIR spectra of Rifampicin physical mixture	68
6.9	FTIR spectra of Rifampicin formulation R3 (SE-SD 1:3)	68
6.10	FTIR spectra of Rifampicin formulation R6 (ME-SD 1:3)	69
6.11	DSC thermogram of Rifampicin	70
6.12	DSC thermogram of Soluplus®	70
6.13	DSC thermogram of Rifampicin formulation R3 (SE-SD 1:3)	71
6.14	DSC thermogram of Rifampicin formulation R6 (ME-SD 1:3)	71
6.15	XRD spectra of Rifampicin	72
6.16	XRD spectra of Soluplus®	72
6.17	XRD spectra of Rifampicin formulation R3 (SE-SD 1:3)	73
6.18	XRD spectra of Rifampicin formulation R6 (ME-SD 1:3)	73

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Atmiya University Rajkot

6.19	Solubility studies of Duloxetine Hydrochloride, its physical mixture, and its solid dispersions	74
6.20	Cumulative % release studies of Duloxetine Hydrochloride, its physical mixture, and its solid dispersions	76
6.21	Release studies of Duloxetine HCl vs formulation **(**SE-SD 1:3)	77
6.22	Release studies of Duloxetine HCl vs formulation **(**ME-SD 1:3)	77
6.23	**%**Drug release study of Duloxetine HCL pure drug, its physical mixture and its solid dispersion	78
6.24	FTIR spectra of Duloxetine Hydrochloride	79
6.25	FTIR spectra of Duloxetine Hydrochloride physical mixture	79
6.26	FTIR spectra of Duloxetine Hydrochloride formulation D3 (SE-SD 1:3)	80
6.27	FTIR spectra of Duloxetine Hydrochloride formulation D6 (ME-SD 1:3)	80
6.28	DSC thermogram of Duloxetine Hydrochloride	81
6.29	DSC thermogram of Duloxetine Hydrochloride physical mixture	81
6.30	DSC thermogram of Duloxetine Hydrochloride formulation D3 (SE-SD 1:3)	82
6.31	DSC thermogram of Duloxetine Hydrochloride formulation D6 (ME-SD 1:3)	82
6.32	XRD spectra of Duloxetine Hydrochloride	83
6.33	XRD spectra of Duloxetine Hydrochloride formulation D3 (SE-SD 1:3)	83
6.34	XRD spectra of Duloxetine Hydrochloride formulation D6 (ME-SD 1:3)	84
6.35	Solubility study of Abiraterone Acetate pure drug, its physical mixture, and its solid dispersion	86
6.36	Cumulative % release studies of Abiraterone Acetate, its physical mixture, and its SDs	88
6.37	% Release studies of Abiraterone Acetate vs formulation (SE-SD 1:3)	88
6.38	% Release studies of Abiraterone Acetate vs formulation (ME-SD 1:3)	89
6.39	%Drug release study of Abiraterone Acetate pure drug, its physical mixture and its solid dispersion	89
6.40	FTIR spectra of Abiraterone Acetate	90
6.41	FTIR spectra of Abiraterone Acetate physical mixture	90

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6.42	FTIR spectra of Abiraterone Acetate formulation A3 (SE-SD 1:3)	91
6.43	FTIR spectra of Abiraterone Acetate formulation A6 (ME-SD 1:3)	91
6.44	DSC thermogram of Abiraterone Acetate	93
6.45	DSC thermogram of Abiraterone Acetate physical mixture	93
6.46	DSC thermogram of Abiraterone Acetate formulation A6 (ME-SD 1:3)	94
6.47	XRD spectra of Abiraterone Acetate	95
6.48	XRD spectra of Abiraterone Acetate formulation A6 (SE-SD 1:3)	95
6.49	XRD spectra of Abiraterone Acetate formulation A6 (ME-SD 1:3)	96
9.1	Λmax of Rifampicin	109
9.2	Λmax of Rfampicin	110
9.3	Standard curve of Rifampicin with water	111
9.4	Standard curve of Rifampicin with methanol	112
9.5	Standard curve of Rifampicin with Phosphate buffer (7.4)	113
9.6	Λmax of Duloxetine hydrochloride	114
9.7	Λmax of Duloxetine hydrochloride	114
9.8	Standard curve of Duloxetine Hydrochloride with water	115
9.9	Standard curve of Duloxetine Hydrochloride with methanol	116
9.10	Standard curve of Duloxetine Hydrochloride with phosphate buffer (6.8)	117
9.11	Λmax of Abiraterone Acetate	118
9.12	Λmax of Abiraterone Acetate	118
9.13	Standard curve of Abiraterone Acetate with methanol	119
9.14	Standard curve of Abiraterone Acetate with distilled water	120
9.15	Standard curve of Abiraterone Acetate with Phosphate buffer (4.5)	121

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

Abbreviations

FT-IR: Fourier transform infrared spectroscopy

DSC: Differential Scanning Calorimetry

%: Percentage

µg/ml: Microgram per milliliter

nm: nanometer

°C: Degree Centigrade

SE: Solvent Evaporation

ME: Melt Evaporation

HME: Hot Melt Extrusion

SD: Solid dispersion

XRD: X-ray Diffraction

PD: Pure drug

PM: Physical Mixture

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ABSTRACT

Treatment of tuberculosis makes great use of rifampicin. While Abiraterone Acetate is generally used for the treatment of prostate cancer, Duloxetine Hydrochloride is advised for the treatment of major depressive disorder. Still, the low water solubility of all these drugs affects their bioavailability. Thus, this work sought to generate solid dispersions thereby enhancing the solubility and hence the dissolution rate of Rifampicin, Duloxetine hydrochloride, and Abiraterone Acetate. Soluplus® was used as a carrier to enhance solubility; phase solubility investigations carried out in preliminary trials helped to ascertain the ratio. First investigations were carried out to select the suitable solvent and techniques; thereafter, solid dispersions were developed. The Physical characterization was done by DSC and FT-IR. DSC was performed to determine the thermal characteristics of the drug and FT-IR was performed to determine the compatibility between the drug and polymer. Melt and solvent evaporation techniques were used to produce the solid dispersion. The batches had ratios ranging from 1:1, 1:2, and 1:3. %Drug content, %yield, solubility studies, and in-vitro dissolution studies were among the evaluation parameters performed for the solid dispersion assessment. The batch showing good results was selected for further investigation with XRD, DSC, and FT-IR methods. The best batches of all the drugs (Rifampicin, Duloxetine HCL and Abiraterone Acetate) showed enhancement in the solubility and dissolution rate.

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CHAPTER 1
INTRODUCTION

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1. INTRODUCTION

Approximately 35-40% of medications are characterized by low solubility in water. The insolubility of certain substances might cause difficulties in their absorption from the gastrointestinal tract, leading to variations in absorption among individuals and even within the same individual [1]. Additionally, there is a reduction in the proportion of drug that can be absorbed via the mouth, therefore there is a necessity to increase the dosage of the drug to attain the required therapeutic effect, potentially leading to difficulties in formulating the medication.

To tackle these problems, a range of methods are utilized to create pharmaceutical formulations. The procedures encompass the formation of solid solutions or solid dispersions utilizing hydrophilic carriers, complexation, micronization, and solubilization. In addition, techniques such as employing dendrimers to enhance drug solubility and utilizing self-micro emulsifying drug delivery systems (SMEDDS) are used.[2]

There are a wide range of methods that have been employed to improve solubility, which also include the utilization of pro-drug strategies, spray drying, salt synthesis, and nanoparticle technologies. An especially encouraging option involves employing numerous hydrophilic carriers in a direct solid dispersion technique.[3]

In 1961, Sekiguchi and Obi enhanced the rate at which Sulfathiazole dissolves and becomes available for absorption in the body by utilizing a eutectic mixture of sulfathiazole with urea as an inactive carrier [4]. Subsequently, other researchers devised distinct methodologies for producing solid dispersions. Goldberg's research revealed that a specific portion of the medication can be evenly distributed at a molecular level inside the surrounding material, resulting in the formation of solid solutions [5]. According to some researchers, drug could potentially be integrated into the matrix in the form of amorphous substances.

Definition: Solid dispersion can be defined as the dispersion of one or more active pharmaceutical ingredients in an inert carrier at the solid state. It can also convert the API's crystalline state to an amorphous state for better solubilization.[3]

Solubility and bioavailability are interconnected. To understand bioavailability, it's important to grasp the Noyes-Whitney equation, as it helps comprehend dissolution [6]

Noyes-Whitney eq. is written as

$$\frac{dC}{dt} = \frac{AD(Cs - C)}{H}$$

Where,

dC/dt = It is the rate of dissolution.

A = Surface area appropriate for dissolution.

D = Diffusion coefficient.

Cs = Solubility of molecule in dissolution medium.

C = Concentration of a drug in the medium at time t.

H = Thickness of diffusion membrane

1.1 BCS Classification of Drugs

The Biopharmaceutical classification system classifies the drugs based on their aqueous solubility and intestinal permeability.[7]

This is an important classification system as it can reduce the need for in-vivo bioequivalence studies. With the Invitro characteristics of the drug, the BCS takes into account the 3 major factors which are intestinal permeability, aqueous solubility, and Dissolution rate.

The BCS classifies the drug into 4 different classes as shown in Table 1.1:

TABLE: 1.1 BCS CLASSIFICATION OF DRUGS

Class	Dissolution in aq. environment	Permeation over the intestinal membrane
1.	Fast	Fast
2.	Slow	Fast
3.	Fast	Slow
4.	Slow	Slow

1.2 Types of solid dispersion according to the generation of carriers used

The Solid dispersions are classified according to the generation of the polymer used in the formulation. Based on the generation of the polymers the classification is divided into 4 types.[8] They are as follows:

1. First Generation Solid Dispersion
2. Second Generation Solid Dispersion
3. Third-generation Solid Dispersion
4. Fourth Generation Solid Dispersion

1.2.1 First-generation solid dispersion: This formulation is made from crystalline carriers including urea and sugars. This method produces a thermodynamically stable crystalline solid dispersion (SD) with slow dispersal at last. The first step forward in the realm of Solid dispersions came from the creation of eutectic mixtures. The absence of any alteration in the melting points of both the drug and polymer shows the non-ideal nature of the monotectic mixture.

The Eutectic mixture shows lower melting points when compared to the melting points of the drug and carrier. Because the eutectic mixture crystallizes both the drug and the carrier instantly upon cooling, it is better than the monotectic combination. Reducing the particle size increases the specific surface area, therefore improving bioavailability and accelerating the dissolving rate.[9]

1.2.2 Second-generation solid dispersion: Part of the second generation of carriers, amorphous carriers such as Polyvinyl Pyrrolidone (PVP) and Polyethylene Glycol (PEG) are well-known for their exceptional thermodynamic stability when compared to the first generation. amorphous carriers can be synthetic and natural polymers.

Based on the physical state of the drug the amorphous Solid dispersions can either exist as solutions, suspensions, or a mixture of both. Due to the drug's limited solubility in the carrier, the amorphous Solid dispersions consist of two phases. In contrast, amorphous solid solutions evenly distribute components throughout the molecules. The medication may experience recrystallization during storage, leading to a reduction in dissolving crystals.[9], [10]

1.2.3 Third-generation solid dispersion: To address drug nucleation and agglomeration, the carrier in this iteration needs to exhibit surface activity or emulsifying activity. This quality

enhances the dissolution rate, physical stability, and chemical stability of the formulated drug while also hindering recrystallization.

Examples of third-generation carriers such as poloxamer (P188), are efficient in preventing recrystallization, and surfactants like Gelucire 44/14 and Solutol HS 15 are used to increase the dissolving rate of pharmaceuticals.[10]

1.2.4 Fourth-generation solid dispersion: The most recent development in dispersion technology, as opposed to amorphous Solid dispersions (ASD), is Controlled Release Solid dispersions (CRSD). Carriers such as HPC and ERS are suggested for the prolonged release of medications with short biological half-lives. The controlled-release drug delivery system's principal goals are controlled-release medication prolongation and improved solubility.[8]

1.3 Mechanism of solid dispersion

The mechanism of solid dispersion is divided into two parts they are Carrier-controlled and Drug-controlled.[11]

1.3.1 Carrier-controlled Release: A research study was conducted to monitor the dissolution rate of medication and the polymer (specifically PEG) it was integrated with. It was found that the dissolution rate of the drug was controlled by the dissolution rate of the polymer because of the correlation between the dissolution rate of the drug from the polymer and the dissolution rate of the polymer itself.

This observation was supported by another scholar, who noticed similar dissolution rates of various medications in a single carrier prepared under comparable conditions. In these instances, the particles dissolve rapidly into a polymer-rich diffusion layer. Such fast dissolution prevents the particles from being released in their original form into the surrounding liquid. The medicine is uniformly dispersed at a molecular level across this densely concentrated layer, leading to even distribution.[11], [12]

1.3.2 Drug-controlled Release: An investigation was conducted by a researcher in which, the particle size of griseofulvin particles released from dispersions was evaluated, revealing that the rate at which the particles dissolved was directly impacted by their size. Furthermore, Craig (2002) used a series of pharmaceuticals (para-aminobenzoates) to investigate the relationship between the

solid-state structure, drug solubility, and dissolution rate, aiming to reconcile these discrepancies.[13]

Their research showed that the solubility of the model pharmaceuticals was directly related to their intrinsic dissolution rate in the dispersions. The solubility rate was found to be directly related to drug characteristics, not polymer. There is a difference between carrier-controlled release and this method, it can be called the drug-controlled release.[14]

Slow solubility into the polymer diffusion layer is the key to drug-controlled dissolution, which allows for the controlled release of solid drug particles. Therefore, the drug's properties, including its size and physical shape, govern the dissolution process, rather than the polymer. Using larger surface area particles can still significantly improve solubility, leading to greater wetting and less agglomeration, even when using normal dose forms.[14], [15]

1.4 Mechanism of bioavailability enhancement

Making solid dispersions, which speeds up the medication's dissolving process, is the technique by which bioavailability is enhanced. This acceleration can be less than twice the dissolving rate or as high as 400 times that of pure medicine. The enhanced rate of dissolution might be ascribed to a multitude of causes, making it difficult to empirically demonstrate the relative significance of any individual element [16], [17]. Solid dispersions enhance the rate at which the drug dissolves through one of the following mechanisms:

- Decrease in particle size
- Enhancement in the ability of a substance to spread and mix with a liquid, as well as its ability to disperse evenly.
- Altering the drug's crystalline structure to an amorphous state.
- By reducing the clustering and clumping of medication particles.

1.5 Advantages and Disadvantages

1.5.1 Advantages: The improved solubility of poorly water-soluble drugs through SD technology can be linked to several factors [18], [19]. The advantages of Solid dispersions can be succinctly outlined as follows:

Particles with reduced particle size: Solid dispersions refer to the final stage of reducing particle size, where the medication is dissolved in an inert carrier or matrix and distributed at a molecular

level in the dissolution media. An elevated surface area is created, leading to an enhanced rate of dissolution, and further improving the bioavailability of the drug that is not easily soluble in water.

Particles with improved wettability: Improved wettability of drugs can lead to enhancement in solubility.

Particles with higher porosity: Higher porosity particles resulting from Solid dispersions depend on the characteristics of the carrier material with good characteristics can lead to the formation of Solid dispersions with higher porosity particles; the degree of enhancement determines this as well. Larger and more porous particles are generated from linear polymers than from Solid dispersions made using reticular polymers. The higher dissolving rate of the particles comes from their porous construction.

Drugs in the amorphous state: Generally speaking, low water solubility crystalline drugs show higher solubility in this form. The lack of energy required to disturb the crystal structure during the dissolving process causes a drug to show more drug release in an amorphous form.

1.5.2 Disadvantages: The primary drawbacks of Solid dispersions arise from their intrinsic instability. With time, the process of aging can cause alterations in the crystalline structure and a reduction in the pace at which a substance dissolves in different systems. Moisture absorption can initiate phase separation, formation of crystals, or a stable form from the unstable or less stable crystalline phase. This can impact the formulation and ultimately decrease the solubility of the drug. Solid dispersions are more vulnerable to the adverse impacts of moisture and temperature in comparison to physical mixes. At times, it can be difficult to handle because of its adhesive nature.[18], [19]

1.6 Formulation Methods

There are several methods involved in the formulation of solid dispersion. They are as follows:

1. Melting Fusion method
2. Melting Extrusion method
3. Solvent Evaporation method
4. Spray Drying method
5. Super Critical Fluid Technologies
6. Electro-spinning

7. Lyophilization. technique
8. Melt Evaporation method

1.6.1 Melting Fusion: In this process, the drug and polymer both are melted together to form a molten mass and then it's cooled rapidly by stirring continuously on an ice water bath.

Although it's easy and simple some drugs may get degraded due to high temperatures. One way is to handle is to physically heat it inside a jar hermetically or by using an inert gas such as nitrogen to shield the medication.[20]

1.6.2 Melting Extrusion: Like fusion, melt extrusion employs the same method but it does it by using an extruder through which the molten mass passes. Although the old melt fusion techniques have their disadvantages, mixing polymer and drug through an extruder is also quite difficult.

An appropriate matrix must be identified that can be suitable for this method. This method, however, is different from the traditional method as it is performed continuously.[21]

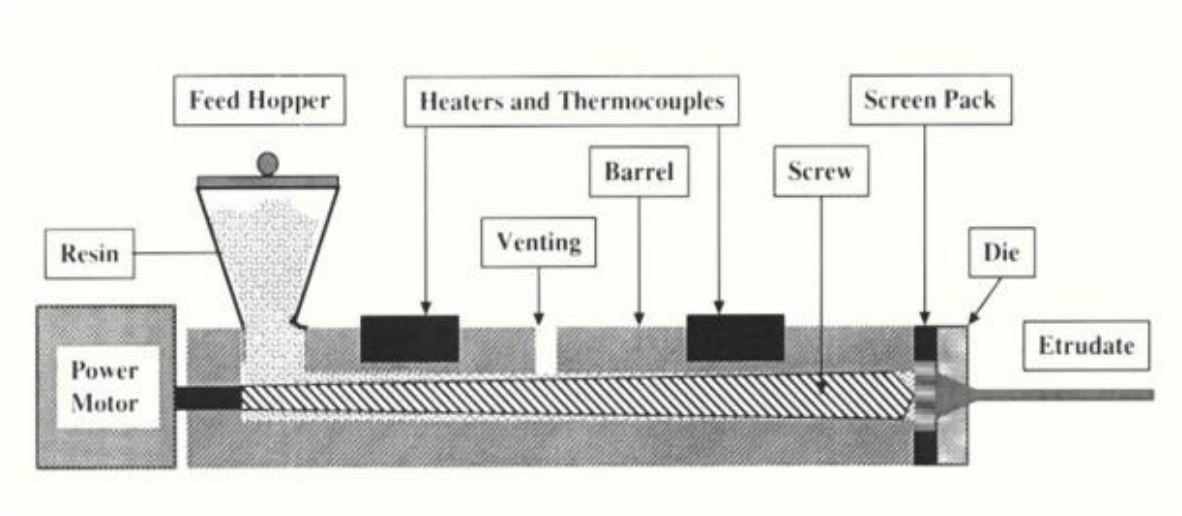

FIGURE: 1.1 SCHEMATIC DIAGRAM OF MELT EXTRUSION

1.6.3 Solvent Evaporation: In the initial stage of the solvent evaporation technique, a solution is created containing both the matrix material and the medication. The subsequent step involves removing the solvent(s), resulting in the formation of Solid dispersions. Achieving optimal dissolving qualities requires thorough mixing at the molecular level. However, pharmaceutical engineers face two challenges when employing the solvent technique due to substantial

differences in polarity, there is a huge obstacle to merging the drug and matrix in a single solution. By finely dispersing the drug and matrix in a solvent, the drug particle size in the Solid dispersions can be reduced. Ideally, both the drug and matrix material should be dissolved in a single solution.

Lipophilic medicine and hydrophilic matrix material have been combined in a single solution using various ways. However, because a lot of solvent has to be evaporated, this method is expensive and not practical. There has been an enhancement in the water-solubility of medication with the addition of cyclodextrins and surfactants like Tween80®.

The final product has a high amount of solubilizers or surfactants. These additives predominate in the Solid dispersions that eventually develop, which drastically changes the matrix's physical properties like its glass transition temperature (Tg). Furthermore, this method typically yields dose forms with minimal amounts of medication. These additive substances in high amounts can potentially be hazardous for the body. Chloroform or dichloromethane has been utilized to concurrently dissolve both the drug and PVP as a matrix.

Furthermore, these solvents are employed in alternative ways of preparation. However, as per the ICH guidelines, these solvents are classified as Class I, which includes the most dangerous solvents. Hence, the utilization of these solvents is deemed inappropriate and unfeasible because there may be a proportion of residual solvents left in the Solid dispersions which may be undetectable. The final approach for dissolving both the medication and matrix involves the utilization of solvent combinations. For this aim, water and ethanol, or dichloromethane and ethanol have been employed.

Nevertheless, achieving the desired concentration or ratio of drug and matrix dissolution in these mixtures is not always feasible. The second obstacle in the solvent approach is to avoid phase separation, such as the crystallization of either the medication or the matrix, while removing the solvent(s). Subjecting the material to elevated temperatures accelerates the drying process and diminishes the duration during which phase separation can occur. Conversely, when exposed to high temperatures, the drug and matrix molecules maintain a high level of mobility, which promotes the separation of phases, such as crystallization.

Vacuum drying is frequently employed to remove moisture from solutions. Under controlled heating and the use of a vacuum, the moisture present in the solution is removed. Sometimes a rotating evaporator is utilized for the removal of moisture or solvent. Vacuum desiccators can also

be utilized to store Solid dispersions for the removal of moisture content. Vacuum drying at high temperatures poses the risk of phase separation due to the gradual decrease in the mobility of the medication and matrix.

In addition, the Solid dispersions produced through spray drying are composed of particles that can be tailored in size by adjusting the droplet size to fulfill specific needs for subsequent processing or application, such as the production of easily flowing particles or particles suitable for inhalation. The process of spray-drying normally leads to the development of the medication or drug in its non-crystalline state, although there are times when the drug may become partially crystalline during the process [22], [23]

1.6.4 Spray Drying: Spray drying lets many pharmaceutical businesses manage the size and shape of the particles while rapidly drying items. Furthermore, cheap and simple since it costs "50 times less than freeze-drying. The technique atomizes suspensions or solutions into small droplets and then dries them to produce solid particles. This method is dependable. The technique produces finely ground powder free from dust and agglomerated powder satisfying set parameters. Great volatility and strong power to dissolve poorly water-soluble drugs define commonly utilized organic solvents in the spray-drying process. Solid dispersions form, degree of dissolution, and stability are affected by the process parameters and equipment geometry. Changing the solute concentration in the liquid used for spray-drying and the droplet size during the spray-drying process will affect the particle size in spray-dried Solid dispersions. Rankell et al. devised this method to create loperamide Solid dispersions using PEG 600. They spray dry using loperamide at a fixed concentration and solutions varied in PEG 6000 concentration. Chouhan et al. investigated if this method would be appropriate for generating Solid dispersions (SD) of glibenclamidepolyglycerides.[23]

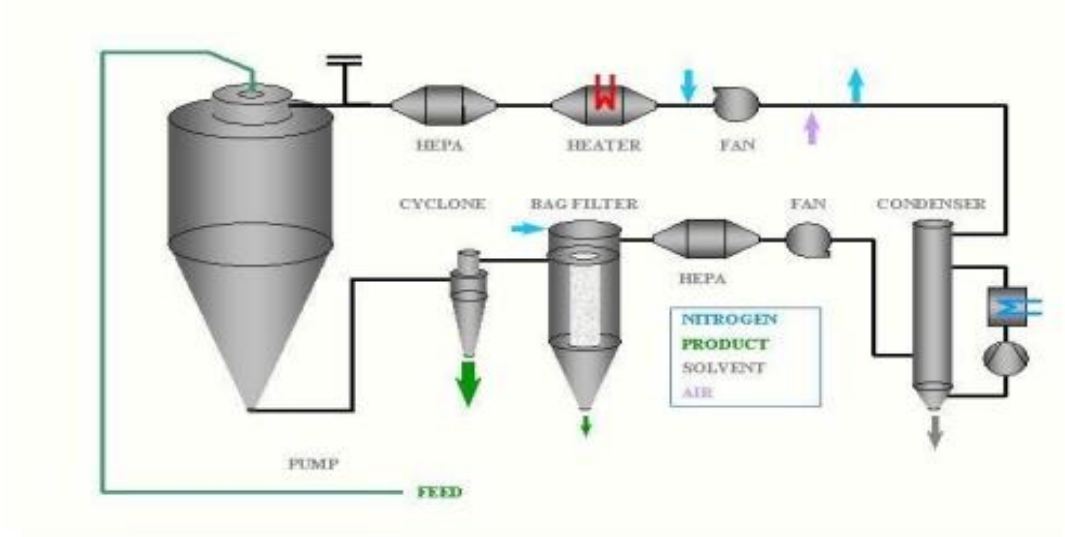

FIGURE: 1.2 SCHEMATIC DIAGRAM OF SPRAY DRYING

1.6.5 Supercritical fluid Technologies: Mostly used as either an anti-solvent or a solvent for pharmaceuticals and matrices, supercritical fluid techniques rely on both the matrix and the medicine is dissolved using supercritical CO_2 as a solvent. Then, when sprayed from a nozzle into an expansion vessel with low pressure, the resulting solution produces particles. The combination of experiencing adiabatic expansion produces a rapid temperature drop. Since carbon dioxide is good for the environment, this process—which does not call for organic solvents—is frequently called "solvent-free".

Still, the usefulness of this method is very restricted since most pharmaceutical compounds have quite poor solubility in CO_2, usually less than (<0.01wt-%), and this solubility further lowers as the polarity increases. This method is not applicable for preparation meant on a kilogram scale.

All other processes in a supercritical condition are precipitation techniques. All of these supercritical fluid techniques use organic solvents to dissolve both the drug and matrix, occasionally referred to as solvent-free due to the limited solubility of drugs in CO_2. A technique called the Gas Anti-solvent strategy is used.

The answer comes across under compressed CO_2. The settings are chosen to guarantee that, under supercritical levels, CO_2 is soluble in the solution; the drug and matrix will separate when the solution is extended. The solvent strength—that is, the power to dissolve the medication—falls as

the volume of the solution rises. This results in the firm deposit of the matrix and the medicine developing. PEG is widely employed as the matrix in this technique, so it results in Solid dispersions with a crystalline matrix usually of type II or III.

Using atomizing a drug-and-matrix solution through a nozzle, one can transport it to a container of liquid or supercritical anti-solvent second way of precipitation. The drug and matrix solidify and generate particles when the supercritical anti-solvent droplets supersaturation occurs.

Still, mixing the drug and matrix into a single solution is the most important part of these dissolution methods, just like it was in earlier solvent-based methods. Due to the lesser solubility of compressed CO_2 in water, the amount of water that can be used is limited because of this reason sometimes methanol or dichloromethane are used to mix drug and matrix.[22], [24]

1.6.6 Electro-spinning: In electro-spinning, solid threads are created by applying pressure to a polymeric liquid that is released from the nozzle. Using a powerful electric field, a conductive capillary, and a conductive collection screen, a polymer solution can be separated from its storage. Due to the increase in the strength of the electrostatic field, there is a conversion in the shape of the hanging droplet into a cone called Taylor's cone caused by the accumulation of charged particles on the surface of the droplet.

A cone-shaped device emits a polymer jet, either positively or negatively charged, when the charge reaches a specific amount. This means that the charge is free. Electricity will be used to move the charged jet toward the screen to catch it. Because of the way Coulomb resistance works, the screen gets smaller. The charged jet, on the other hand, runs out because it gets harder for its thickness to go down as its viscosity rises.[25]

1.6.7 Lyophilization Technique: Lyophilization is somewhat similar to solvent evaporation as both drug and carrier are dissolved in the same solvent but instead of evaporation here the solvent along with the drug is frozen and then sublimed to produce Solid dispersions

Combine the medication with a solvent at a consistent concentration. Combine the carrier with water until it completely disperses. Combine the solution in a volumetric ratio of 40 parts solution A to 60 parts solution B. Afterwards, the mixture is submerged in liquid nitrogen until it becomes completely frozen. Different concentrations of the medicine in the Solid dispersions are achieved by altering the concentrations of the carrier while keeping the drug concentration constant.

Subsequently, freeze-dry the solution using a lyophilizer. Lyophilization is conducted using a two-step process. 1) The pressure is set to 0.22 mbar and the shelf temperature is set to -35°C for one day. 2) Then, gradually decrease the pressure to 0.05 mbar, while simultaneously increasing the shelf temperature to 200 degrees. Continue to uphold these circumstances for an additional day. The samples are kept in a vacuum desiccator for a day at room temperature after they are removed from the freeze-dried.

Combine the medicine with a solvent at a consistent concentration and mix it with water as a carrier. Dilute the solution at a volumetric ratio of 40 parts solution to 60 parts solvent. Inject the solutions into liquid nitrogen using a nozzle. Adjust the rate at which the liquid is fed, and the flow of air used for atomization.[26], [27]

1.6.8 Melting Evaporation: The process entails creating Solid dispersions by dissolving the medicine in a compatible liquid solvent and thereafter adding the solution straight into the molten carrier. The mixture is then evaporated until a transparent film, devoid of any solvent, remains. Dry the film. The solid characteristic of the carrier remains largely unaffected when incorporating liquid chemicals at a concentration of 5-10% (w/w). There is always a chance that the melted carrier may not be compatible with the chosen solvent or the dissolved drug. The precipitation of the drug as a Solid Dispersion can be highly affected by the solvent, as it can influence the polymorphic structure of the drug. This technique combines the distinct advantages of both the fusion and solvent evaporation procedures.[28]

1.7 Type of Carriers

There are several types of carriers utilized in the formulation of solid dispersions and some of those carriers are mentioned below [29], [30]:

Sugars: Sucrose, Mannitol, Lactose

Acids: SA and CA

Polymeric Materials: Povidone, Polyvinyl pyrrolidone, Polyethylene Glycol, Hydroxy polymethyl Cellulose, Methyl Cellulose, HEC, Cyclo-dextrin, HPROSTATE CANCER, Pectin, Soluplus®

Insoluble and Enteric Polymers: HPMC phthalate, Eudragit L-100, Eudragit S-100, Eudragit RL, and RS.

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Surfactants: Renex poloxamer 188, Deoxycholic acid, Polyoxyethylene Stearate, Texafor AIP, Tweens, Spans

Miscellaneous: Penta erythritol, Penta erithryl tetra acetate, Urea, Urethane, Hydroxy alkyl Xanthin.

1.8 Current Trends in Solid Dispersion:

The formulation of viable dosage forms has become difficult for the scientists because of the low water solubility of many novel medication candidates. The reason behind this is the usage of combinational chemistry and high-throughput screening.

A chemical with low water solubility is traditionally defined as one that dissolves in less than 0.01% (1 part per 10000) of water. It has been stated that a medicine that does not dissolve properly in water has been described as taking longer time to dissolve in the fluid of the digestive system than it does in the digestive tract. A complete understanding of the mechanism of drug absorption and drug dissolution in the body must be known to completely transform the poorly soluble drugs into formulations that can be easily absorbed by the body.[31]

Historically, techniques like salt creation and reduction in the size of particle have been used to increase the rate at which pharmaceuticals dissolve. But these methods also have their own sets of limitations which could affect the bioavailability of final products. As a result of this, many investigators are seeking techniques or methods that can enhance drug absorption for medications that are poorly soluble in water. Medications can be made more bioavailable by forming them into Solid dispersions.[32]

Solid dispersion is the process of dispersing one or more active constituents in a solid state within an inert carrier or matrix. This is achieved using methods such as melting (fusion), solvent, or the melting solvent method. According to Sekiguchi and Obi, the API existed in a microcrystalline form in the eutectic mixture. This was then supported by Goldberg et al. after a few years. According to a report, not all drugs or APIs are present in the micro-crystalline state as some part of the medication may exist as a molecular dispersion inside the matrix, which leads to the formulation of solid solutions.

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Surface-active agents are compounds that, when present in small amounts, attach to the surfaces or interfaces of a system and modify the free energy and tension of the surface or interface. Surface-active drugs exhibit a distinctive molecular structure, containing both hydrophilic (polar) and hydrophobic (non-polar) regions. The surface-active carriers are characterized as amphipathic.[32]

1.8.1 Newer Techniques: Both the utilization of surface-active carriers and self-emulsifying carriers and the development of methods for filling of Solid dispersions in gelatin capsules can be considered a breakthrough in the field of Solid dispersions formulation. The original description of the process of filling hard gelatin capsules with Solid dispersions in a molten condition was given by Francol and Jones in 1978. The dispersion then solidifies at room temperature. Nevertheless, the potential use of such technology was immediately apparent to Chatham. The carriers should be able to be filled with liquid and subsequently formed into hard gelatin capsules to make the production process easier. To make sure the solutions don't go over the maximum temperature that may be tolerated for hard gelatin capsule shells, the carriers' melting points should be lower than approximately 70°C.[33]

The dissolution of the drug is slower compared to the water-soluble carrier. Due to the formation of a dense layer containing a large amount of drug on the surface of the dissolving plug hinders the release of the drug from Solid dispersions continuously. Consequently, the act of directly filling a hard gelatin capsule is not a viable approach for creating Solid dispersions, unless precautions are implemented to hinder the development of a concentrated layer of medication on the exterior of the dissolving plug.

The self-emulsifying agent functions as a dispersing or self-emulsifying agent for the drug. It prevents the creation of any water-insoluble surface layer, hence increasing the dissolution of the drug. However, the freed drug remains undissolved in the dissolving medium. When the concentration reaches the maximum amount, because of the surface activity of the dissolved ingredients it will either break down or emulsify into smaller particles. This will increase the surface area, making it easier for it to dissolve in the gastrointestinal fluid.

Serajuddin et al. conducted a study on enhancing the dissolution of dispersions of REV-5901. The user prepared Solid dispersions of the poorly water-soluble compound REV-5901 (alpha-pentyl-3-(2-quinolinylmethoxy) benzene methanol) in different polyethylene glycols (PEGs) and

Gelucire® 44/14. Subsequently, the blend was introduced into a rigid gelatin capsule. The Gelucire® 44/14 formulation demonstrated efficient and rapid dispersion of the medication in both water and simulated stomach fluid. However, the PEG formulations were only successful in achieving limited dispersion of the medicine. Removing the Gelucire® 44/14 formulation from a soft gelatin capsule does not affect REV-5901's solubilization capabilities.[34], [35]

The most often employed surface-active carrier is Gelucire® 44/14, along with different variations of Gelucire®. These carriers are formulated to possess a high melting point, not exceeding 70°C, to be compatible for filling into hard gelatin capsules. The grades of Gelucire® are distinguished by different numbers, such as Gelucire® 44/14 and Gelucire® 50/13. The melting point and HLB values of the carrier are represented by the first and second digits, respectively. Based on these qualities, these classes are classified and used for diverse reasons. Glyceryl and the long-chain fatty acid-derived PEG-1500 ester make up Gelucire® 44/14. In the European pharmacopeia, it is listed as lauryl macrogol glycerides.

To find out how Gelucire® 44/14 affected the solubility of Temazepam, Dordunoo et al. compared it to different PEGs. The results demonstrated a notable increase in the water solubility of Gelucire® 44/14. A firm gelatin capsule containing 12.5% Triamterene dispersion in various PEGs or Gelucire® 44/14 was compared to a capsule containing the drug alone in a study by Dordunoo et al. about the dissolving of the two. Without excipients, the dissolving studies showed that Triamterene dissolved to a mere 30%. The active ingredient, on the other hand, broke down totally in less than an hour after PEG-1000 or Gelucire® 44/14 was added.[34], [35]

Gelucire® 44/14 and Labrasol were used as carriers in an in vivo test by Aungst B.J. and coworkers to improve the oral bioavailability of an HIV protease inhibitor.

The HIV protease inhibitor DMP-323 has a solubility in water of less than 10 µg/ml. Aungst et al. tested several concentrations of excipients in a water-based combination to find the apparent solubility of DMP-323 in Gelucire® 44/14 and PEG-400. Gelucire® significantly enhanced the apparent solubility of the medicine, but PEG-400 did not have any solubilization effect on the drug.

Chen et al enhanced the solubility and absorption of ABT-963, a chemical with low water solubility, by creating Solid dispersions utilizing Pluronic F-68 as a carrier through the processes

of evaporation and hot melt. The findings indicate that Solid dispersions are a highly promising method for enhancing oral bioavailability.[36]

Passerini et al created granules incorporating Ibuprofen, a model medication with low solubility, by the process of melt granulation. The objective was to enhance the process of dissolving and making a substance available by including lactose as a diluting agent and Poloxamer 188 (Lutrol F68) as a novel hydrophilic binder with a metastable property. The conclusion proposes that the melt granulation technique is a simple and rapid approach to enhance the dissolving rate of ibuprofen. This is achieved by utilizing Poloxamer 188 as a novel hydrophilic binder with metastable properties.

The Solid dispersions system of nifedipine in a polymer matrix consisting of Pluronic F 68 and Gelucire 50/13 in a 1:1:1 ratio was studied by Vippagunta et al. to determine its nature and solid-state properties. The findings show that the Solid dispersions of nifedipine are physically stable. Nifedipine's Solid dispersions helped it to be released more quickly than pure crystalline form.

1.8.2 Future Prospects: The simplicity of manufacturing and scale-up techniques causes the physicochemical properties to vary as expected during the scale-up. For this reason, the popularity of Solid dispersion systems to oversee challenging bioavailability problems concerning poorly water-soluble pharmaceuticals will develop quickly.[37]

One problem with making Solid dispersion systems might be that drugs do not dissolve well in carriers. Having more options will help make dose form development more successful.

Further research should focus on identifying carriers or excipients that can impede or inhibit the crystallization of medicines from supersaturated solutions. It is important to carefully consider the physiological and pharmacological impacts of the carriers that are being employed. Several surface-active and self-emulsifying carriers are lipid-based. Therefore, it is important to carefully assess the possible impact of these carriers on drug absorption, particularly their influence on p-glycoprotein-mediated drug efflux. Furthermore, current studies on SD systems have focused on the advancement of extended-release dosage forms, in addition to improving bioavailability. The availability of surface-active and self-emulsifying carriers, along with the development of innovative capsule-filling techniques, has revitalized research in this field. Given that the development of Solid dispersions for improving the absorption and prolonging the release of drugs involves mostly the same procedures, except for employing carriers that dissolve at a slower rate

for the latter purpose, it is anticipated that research in these two fields will advance concurrently and mutually benefit each other.[37]

1.9 Introduction to Diseases

1.9.1 Introduction to Tuberculosis

Tuberculosis (TB), sometimes called the "white death" or "consumption" in the past, is an infectious disease that is mainly caused by the Mycobacterium tuberculosis (MTB) bacteria. People with tuberculosis usually get it in their lungs, although it has the potential to disseminate to other organs and tissues.[38]

To decrease the spread of TB and prevent it, is possible by screening people who are at high risk for TB, finding and treating cases, and getting vaccinated with BCG vaccine. People who interact on a day-to-day basis with someone who has current TB are at higher risk compared to others. The medications are supposed to be taken over a long period for the treatment to work. Multiple drug-resistant tuberculosis (MDR-TB) rates are going up, which is a sign that antibiotic resistance is getting worse.[38], [39]

According to an estimation in 2018 it was recorded that almost 25% of people around the world carried a latent TB infection. Roughly 1% of the population develops a fresh disease annually. In 2022, 1.3 million individuals died and almost 10.6 million persons developed active TB. This is the second most often occurring cause of death from a viral disease after COVID-19. By 2021, the number of new cases was going down by about 2% each year. About 80% of people in Asian and African countries show TB positive by Tuberculin test. In the US, only 5–10% of people who take the test are positive. Tuberculosis has been around in people for a very long time.[40]

1.9.1.1 Signs and Symptoms

Based on signs and symptoms, TB can be divided into two types Latent TB and Active TB. Latent TB is asymptomatic; however, it can be determined using either a skin test or a blood test.[38]

Active tuberculosis symptoms in the lungs include:[41]

- Coughing for more than 3 weeks
- Chest pain
- Blood found in cough

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- Persistent fatigue feeling
- Night sweats
- Chills
- Fever
- Anorexia
- Weight loss

Patients may experience the same symptoms along with localized pain in the affected area if the lungs are affected by tuberculosis.

Adolescents, youngsters, and infants may exhibit diverse tuberculosis symptoms. The symptoms experienced by teenagers are like those experienced by adults. Children aged one to twelve may have weight loss and a persistent fever.[41]

Babies may:

- Exhibit immobility or sluggishness
- Present a swelling in the fontanelle
- Display excessive irritability
- Experience vomiting or encounter difficulties while eating

1.9.1.2 Etiology

Mycobacterium tuberculosis is a particular kind of bacterium causing an infection that results in tuberculosis (TB). TB bacteria inhaled can settle in the lungs and start development. These bacteria then can spread via the bloodstream to the kidney, spine, and brain among other anatomical areas. The tuberculosis (TB) germs can live in the body in a dormant or latent state, not inflicting any symptoms at all. Latent tuberculosis (TB) infection is characterized by the presence of TB germs in the body without the outward manifestation of active TB disease symptoms. They do not show any symptoms of TB, do not have any signs of sickness caused by TB, and cannot transmit TB bacteria to other people. Those close by could breathe these bacteria and then start to feel sick. Treating latent tuberculosis (TB) is vital to stop the disease from turning active.[41], [42]

1.9.1.3 Pathophysiology

The way tuberculosis (TB) affects the body involves a complex relationship between the bacteria and the immune system of the person infected.[43], [44]

The disease advances through several stages: aerosolization, phagocytosis, phagolysosome obstruction, and replication. When someone who has active tuberculosis coughs, sneezes, or sings, they release tiny droplets into the air that contain the bacteria. When another person breathes in the air, the bacteria present in the air enter the respiratory system.

Aerosolization and Phagocytosis: The disease advances through several stages: aerosolization, phagocytosis, phagolysosome obstruction, and replication. People affected with active TB release tiny droplets containing bacteria when they cough or sneeze which mix with the air. Later when another person breathes the air, he/she also breathes in the bacteria that enter their respiratory system.

Phagocytosis and Phagolysosome Blockage: When the bacteria enter the lungs, they are engulfed by macrophages, which are a specific type of immune cell. The bacteria multiply within phagolysosomes, which are special organelles responsible for breaking down foreign particles and are found in macrophages. However, Mycobacterium tuberculosis (Mtb) can evade the immune response of the host by blocking the phagolysosomes, allowing it to survive and reproduce.

T-Helper Response and Granuloma Formation: The infection triggers the host's immune system to activate T-lymphocytes, a specific type of immune cell. T-lymphocytes identify the Mtb antigens and initiate an immunological reaction, resulting in the development of granulomas, which are collections of immune cells that enclose and try to control the infection.

Clinical Manifestations and Active Disease: The Location of infection and the immunological response of the individual can cause variance in the symptoms of TB. Tuberculosis commonly manifests in the lungs as a persistent cough, elevated body temperature, loss of body mass, and a general feeling of discomfort. Without treatment, the condition might advance to active tuberculosis (TB), which can result in respiratory failure, widespread infection, and mortality.

Extrapulmonary TB: Tuberculosis (TB) can disseminate to several regions of the body, including the lymph nodes, bones, joints, and kidneys, resulting in extrapulmonary TB. The manifestations of extrapulmonary tuberculosis differ according to the specific site of infection but can encompass

symptoms such as elevated body temperature, loss of body mass, and discomfort in the affected region.

Pathophysiological Stages

The pathophysiology of TB can be divided into several stages:

1. **Primary TB**: The primary infection, which frequently lacks symptoms and resolves on its own.
2. **Latent TB:** The germs remain in a state of dormancy within the host, and the individual does not possess the ability to transmit the infection.
3. **Active TB**: The bacteria undergo replication and induce symptoms, rendering the individual contagious.
4. **Extrapulmonary TB**: The germs disseminate to other regions of the body, resulting in extrapulmonary tuberculosis.

1.9.1.4 Treatment

Tuberculosis (TB) is a serious contagious disease that needs proper medical treatment to prevent it from spreading and to ensure complete recovery. Typically, doctors use four drugs, namely Isoniazid (INH), Rifampin, Pyrazinamide, and Ethambutol, to treat active tuberculosis (TB). These drugs work in tandem to eliminate the bacteria that cause TB and help prevent the bacteria from becoming resistant to treatment.

Treatment Regimen: Typically, TB is treated with a medication regimen lasting from six to twelve months. Factors such as the specific type of tuberculosis, the patient's age, and any pre-existing medical conditions can influence the duration of tuberculosis treatment[45], [46]. While there may be different approaches, the most used ones are:

- The standard treatment for drug-susceptible tuberculosis is a 6-month course. The treatment regimen requires the administration of four drugs over six months.
- The 4-month regimen is recommended for patients with smear-negative, culture-negative, non-cavitary pulmonary tuberculosis (TB) illness. The treatment entails the administration of four drugs over four months.

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- The 4-month rifapentine-moxifloxacin regimen is employed to treat drug-susceptible pulmonary tuberculosis. The treatment entails the administration of two drugs over four months.

Treatment for Latent TB Infection: Commonly known as TB infection, it can also be called asymptomatic TB where there are no symptoms, and the bacteria present in the body have non-active replication. The common treatment of latent TB involves a single therapy approach such as isoniazid for 9-12 months. [45], [46].

Treatment for Drug-Resistant TB: Usually referred to as multidrug-resistant tuberculosis (MDR-TB), drug-resistant tuberculosis occurs when the bacteria develop resistance to the initial tuberculosis therapies. mainly consisting of second-line drugs including Bedaquiline, Pretomanid, and linezolid, given for a period of 18 to 24 months, the standard treatment for multidrug-resistant tuberculosis (MDR-TB) mainly consists of. [45], [46], [47].

1.9.2 Introduction to Major Depressive Disorder

Major depressive disorder (MDD), also known as recurrent depressive disorder, clinical depression, major depression, unipolar depression, or unipolar disorder, is a mental illness characterized by episodes of passive sadness, followed by low self-esteem and lack of interest in day-to-day activities.[48]

A person with a serious depressive disorder must consistently lack enjoyment or enthusiasm in daily activities or persistently have a low mod for two weeks or more, these shifts in mood can be due to either social, educational or occupational, and other aspects of functioning.[48]

1.9.2.1 Types of Depression

Primarily two categories of depressive illnesses are there [49]. They are as follows:

A) Unipolar Depression: About 75% of cases of unipolar depression—which usually does not run in families—are closely associated with demanding life events. Sometimes referred to as reactive depression, it is typified by restlessness and anxiety. About 25% of cases—known as endogenous depression—show a hereditary pattern and are not affected by outside events. Furthermore, present among these people are different symptoms. Although this difference is demonstrated in a clinical environment, there is little data to justify the belief that antidepressant drugs show appreciable specificity in differentiating between these disorders.

B) Bipolar Depression: Usually showing up in early adulthood, bipolar depression is somewhat rare and consists of alternating spells of mania and sadness spanning several weeks. Genetic linkage studies of afflicted families or using comparison between affected and non-affected individuals have not identified any specific genes that increase an individual's vulnerability to the disorder, despite a clear hereditary tendency. It is alternatively referred to as manic depression.

1.9.2.2 Signs and Symptoms

There are various signs and symptoms, intensity varying from patient to patient[49], [50]. Some of them are mentioned below

- Depressed mood
- Diminished interest or pleasure in all activities
- Decrease or increase in appetite
- Insomnia or hypersomnia nearly every day
- Psychomotor agitation or retardation
- Fatigue or loss of energy
- Feelings of worthlessness or excessive or inappropriate guilt
- Diminished ability to think or concentrate
- Recurrent thoughts of death
- Recurrent suicidal ideation without a specific plan, or a suicide attempt

1.9.2.3 Etiology

Like other mental illnesses, the genesis of affective ones is still obscure. Combining genetic, hormonal, physiological, environmental, and social elements influence depression; each one of them adds to a person's sensitivity to acquiring the disorder. Furthermore, significant events in life can also have an influence. Although pharmaceutical therapies are helpful, emotional problems and metabolic abnormalities have no clear relationship.[50]

1.9.2.4 Pathophysiology

Like other mental illnesses, the genesis of affective ones is still obscure. Combining genetic, hormonal, physiological, environmental, and social elements influence depression; each one of them adds to a person's sensitivity to acquiring the disorder. Furthermore, significant events in life

can also have an influence. Although pharmaceutical therapies are helpful, emotional problems and metabolic abnormalities have no clear relationship.[51]

1.9.2.5 Treatment of Depression

The medications used in the treatment of Major depressive disorder are mainly Antidepressants.[49], [52]

A) Antidepressant drug treatment:

Antidepressant drugs fall into the following categories

1. Monoamine uptake inhibitors:
    - Non-selective uptake inhibitors, such as tricyclic antidepressants (TCAs) like imipramine and amitriptyline, as well as more contemporary antidepressants like venlafaxine (which is slightly selective for serotonin, albeit less so than selective serotonin uptake inhibitors), work by inhibiting the uptake of both noradrenaline and serotonin.
    - Including paroxetine, sertraline, fluvoxamine, fluoxetine, and duloxetine, selective serotonin reuptake inhibitors (SSRIs)
    - Maprotiline and reboxetine are selective, noradrenaline reuptake inhibitors
2. Monoamine Oxidase (MAO) Inhibitors:
    - Irreversible, non-competitive inhibitors not specific for the MAO-A and -B subtypes are tranylcypromine and phenelzine.
    - One such reversible inhibitor aiming especially at MAO-A is moclobemide.
3. Miscellaneous receptor-blocking drugs with poorly understood antidepressant effects include mianserin and trazodone.

B) Other treatments

- Electroconvulsive theory
- Nondrug treatment

1.9.3 Introduction to Prostate Cancer

The hallmark of prostate cancer is the too-rapid proliferation of cells in the prostate, a gland in the male reproductive system below the bladder. Screening procedures—typically using blood tests

measuring levels of prostate-specific antigen (PSA)—often reveal aberrant growth of prostate tissue. [53]

Tumors can metastasize, enabling them to migrate to different regions of the body, with a particular tendency to affect bones and lymph nodes.

1.9.3.1 Signs and Symptoms:

In most cases prostate cancer cases are asymptomatic, certain individuals may develop symptoms as the cancer progresses and metastasizes [54], [55], [56]. The following are typical indications and manifestations of prostate cancer:

Symptoms related to the urinary system:

- Excessive urination, particularly during nighttime\
- Urinary hesitancy or retention
- Diminished or disrupted urinary flow
- Hematuria
- Dysuria, characterized by pain or a burning sensation during urination
- Additional manifestations:
- Discomfort or rigidity in the dorsal region, pelvis, or upper legs
- Legs experiencing diminished strength or loss of sensation
- Anorexia
- Reducing body mass
- Tiredness
- Occasionally, individuals may experience erectile dysfunction.

1.9.3.2 Etiology

The development of prostate cancer is a complicated process with many factors that affect it[54], [56]. While the exact cause of prostate cancer is still not fully understood, several factors have been identified as possible culprits.

Risk Factors:

- **Age**: The chances of getting prostate cancer increase with age. People with age 60 or more are more susceptible to prostate cancer

- **Family History:** Men who have a history of prostate cancer in their family, especially close relatives like fathers, brothers, or sons, are more likely to get the disease themselves.
- **Ethnicity:** African American men are at a greater risk of getting prostate cancer compared to other men.
- **Genetics:** Genetic defects can lead to prostate cancer. Some of these genes including BRCA1 and BRCA2 carry these mutations.
- **Diet:** Prostate cancer risk is higher in those who overconsume red meat, dairy, and animal fat.
- **Hormones:** Hormones, particularly androgens like testosterone, are the primary agents that influence and drive the progression of this disease.
- **Infections:** people who contract infections caused by bacteria such as bacterium chlamydia are more susceptible to this sort of cancer.
- **Obesity:** People who are overweight or obese have a great risk of getting this cancer.
- Other Factors:
- **Environmental Factors:** Heavy metals and pesticides increase the risk of getting prostate cancer
- **Lack of Physical Activity:** men with little to no activity are also at high risk
- **Smoking:** Smoking enhances the chances of getting prostate cancer

Unknown Factors:

- **Genetic Predisposition:** According to some investigations done by researchers, PROSTATE CANCER may be caused by genetic elements, the exact genetic processes are yet unknown.
- **Epigenetic Factors:** Two epigenetic changes that might help prostate cancer progress are changes to histones and DNA methylation.
- **Microbiome:** The gut microbiome might help prostate cancer spread even if the exact processes are yet unknown.

1.9.3.3 Pathophysiology

Most prostate tumors start in the prostate's periphery. An abnormal cluster of cells known as prostatic intraepithelial neoplasia (PIN) forms when cell growth becomes uncontrolled. While

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some PINs proliferate and develop into new layers of tissue, the genes expressed by these new layers shift from those of the original tissue location (p63, cytokeratin 5, and cytokeratin 14) to those of the cells lining the pancreatic duct (cytokeratin 8 and cytokeratin 18). An additional characteristic of these multilayered PINs is the overexpression of the AMACR gene, which is linked to the advancement of prostate cancer.[57]

PINs have the potential to develop into tumors in the long run. There are typically significant alterations to the genome that accompany this, such as the repeated duplication of chromosome sequences or the rearrangement of chromosome sequences.[54]

RB1 is responsible for one percent of tumors in localized areas and more than five percent of tumors in metastatic areas; protein kinase K (p53) is responsible for eight percent of tumors in localized areas and more than twenty-seven percent of tumors in metastatic areas; and many more mutations are found in genes that keep DNA from being damaged. The gene ATM is implicated in DNA repair. Mutations in ATM are identified in approximately seven percent of cases with localized disease and five percent of cases with metastasized malignancy.[55]

Alterations are displayed in more than 70% of cases in the androgen receptor signaling pathways. Alterations like these cause an increase in receptor activity or enhanced expression of the receptor gene, its activators (such as FOXA1), or its negative regulators (such as ZBTB16 and NCOR1). Androgen receptor disruptions are found in only 6% of castrate-sensitive metastatic cancer biopsies. Approximately 12-17% of tumors that exhibit sensitivity to castration treatment display deletions in the tumor suppressor PTEN gene. In contrast, a significantly higher percentage, exceeding 40% of tumors that are resistant to castration treatment also possess these deletions. PI3KCA/PI3KCB mutations are responsible for 6% of tumors, while AKT1 mutations account for 2% of tumors. Aberrant activation of the Wnt signaling pathway is found in 9% and 4% of tumors, respectively, making them less common.[57]

1.9.3.4 Treatment

The treatment of prostate cancer is divided according to the different stages of prostate cancer [58]. They are as follows:

Treatment of Stage I Prostate Cancer:

- Overseeing the patient

- Active observing. Hormone treatment can be prescribed should the cancer start to spread.
- Following a pelvic lymphadenectomy and radical prostatectomy, patients may undergo adjuvant radiation therapy
- Patient can undergo hormone treatment after undergoing External radiation therapy
- Patients can undergo brachytherapy also known as Internal radioactive seed radiation treatment.
- Clinical trial therapy consists of high-intensity focused ultrasound.
- Photodynamic therapy which uses photosensitizer or photosensitizing agent to kill cancer cells.
- Cryoablation and cryotherapy

Treatment of Stage II Prostate Cancer:

- Overseeing the patient
- Patient monitoring. Hormone treatment could be prescribed should the cancer start to spread.
- Following a pelvic lymphadenectomy and radical prostatectomy, patients may undergo adjuvant radiation therapy
- Patient can undergo hormone treatment after undergoing External radiation therapy
- Patients can undergo brachytherapy also known as Internal radioactive seed radiation treatment.
- Cryoablation and cryotherapy
- Clinical trial therapy consists of high-intensity focused ultrasound.
- Proton beam therapy
- Photodynamic therapy which uses photosensitizer or photosensitizing agent to kill cancer cells.
- Hormone treatment after radical prostatectomy as guided by clinical studies

Treatment of Stage III Prostate Cancer:

Patients can undergo hormone treatment after undergoing external radiation therapy

- After hormone therapy is given, the patient undergoes radiation therapy.
- Following a radical prostatectomy, patients may undergo adjuvant radiation therapy

- Waiting and watching.
- Monitoring the patient and if the cancer grows hormone therapy may be given

Treatment that can control cancer's growth and reduce the urinary symptoms may include the following:

- Patient can undergo brachytherapy also known as Internal radioactive seed radiation treatment
- Endocrine therapy
- Radiation therapy of new types from clinical trials.
- Cryoablation and cryotherapy

Treatment of Stage IV Prostate Cancer: Treatment for stage IV prostate cancer typically encompasses the following:

- Administration of hormones to regulate physiological processes.
- Combining hormone therapy with chemotherapy.
- Treatment with bisphosphonates.
- Post-radiation hormone therapy may be administered.
- Treatment using alpha emitter radiation.
- Observation without immediate intervention.
- A study that looks at the effectiveness of a radical prostatectomy with orchiectomy.
- To address an enlarged prostate, surgeons perform transurethral resection of the prostate, also known as TURP.
- The use of high-energy radiation in medical treatment with the specific goal of destroying cancer cells.

CHAPTER 2
LITERATURE REVIEW

2. LITERATURE REVIEW

2.1 Review of work done on Solid dispersion

Patel et al., (2014) [59] prepared and characterized ternary solid dispersion of domperidone fast-dissolving tablets. Ternary solid dispersion of domperidone was created to formulate stable sand fast-dissolving tablets. Both ternary and binary solid dispersion were obtained through the fusion method. Both were evaluated by drug content, dissolution efficiency, in-vitro dissolution studies, and solubility studies. While their solid-state characteristics were evaluated by DSC, FTIR, and XRD. The solid dispersion was then converted into tablets with a direct compression process. Stability studies were performed along with pre- and post-compression studies. The drug-to-polymer ratio of 1:2:1.5 of the drug: Gelucire 50/13: Poloxamer 188 containing solid dispersion showed the best results in dissolution studies. The FTIR, DSC, and XRD were found to be accurate. The ternary solid dispersion showed better results compared to binary solid dispersion in stability studies. As a disintegrant crospovidone (4%) showed good results with a disintegrating time of 19s and almost 100% dissolution in 30mins in 0.1N HCL. The results revealed that ternary agents stabilize and enhance the dissolution of solid dispersion compared to binary agents.

Aya M et al., (2022) [60] prepared and characterized fast-dissolving haloperidol solid dispersion tablets. This study was performed to formulate fast-dissolving tablets of haloperidol in solid dispersion form to enhance its dissolution properties and its anti-psychiatric effect. Preliminary trials were performed for solubility with various polymers. Formulation of solid dispersion were carried out using two techniques solvent evaporation and melting methods with peg 4000 as a carrier. Other excipients were used to formulate the solid dispersion into tablet forms. Pre and post-compression studies were performed. Solid excipients and drugs showed good compatibility when performed pre-compression studies. The SD2 batch showed good disintegration and water absorption ratio. Thermodynamic studies and in-vitro dissolution studies showed good results for batch SD2 and also the batch produced with the melting method. When the haloperidol SD tablets were compared with normal haloperidol tablets in rats the SD one showed better results.

Verma et al., (2017) [61] prepared and characterized Ivermectin's solid dispersion. This study work was done to create a formulation with enhanced solubility. Ivermectin comes in BCS class 2 because of its high permeability and low solubility. Because of its low solubility, there is variance in the absorption of drug from oral dosage forms. This low solubility of ivermectin can be

enhanced by formulating solid dispersion with Gelucire (44/14). The formulated solid dispersions were then evaluated further with drug content, yield, solubility studies, in-vitro dissolution studies, and solid-state characteristics were evaluated with FT-IR, DSC, and XRD.

Ramu A et al., (2024) [62] developed, tested, and analyzed how super disintegrants affected Olmesartan Medoxomilfast-dissolving tablets. This study was performed to enhance the dissolution rate and solubility of poorly soluble drugs by formulating them into solid dispersion. The formulation was done by 3 methods including physical mixing, SE, and KM using soluplus® as a carrier. The formulated solid dispersions were then evaluated for drug content, solubility studies, flow characteristics, and in-vitro dissolution studies. The solid-state characteristics were evaluated with FT-IR, DSC and XRD. The optimized solid dispersion was then converted into fast-dissolving tablets with the help of disintegrants like crocarmellose, crospovidone etc. The formulated fast-dissolving tablets were then evaluated for further parameters like weight variation, friability, disintegration test, dissolution studies, and content uniformity. The fast-dissolving tablets were prepared by combining solid dispersion with disintegrants.

Thota V, (2024) [63] prepared and characterized amorphous solid dispersion of atorvastatin calcium trihydrate using hot melt extrusion. This work aimed to enhance the solubility of calcium trihydrate by formulating solid dispersion by HME. Because of its scalable, single-step, continuous manufacturing technique, the HME technique shows success. HPMC K100 LV and PEG 3350, plasticizer was used to produce Atorvastatin solid dispersion with the help of a Hot-melt extruder. Milled extrudes were converted into tablets and their saturation solubility studies were performed in water for 48 hrs. The extruder milled extrudes with varying drug loading to investigate how drug loading affects drug release. The lead formulation F4 showed the best results when evaluated. The DSC performed showed the amorphous conversion of Atorvastatin calcium trihydrate which showed better results when compared with physical mixture lead formulation. so, indicating that this is the case even in terms of drug release. After one month of accelerated stability testing, the lead formulation showed no obvious changes.

Alotaibi BS et al., (2024) [64] designed and described glipizide solid dosage form with improved solubility. A poor water-soluble medicine in the BCS class II group is glipizide. For Formulating solid dispersion PVP and PEG both are utilized. The Drug to polymer ratio of 1:1, 1:2, 1:3, 1:4 was produced. The SE technique was utilized for formulation and PVP k-30,90 and PEG-600 were

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utilized because of their higher effect on solubility of Glipizide. The In-vitro dissolution test was performed for all batches which showed that there is an increase in the dissolution rate of the drug when there is an increase in the concentration of polymer. The batch with polymer PVP showed better results than the batch with PEG. The Best batches were then converted into fast-dissolving tablets which passed Pharmacopeial and non-pharmacopeial tests. Drug: polymer interactions in the solid state were indicated by Fourier transform Infrared (FTIR) spectroscopy X-ray diffraction (XRD) and Differential scanning calorimetry (DSC). Characteristics of the solid dispersion samples revealed their compatibility with the polymer and drug.

Mir KB et al., (2024) [65] prepared and characterized a pharmacokinetic assessment of glibenclamide dispersion for bioavailability enhancement in Wistar rats. ASDs of GLB were prepared with poloxamer-188 to enhance their bioavailability. The solubility of the drug was enhanced with poloxamer-188 which in turn increased the dissolution rate. The formulation of ASD was done by the SE method. The physical state was defined by DSC, XRD, and FT-IR. GLB: PLX-188 ratio of 1:6 (SDE4) showed the best results in-vitro dissolution by releasing 90% of the drug in 3 hrs. The pharmacokinetic analysis was performed in rats with SDE4 batch which showed increased bioavailability. During the six-month study, solid dispersion formulation (SDE4) formulation was found to be stable.

Adeli E, (2016) [66] prepared and characterized azithromycin binary solid dispersions with multiple grades of PEG. Thus, the main goal of this work was to formulate solid dispersions of azithromycin using several grades of PEG to enhance solubility and dissolution. The formulation was done by SE method and PEG grades of 4000, and 6000. 8000, 12000, and 20000 were used in different ratios. From the Infrared (IR) spectra, the drug and polymer had no chemical incompatibility. Using DSC, XRD, and SEM the formulations were evaluated for solid-state characteristics. The batch with PEG 6000 showed increased solubility and dissolution rate compared to others.

Simonazzi A et al., (2018) [67] prepared and characterized solid dispersion as a means of enhancing Albendazole Biopharmaceutical Behavior. Albendazole (ABZ) solubility and dissolution profiles were improved by formulating solid dispersion using poloxamer 407. After the formulations of solid dispersions mathematical models and comparison with physical mixtures, pharmaceutical ABZ, and a commercial formulation were computed. There was an exponential increase in the dissolution rate of ABZ. When the solid dispersion ABZ was compared with the commercial

formulation, the commercial formulation showed dissolution in 40minutes all the solid dispersion needed only 2.2minutes to reach 90% ABZ dissolution

Sood S et al., (2020) [68] improved nitazoxanide solubility using solid dispersions technique: formulation, testing cytotoxicity. Nitazoxanide (NTZ) finds extensive use as an anti-microbial agent. The NTZ is poorly soluble which affects its bioavailability. Usually considered as a fundamental requirement for improved absorption and bioavailability is low aqueous solubility. This study aimsto formulate solid dispersions of NTZ by the HME technique. Later on, evaluations were performed such as drug content, solubility, in vitro dissolution, FTIR, DSC, SEM, XRD, in vitro MTT safety on HEK-293 and A-549, and stability study. XRD results revealed following the formation of solid dispersion. The solid dispersion showed the disappearance of crystalline peaks which is attributed to its Amorphous nature. NTZ released from solid dispersion into a simulated gastric releasing medium (pH 1.2) was found in vitro to be rather efficient. Moreover, cytotoxicity research revealed a safe for human use. Stability analyses showed no clear variation in the physical characteristics of solid dispersion.

Yang HB et al., (2017) [69] characterized and prepared solid dispersion of quercetin using phospholipids. In This study, the lipid solubility of the drug Quercetin was enhanced by formulation of solid dispersion with phospholipid. Physical characterizations of the drug as well as its PM were performed by FTIR, DSC, SEM, and XRD, to determine any changes that can occur in the formulations. Solubility of free quercetin and Solid dispersion were performed in n-octanol and water with different ph. It was demonstrated that after solid dispersion, the apparent oil/water partition coefficient changed dramatically; this could help to improve bioavailability and lower the dosage of the drug.

Alhamhoom Y et al., (2024) [70] prepared and characterized pH-modified amorphous solid dispersion-based ODTs tablets of cefdinir. pH-modulated solid dispersions were formulated by solvent evaporation techniques using hydrophilic polymer and alkalizers. Enhancement of solubility was found in pH 1.2 by ASD produced using PEG 6000 with meglumine as alkalizers among several carriers. Physical characterization (DSC, FTIR) showed no signs of polymer-drug incompatibility. ASD8 showed an amorphous state in physical characterization. In in-vitro dissolution, ASD8 showed greater results than any other batch which is why it was chosen. The ODTS were prepared for ASD8. Under demanding physiological pH conditions common in the

stomach, the tablets or ODTs produced from ASD8 showed a reduction in pH-dependent solubility and dissolution characteristics associated with CEF. ODTs of ASD8 thus probably help to efficiently control different infections and prevent the emergence of drug-resistant strains, thus improving the curing rates.

Pardhi VP et al., (2024) [71] designed, developed, and tested bedaquiline fumarate – Soluplus® – solid dispersion. This drug comes under BCS class 2 because of its poor solubility which affects the bioavailability of the drug. This work aims to use Soluplus® to enhance the solubility and dissolution of drugs by formulating solid dispersion. Two solid dispersion systems were generated: binary solid dispersion (BD) and ternary solid dispersion (TSD), where ternary solid dispersion showed greater solubility compared to binary solid dispersion in BQF. Because of the higher solubility of Soluplus® than Poloxamer 188, Soluplus® was used. The amorphous Soluplus® polymer was chosen in the present work to formulate BSD and TSD with BQF.BQF was found to be amorphous in solid dispersion when several characterization tests were performed. FTIR showed no incompatibility between the drug and polymer. TSDs have shown improved solubility and bioavailability in pharmacokinetic studies. Therefore, the present work reveals a feasible formulation approach to improve the solubility of BQF so raising its biopharmaceutical performance.

Nijhawan M et al., (2024) [72] prepared and characterized Felodipine Solid Dispersion using Hot Melt Extrusion for Solubility Enhancement. After oral administration, the drug undergoes significant first-pass metabolism which leads to only 15% of bioavailability. This causes difficulty in therapeutic efficiency. The solubility and dissolution rate of the drug were enhanced by immediate release formulation prepared by solid dispersion technique. The carrier Eudragit EPO, NE30Dwas used according to the drug-polymer ratio. The best batch turned into tablets. Evaluation parameters were performed for the formulated batches. Based on the cumulative percentage release it was found that among the several combinations of drug and Eudragit EPO, only drug and Eudragit EPO by themselves were released in high percentage. It was found that by increasing the concentration of Eudragit NE30D the dissolution rate decreases. Drug release dropped dramatically even with a smaller ratio increase in stabilizers. According to the dissolution profile, the solid dispersion tablets and the solid dispersion alone have rather similar release profiles. HME raises the felodipine dissolution rate by solid dispersion formulation.

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Thawani LM, (2023) [73] prepared and characterized in-vitro mefenamic acid oral disintegrating tablets using solvent evaporation and HME. This study was conducted to enhance the solubility of mefenamic acid. Thus, to increase the solubility, the solid dispersion was formulated for Mefenamic acid and Eudragit RL PO by SE method; then, Hot Melt Extrusion was used to produce the extrudes.; prepared extrude were assessed for their physical and chemical characteristics. The melting temperature of the Mefenamic Acid (MA) dropped with increasing drug loading, according to the Differential Scanning Calorimetry (DSC) thermograms. The FT-IR spectra showed no new formation of bonds between drug and polymer. This implies that during the extrusion process, the drug and polymer stayed physically mixed and underwent no chemical transformation. In-vitro-dissolution studies were performed which showed that extrudes had a higher dissolution rate compared to pure MA. The increase in drug loading also increased the dissolution rate.

Alghadi RY et al., (2023) [74] improved solubility of Atorvastatin Tablets utilizing Fenugreek Seed Mucilage and Solid Dispersions. Since atorvastatin is very slightly soluble in distilled water and pH 7.4 phosphate buffer, there is restricted absorption of the drug orally leading to a reduction in the bioavailability (about 14%). The aim of this work was to enhance the solubility which leads to an increase in the bioavailability by formulating solid dispersion of fenugreek seed mucilage. Extracted from the seed, mucilage was assessed for percentage practical yield, flow characteristics, pH value, FTIR spectroscopy, and flow dynamics. Saturation solubility was determined for Fenugreek seed mucilage SDs, HPMC SDs and pure drug from solid dispersion with varying polymer concentrations. Tablets were tested and assessed first from solid dispersion with the highest saturation solubility. The tablets displayed acceptable physicochemical properties when evaluated for different parameters. FSM can be considered a potential ingredient to enhance solubility by forming solid dosage form.

Adsare MV et al., (2024) [75] designed, developed, characterized, and optimized a Fast-Dissolving Tablet for Celecoxib. This study was performed todevelop fast-dissolving tablets of Celecoxib by formulating solid dispersions with PVP k30 and then making tablets out of those solid dispersions. The researchers prepared different batches according to drug-to-polymer ratio and found that the batch containing a ratio of 1:4 showed good solubility compared to pure drug and other batches The FDTs were tested in a 2% SLS solution, and the in vitro release was ranked by the amount of drug that was released after 50 minutes. The findings showed that FDTs including 1:4 ratio

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celecoxib solid dispersions showed better solubility than the pure drug. This formulation approach sought to reach a supersaturated drug release, enabling quick absorption upon oral intake.

Tabassum G et al., (2023) [76] prepared and characterized Resveratrol's solid dispersion is rather poor. This study work was conducted to formulate the solid dispersion of resveratrol with HP β-Cyclodextrin to enhance the dissolution rate of this drug. Using HP β-Cyclodextrin different drug-to-polymer ratios of 1:2, 1:5, and 1:8 formulations were created with 4 different techniques (Physical mixture, Co-precipitation method, Co-evaporation method, kneading method). Different pre-formulation studies were performed like FT-IR, determination of Lambda Max, solubility studies, melting point, ionization study, and drug-polymer compatibility study. Weight variation tests, drug content, lock length, moisture permeation tests, in-vitro dissolution studies, stability studies, and post-formulation studies were conducted. Every preformulation study produced results within the specification references. All the investigations performed showed better results and passed the IP criteria. Using HP β-Cyclodextrin as a carrier, formulation "K1," with a 1:2 ratio, prepaid by the Kneading method shows better release i.e., 84.06% based on the in-vitro drug dissolution profiles than other techniques.

Nakka VN et al., (2024) [77] prepared and characterized Efavirenz Solid Dispersion using Fusion Techniques and SE. In the present work, Efavirenz (EFV) was formulated into solid dispersion by fusion method and SE method where Sugar carriers like xylitol, sorbitol, lactulose, and one non-sugar carrier like surplus are used. The solubility of the drug was first evaluated in solvent and then through the use ofthe fusion method and SE method with several different carrier ratios (1:0.5, 1:1, 1:1.5, 1:2, and 1:3) Solid dispersion (S.D.s) was produced. Drug content uniformity, saturation solubility analyses, and in vitro dissolution investigations were applied to the produced SDs. The formation of intramolecular hydrogen bonds was discovered by FTIR and pre-formulation studies. In the 7.4 pH phosphate buffer, EFV proved to be more soluble than among the other solvents. Carrier concentration and %yield changed EFV's saturation solubility; in vitro drug dissolution studies were conducted on the S.D.s. The studies showed that the SDs produced through the SE method released more amount of drug than SDs produced by the Fusion method however the Release of formulations was greater than pure drug.

Gill et al., (2014) [78] formulated and evaluated Glimepiride solid dispersion tablets. Glimepiride is a poorly soluble drug that has limited bioavailability. The solid dispersion was created with

Poloxamer-188 to create a model medicine by formulating tablets from the optimal batch of solid dispersions. Different concentrations of disintegrant croscarmellose are used during the direct compression process to make tablet formulations. The formulated tablets from solid dispersion were further evaluated with different parameters including weight variation, %friability, % drug content, hardness, disintegration test, dissolution efficiency, XRD, and in-vitro dissolution studies. Among all the batches, the batch with drug to polymer ratio of 1:4 provides the best results in dissolution efficiency and dissolution profiles and in tablet formulation the batch with 5% croscarmellose shows the best disintegration and dissolution profile. Results showed that Poloxamer-188 presents a potential polymer for improving GMP solubility.

2.2 Review of work done on Rifampicin

Theja D et al., (2012) [79] formulated and evaluated solid dispersion of rifampicin. Solubility is a crucial factor in achieving the desired concentration of a drug in the systemic circulation to elicit a pharmacological reaction. Water-insoluble medicines may necessitate high dosages to achieve therapeutic plasma concentrations following oral delivery. For a medicine to be absorbed, it must be in the form of a watery solution at the location where absorption occurs. Most medications exhibit weak acidity and weak basicity, resulting in limited solubility in water. Therefore, several methods are employed to enhance the solubility of medications that have low water solubility. These methods include micronization, chemical modification, pH adjustment, solid dispersion, complexation, co-solvency, micellar solubilization, and hydrotropy. The objective of this study was to elucidate the improved solubility of rifampicin through the utilization of solid dispersion technology and physical mixing with PEG6000. The drug and carrier ratio are 1:1, 1:2, 1:3, and 1:10, respectively. The generated samples underwent evaluation using scanning electron microscopy (SEM), drug content analysis, in-vitro tests, wettability and solubility testing, infrared spectroscopy (IR) research, and angle of repose measurement. The in-vitro drug release of the solid dispersion (SD 10) was seen to be rapid and complete within 2 hours under pH 7.4 conditions. This release profile was then compared to that of the pure drug and physical mixture. The IR Spectra analysis indicated that there was no interaction between the medication and polymers in the produced solid dispersions.

Rajesh et al., (2013) [80] performed liquisolid technique to enhance the solubility of rifampicin**.** Various techniques are used for the enhancement of the solubility of poorly soluble drugs which include liquisolid technique, micronization, nanonization, sonocrystallization, supercritical fluid method, spray freezing into liquid and lyophilization, evaporative precipitation into aqueous

solution, use of surfactant, use of co-solvent, hydrotropy method, use of salt forms, solvent deposition, solubilizing agents, modification of the crystal habit, co-crystallisation, complexation and drug dispersion in carriers. The "Liquisolid" technique is a novel and capable addition towards such an aim for solubility enhancement and dissolution improvement, thereby increasing bioavailability. Rifampicin is an orally administered broad-spectrum anti-tubercular drug. It is freely soluble in chloroform and DMSO; soluble in ethyl acetate, methanol, tetrahydrofuran; and slightly soluble in acetone, water, and carbon tetrachloride. Liquisolid formulations were prepared by Avicel PH 102 as carrier material and Aerosil 200 as coating material. PEG 400, PG, and Polysorbate 80 were used as liquid vehicles. The absence of significant drug-carrier interaction was confirmed by IR studies. High drug content and high dissolution rate were observed in F2.

Arca et al., (2018) [81] formulated Amorphous Solid Dispersion of rifampin in Cellulose ω-Carboxyalkanoate Matrices**.** Tuberculosis (TB) is a deadly infectious disease; approximately 2 billion people are currently latently infected with the causative agent *Mycobacterium tuberculosis*. Approximately 8 million new active cases and 2 million deaths due to TB are recorded annually.[1] Rifampin (Rif) is a vital first-line TB treatment drug. Its effectiveness is hampered by the high dose required (600 mg 1×/day) and by its moderate, variable bioavailability. These issues can be explained by Rif instability at gastric pH, limited solubility at neutral pH, polymorphism, and stimulation of its metabolism. To overcome these obstacles, we developed new cellulose-based oral drug delivery systems aiming to increase and make more consistent Rif solubility and bioavailability. Amorphous solid dispersions (ASDs) of Rif with cellulose ω-carboxyalkanoates (cellulose acetate suberate, cellulose acetate propionate adipate, and cellulose acetate butyrate sebacate) were prepared and compared with crystalline Rif (negative) and carboxymethyl cellulose acetate butyrate ASD (positive) controls. Cellulose ω-carboxyalkanoate ASDs prevented acid-catalyzed degradation in conditions mimicking the acidic stomach and provided the complete release of intact Rif at intestinal ph. Rif incorporation into ASD in these novel cellulose derivative matrices creates the potential for convenient, robust, consistent, and high Rif oral bioavailability for the treatment of TB.

2.3 Review of work done on Duloxetine Hydrochloride

Pandya et al. (2015) [82] formulated and characterized ternary complex of poorly soluble Duloxetine Hydrochloride. Duloxetine hydrochloride (DXH) suffers from poor solubility and

thereby poor absorption, which ultimately leads to poor bioavailability. In present study, an attempt has been made to formulate and characterize duloxetine hydrochloride (DXH) complex, using β-cyclodextrin (β-CD) and different hydrophilic polymers in order to enhance its solubility and dissolution rate. Phase solubility study was used to investigate the interaction of the drug in binary systems (DXH-β-CD) as well as ternary systems (DXH-β-CD-hydrophilic polymer). It was observed that solubilization of DXH by β-CD was further enhanced by using HPMC K4M at 0.1% w/v concentration. Several methods were used to prepare ternary complex of DXH-β-CD-HPMC K4M. Ternary complex prepared by co-evaporation method containing DXH-β-CD-HPMC K4M in the ratio of 1:1.10:0.01 has shown the fastest dissolution rate (53.65 ± 2.83% in 5 min) as compared to pure DXH (3.03 ± 1.88% in 5 min) as well as other methods used to prepare these complexes. The prepared ternary complex system was characterized by the help of X-ray powder diffraction studies, differential scanning calorimetry and scanning electron microscopy. It was observed that enhancement in solubility as well as dissolution rate of DXH was due to formation of ternary complex system.

Aaron A et al., (2023) [83] formulated a solid dispersion of Duloxetine Hydrochloride to enhance its solubility. The core objective of the present study is to enhance the solubility of poorly-water soluble drug Duloxetine HCl, a selective serotonin and norepinephrine reuptake inhibitor antidepressant (SSNRI) by using different hydrophilic carriers and formulating them into solid dispersions with solvent evaporation technique and establishing shelf life of the same by conducting stability studies. The solubility of Duloxetine HCl in various hydrophilic carriers (polymers) such as PVP K30, HPMC, HPMC AS, and Killiphor P188 was studied. A total 0f 15 SD formulations were prepared by solvent evaporation technique with different polymers and evaluated for preformulation studies, particle size analysis, drug content, in-vitro dissolution studies, and accelerated stability studies. The dissolution profile of pure SD formulation F14 prepared with HPMC AS in 1:3:(0.5+0.5) ratio of drug: polymer: surfactants [Table.3] showed a maximum drug release of 99.94 in 15 mins. Solubility of Duloxetine HCl was also increased by 15 folds in SD formulation F14 when compared to pure drug. Maximum dissolution rate is attributed to the use of a combination of surfactants which showed a synergistic effect in decreasing the interfacial tension and enhancing the wettability. This synergistic effect acted as the key factor in further enhancing the dissolution rate to the maximum.

2.4 Review of work done on Abiraterone Acetate

Katekar et al. (2022) [84] augmented experimental design for bioavailability enhancement a robust formulation of abiraterone acetate. Abiraterone acetate (ABRTA) is clinically beneficial in management of metastatic castration-resistant prostate cancer (PC-3). With highlighted low solubility and permeability, orally hampered treatment of ABRTA necessitate high dose to achieve therapeutic efficacy. To triumph these challenges, we aimed to develop intestinal lymphatic transport facilitating lipid-based delivery to enhance bioavailability. ABRTA-containing self-nano emulsified drug delivery (ABRTA-SNEDDS) was statistically optimized by D-optimal design using design expert. Optimized formulation was characterized for particle size, thermodynamic stability, *in vitro* release, *in vivo* bioavailability, intestinal lymphatic transport, *in vitro* cytotoxic effect, anti-metastatic activity, and apoptosis study. Moreover, hemolysis and histopathology studies have been performed to assess pre-clinical safety. Nano-sized particles and successful saturated drug loading were obtained for optimized formulation. *In vitro* release upto $98.61 \pm 3.20\%$ reveal effective release of formulation at intestinal pH 6.8. ABRTA-SNEDDS formulation shows enhanced *in vivo* exposure of Abiraterone (2.5-fold) than ABRTA suspension in Sprague–Dawley rats. *In vitro* efficacy in PC-3 cell line indicates 3.69-fold higher therapeutic potential of nano drug delivery system. Hemolysis and histopathology study indicates no significant toxicities to red blood cells and tissues, respectively. Apparently, an opportunistic strategy to increasing bioavailability of ABRTA *via* intestinal lymphatic transport will create a viable platform in rapidly evolving chemotherapy. Enhanced translational utility of delivery was also supported through *in vitro* therapeutic efficacy and safety assessments.

Yang et al. (2022) [85] prepared multicomponent crystal forms of Abiraterone Acetate to enhance its dissolution and bioavailability. Abiraterone acetate (ABA), the first-line drug for the treatment of metastatic castration-resistant prostate cancer (mCRPC), is administered at a high daily dosage of 1000 mg due to its poor solubility, and its fasted absolute oral bioavailability is estimated to be less than 10%. In this work we have focused on developing multicomponent forms with improved dissolution behaviors and bioavailability. Two salts of ABA with malonic acid (ABA-MA) and saccharin (ABA-SAC), and five cocrystals with *trans*-aconitic acid (ABA-TAA), 1-hydroxy-2-naphthoic acid (ABA-1HNA), pyrocatechol (ABA-PCA), resorcinol (ABA-RES) and hydroquinone (ABA-HDE) were successfully obtained. Their crystal structures were elucidated by single crystal X-ray diffraction, and these multicomponent forms were fully characterized by powder X-ray diffraction, thermal analysis and Fourier Transform Infrared spectra. Among them,

ABA-TAA cocrystal shows substantial enhancements both in the solubility and intrinsic dissolution rates in different buffer solutions. In the meantime, we unexpectedly found the gelation of ABA-MA salt and ABA-SAC salt in pH 2.0 buffer solution. The gel-like materials generated on the surface of the drug will suppress the release of ABA. Moreover, *in vivo* pharmacokinetic study on beagle dogs was conducted for ABA-TAA cocrystal preparation and ABA commercial product, and ABA-TAA cocrystal preparation shows enhanced absorption. These advantages in dissolution behaviors and bioavailability demonstrate the potential of ABA-TAA cocrystal to be a better candidate for the treatment of mCRPC compared with ABA.

Liu et al. (2022) [86] developed abiraterone acetate nanocrystal tablets to enhance its oral bioavailability. Abiraterone acetate is a prodrug of abiraterone used in combination with prednisone as a standard therapeutic strategy for hormone-resistant prostate cancer (mCRPC). Due to the poor solubility and permeability, the release and absorption of abiraterone acetate are low and reduce its bioavailability. In this project, abiraterone acetate tablets prepared using nanocrystal technology were developed to overcome the drawbacks of normal tablets by enhancing in vitro dissolution rate and oral bioavailability. The abiraterone acetate nanocrystal suspensions were prepared by top-down wet milling method using a planetary ball mill with the mixture of Poloxamer 407 and Poloxamer 188 as the optimized stabilizer at a ratio of 7:1. The optimized nanocrystals were freeze-dried and characterized using DLS, TEM, DSC, and XRD. The abiraterone acetate nanocrystal tablets significantly improve the in vitro dissolution rate of abiraterone acetate compared to raw materials. Although exhibiting a similar dissolution rate compared to the Zytiga® tablets, the nanocrystal tablets significantly improve the oral bioavailability with C_{max} and AUC_{0-t} being 3.51-fold and 2.80-fold higher, respectively, in the pharmacokinetic study. The present data indicate that nanocrystal is a promising strategy for improving the dissolution and bioavailability of abiraterone acetate.

CHAPTER 3
AIM AND OBJECTIVES

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3. AIM AND OBJECTIVES

3.1 Aim

The main aim of this research work was to augment the solubility of poorly water-soluble drugs, such as rifampicin, Duloxetine Hydrochloride, and Abiraterone Acetate, by formulating them into solid dispersions. This formulation process was intended to enhance the dissolution rate of the drugs.

Insufficiently soluble medicines require greater doses to achieve therapeutic levels in the bloodstream following oral ingestion. Enhancing the degree and speed of dissolution is extremely advantageous for compounds like this, as it can result in higher and more consistent absorption through the oral route, leading to a reduction in the required dose for effective treatment.

Currently, pharmaceutical procedures offer numerous methods to improve the rate at which poorly water-soluble medicines dissolve. The solid dispersion technique is employed to improve the solubility, dissolution rate, and absorption of many medications that are not soluble in water.

The Secondary aim is to investigate the potential of Soluplus® as carrier for the enhancement of those poorly soluble drugs and to evaluate its impact on the solid dispersion formulation.

3.2 Objectives

The Specific Objectives of the present research were:

1. Review existing Literature on solid dispersion technology, including its origins, characterization, and preparation Methods.
2. To study the possible interaction between Drug and polymer by FTIR
3. To select a suitable method for the preparation of solid dispersion and compare them
4. To formulate Solid Dispersion.
5. To Characterize the physical properties of solid Dispersion Including Drug Content, percentage yield, DSC, XRD, etc.
6. To conduct dissolution studies to evaluate the release behavior of solid dispersion.
7. To compare the release behavior of the solid dispersion with the pure drug.

Rifampicin is a prominent medicine used in the treatment of Tuberculosis. It was chosen for its low solubility and specific solubility in acidic environments, which makes it suitable for improving solubility. This study aims to improve the solubility of the substance and decrease its solubility that is reliant on pH.

Similarly, Duloxetine hydrochloride is employed for treating major depressive illness. Despite its low dosage, it can still lead to toxicity. Therefore, by increasing the drug's solubility, we can minimize the required dosage.

Among these three medications, Abiraterone Acetate has the greatest dosage. Due of its limited solubility, the current dosage is 1 gram per day, and our goal is to decrease the dosage by improving its solubility.

CHAPTER 4
PROFILES

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4. PROFILES

4.1 Drug Profiles:

4.1.1 Rifampicin (Rifampin)

Rifampin, sometimes referred to as rifampicin, falls into the antibacterial class of medications. Many different mycobacterial infections as well as gram-positive bacterial infections are managed and treated with this drug. Against a broad spectrum of gram-positive cocci, including Mycobacteria and Clostridium difficile, as well as particular gram-negative species including Neisseria meningitidis, N gonorrhoeae, and Hemophilus influenza, rifampin has antibacterial action.[87], [88], [89]

Drug: Rifampicin

IUPAC-Name: 5,6,9,17,19,21-Hexahydroxy-23-methoxy-2,4,12,16,18,20,22-heptamethyl-8-[N-(4-methyl-1-piperazinyl)formimidoyl]-2,7(epoxypentadeca[1,11,13]trienimino)naphtho[2,1-b]furan-1,11(2H)-dione 21-acetate

Structure:

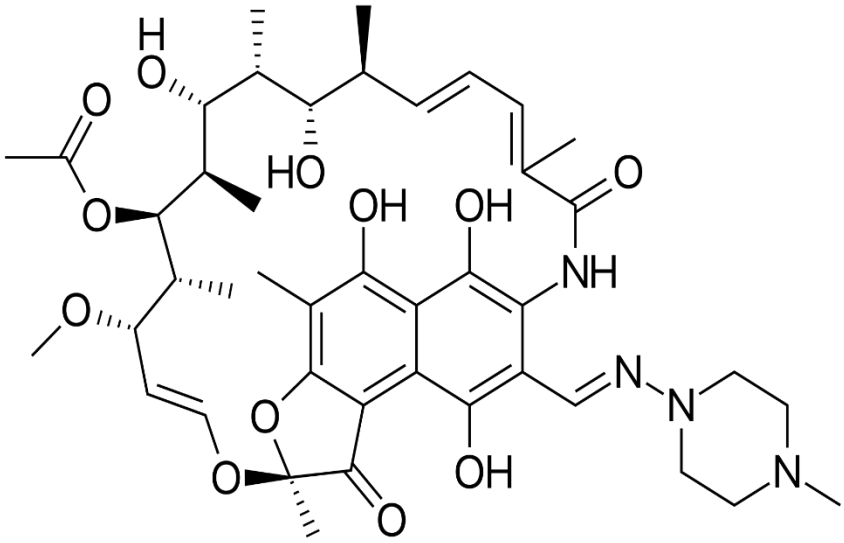

FIGURE: 4.1 CHEMICAL STRUCTURE OF RIFAMPICIN

Molecular Formula: $C_{43}H_{58}N_4O_{12}$

Molecular weight: 822.953 g/mol

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Melting point: 192°C

Description: Red powder and crystalline in nature

Solubility: Soluble in DMSO, Methanol, Chloroform, and Acetone.

Stability/Storage: Protect it from light exposure. Rifampicin remains stable as a solid at temperatures up to 70°C. Acidic or alkaline conditions at 25°C can lead to degradation.

Dosage form: Capsule, Injection

Dose: Capsule-150, 300, and 600mg, Injection-600mg/10ml

Mechanism of action: Rifampicin hinders bacterial DNA-dependent RNA synthesis by blocking bacterial DNA-dependent RNA polymerase.

Crystallographic and biochemical evidence indicates that Rifampicin interacts with the RNA polymerase β subunit's pocket located within the DNA/RNA channel, but not at the active site. The inhibitor hinders RNA synthesis by physically obstructing elongation, hence inhibiting the production of host bacterial proteins. Rifampicin inhibits RNA synthesis by utilizing the "steric occlusion" mechanism. It hinders the formation of the second or third phosphodiester link between nucleotides in the RNA backbone, hence limiting the extension of the RNA transcript beyond 2 or 3 nucleotides from the 5' end.

A recent study demonstrated that Rifampicin binds to cytochrome P450 reductase, causing changes in its shape and activity. This alteration affects the enzyme's ability to assist the metabolism of progesterone through CYP21A2.

Bioavailability: >70%

Protein binding: 80%

Metabolism: Liver and intestinal wall

Plasma half-life: 3–4 hours

Time to peak: The time to peak concentration for Rifampicin (also known as Rifampin) varies. When taken orally, it typically reaches peak serum levels within 2 to 4 hours after administration.

Peak plasma concentration: Within two hours of taking a single 600 mg dose, the serum concentration usually reaches its peak, which is around 10 µg/ml. Furthermore, an independent

indicator of sterilizing action is a peak concentration (Cmax) of Rifampicin that exceeds 8.2 µg/ml. Monitoring the levels of the therapeutic drug at 2, 4, and 6 hours after taking the dose can help in adjusting the dosage to reach the desired concentration of Rifampicin, which is advised to be 8 µg/mL or higher.

Excretion: 30% in urine, 60-65% in feces

Adverse effects: Rifampicin, sometimes referred to as Rifampin, can induce a range of adverse effects. Below are many often encountered examples: Gastrointestinal discomfort, acid reflux, queasiness, or headache may manifest. Rifampicin can induce a change in the color of body fluids, such as urine, perspiration, saliva, or tears, resulting in an orange-red hue. This side effect is benign and will resolve upon discontinuation of the medication.

Apart from above mentioned side effect, more detrimental outcomes such as: Agitation, Gums that are actively releasing blood, the presence of blood in urine or stools, Contusion, Tightness in the chest, confusion, Pyrexia with or without rigors, Vertigo, Elevated blood pressure Itching, rashes, or redness of the skin, Abnormal bleeding or bruising, Jaundice may occur.

Applications: Rifampicin, sometimes referred to as Rifampin, has multiple significant applications

Treatment of Tuberculosis (TB):

- Rifampicin is an essential element in the therapy of tuberculosis.
- It is utilized in conjunction with other antibiotics, including Pyrazinamide, Isoniazid, and Ethambutol.
- The conventional treatment protocol entails the daily administration of medication for a minimum duration of six months in order to effectively combat tuberculosis.

Prophylaxis for Meningococcal Meningitis and Haemophilus influenzae Type B Meningitis:

- As standalone treatment for prophylaxis for people who were in close proximity to person who were suffering from certain forms of meningitis Rifampin is used.
- Helps in the prevention of infection in individuals.

Combination Therapy to Prevent Resistance:

- To prevent the emergence of drug resistance, Rifampicin is provided in tandem with other medications.
- Additionally, it reduces the total length of the treatment.

4.1.2 Duloxetine Hydrochloride

Drug: Duloxetine Hydrochloride

Duloxetine hydrochloride is a medicine used to treat depression. It works by selectively inhibiting the reuptake of serotonin and norepinephrine, which are neurotransmitters in the brain. Its main application is in the treatment of depression, anxiety, fibromyalgia, and chronic pain diseases including diabetic peripheral neuropathy, chronic musculoskeletal pain, and arthritis. Duloxetine functions by augmenting the concentrations of serotonin and norepinephrine in the brain, thereby facilitating the regulation of mood and pain.[90], [91], [92]

IUPAC-Name: (3*S*)-*N*-methyl-3-naphthalen-1-yloxy-3-thiophen-2-ylpropan-1-amine; hydrochloride

Structure:

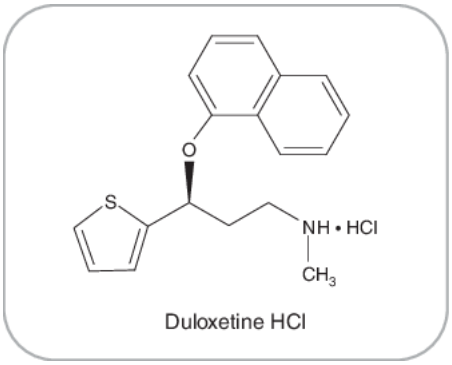

FIGURE: 4.2 CHEMICAL STRUCTURE OF DULOXETINE HYDROCHLORIDE

Molecular Formula: $C_{18}H_{19}NOS$ HCL

Molecular weight: 297.4145 g/mol

Melting point: 169°C

Description: white Powder

Solubility: soluble in organic solvents such as Ethanol, DMSO, and dimethyl formamide (DMF).

Stability/Storage: Keep duloxetine hydrochloride containers tightly sealed in a cool, shaded spot with good air circulation and ignition sources. The recommended storage temperature is 4°C (sealed storage, away from moisture). In solvent: -80°C (for 6 months) or -20°C (for 1-month, sealed storage, away from moisture)

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Dosage form: capsules

Dose: 20-60mg

Mechanism of action: Duloxetine HCl works by inhibiting the uptake of serotonin and norepinephrine in neurons. Enhancement of the effect of serotonin and norepinephrine in CNS can be attained by Duloxetine HCl. Duloxetine exhibits a notable affinity for multiple receptors.

Bioavailability: 50%

Protein binding: 95%

Metabolism: Hepatic

Plasma half-life: 12h

Time to peak: Six hours or so taken without food. If taken with food, though, it might take up to ten hours to reach optimal concentration.

Peak plasma concentration: The maximum concentration of duloxetine hydrochloride (DUL) in the bloodstream is reached around 6 hours after taking the dose. The PPC ranges between roughly 47 µg /ml (40 mg twice daily) and 110 µg /ml (80 mg twice daily).

Excretion: 70% in urine, 20% in feces

Adverse effects: Duloxetine hydrochloride (DUL) might have several adverse effects. Below are many often-encountered examples: The side effects of the medication include nausea, xerostomia, constipation, drowsiness, dizziness, insomnia, anorexia, and heightened perspiration. Furthermore, there are certain uncommon yet highly detrimental effects: Symptoms include confusion, easy bruising or bleeding, decreased interest in sexual activity, Alterations in sexual potency, symptoms of muscle cramps/weakness, shaking, difficulty urinating and Indications of liver issues

Applications: Duloxetine hydrochloride (DUL) has several applications:

MDD:

- DUL is prescribed as a treatment for depressive disorders
- It aids in regulating the levels of serotonin and norepinephrine in the brain.

General Anxiety Disorder (GAD):

- Duloxetine Hydrochloride can treat GAD in Patients from 7 to adults

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Nerve Pain:

- DUL is utilized to alleviate neuropathic pain resulting from diabetes (diabetic neuropathy).
- Persistent muscle pain and bone pain can be aided with the help of Duloxetine HCl

Fibromyalgia:

- Certain brands of DUL (such as Cymbalta) have a stated purpose of treating fibromyalgia in both adults and children aged 13 and above.

4.1.3 Abiraterone Acetate

Drug: Abiraterone Acetate

A medication used in treating prostate cancer is abiraterone acetate. Its mode of action is lowering body testosterone levels, preventing the spread and growth of prostate cancer cells. Often used in conjunction with prednisone, abiraterone acetate treats castration-resistant prostate cancer—a disorder in which prostate cancer has spread and responded poorly to treatments lowering testosterone levels.[93], [94, [95]

IUPAC-Name: [(3S,8R,9S,10R,13S,14S)-10,13-dimethyl-17-pyridin-3-yl-2,3,4,7,8,9,11,12,14,15-decahydro-1H-cyclopenta[a]phenanthren-3-yl] acetate

Synonyms: CB-7630, JNJ-212082, 17-(3-Pyridinyl)androsta-5,16-dien-3β-ol acetate, Abiraterone (BAN UK), Abiraterone acetate (JAN JP), Abiraterone acetate (USAN US), Zytiga, Yonsa, Others

Structure:

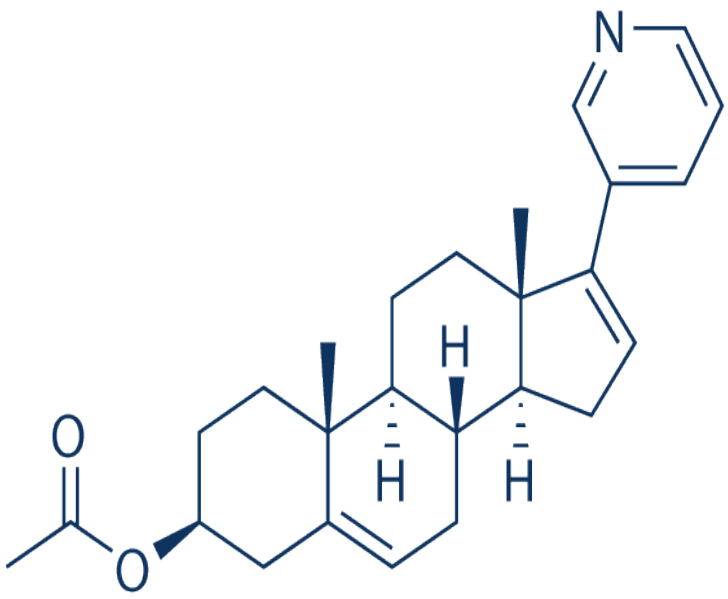

FIGURE: 4.3 CHEMICAL STRUCTURE OF ABIRATERONE ACETATE

Molecular Formula: $C_{26}H_{33}NO_2$

Molecular weight: 391.555 g/mol

Melting point: 144-98°C

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Description: White Powder

Solubility: In Methanol, Ethanol, DMF, and DMSO

Stability/Storage: Abiraterone acetate should be stored at 20°C to 25°C (68°F to 77°F), with excursions permitted between 15°C and 30°C (59°F and 86°F)

Dosage form: Tablet

Dose: 125mg, 250mg, 500mg and 1000mg

Mechanism of action: Abiraterone acetate works by suppressing the production of androgens – specifically, it inhibits the enzyme CYP17A1. By doing so, it decreases the production of testosterone, which is crucial in prostate cancer

Bioavailability:<10%

Protein binding: 99.8%

Metabolism: Esterases, CYP3A4, SULT2A1

Plasma half-life: 12-24hr

Time to peak approximately 2 hours after ingestion

Peak plasma concentration: The maximum plasma concentration (C_{max}) of Abiraterone acetate is approximately 54.67 ± 68.30 µg/ml, and the median time to maximum concentration (t_{max}) is 5.53 hours (range: 2.67–35.00 hours)

Excretion: 80% in feces, 5% in Urine

Adverse effects: Detrimental effects that you should report

Allergic reactions: Itchiness, rashes, swelling of the face, tongue, or throat.

- Heart rhythm changes: Fast or irregular heartbeat, dizziness, feeling faint or lightheaded, chest pain, trouble breathing, Increase in blood pressure.
- Common shown effects are Arm, back, or jaw pain, chest tightness or heaviness.
- Clay-colored stools.
- Cool, sweaty skin.
- Dark urine.

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Applications: It's one of the core treatment plan for treating metastatic castration-resistant prostate cancer and metastatic high-risk castration-sensitive prostate cancer.

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4.2 Polymer Profile

Introduction: Soluplus® is a polymeric solubilizer with an amphiphilic chemical structure, that was specifically designed for the formulation of solid solution.[96], [97]

Description: Soluplus® is a polyvinyl caprolactam-polyvinyl acetate-polyethylene glycol graft co-polymer.

Composition: Being a Graft co-polymer it has multiple uses

- **Polyvinyl Caprolactam:** provides solubility enhancement and stability
- **Polyvinyl Acetate:** forms part of the unique structure
- **Polyethylene glycol:** contributes hydrophilic properties

Appearance: White to yellowish free-flowing granules

Molecular weight: 118,000g/mol

Critical Micelle concentration: 7.6mg/L

HLB: Approximately 14

Melting Point: 76°C

Structure:

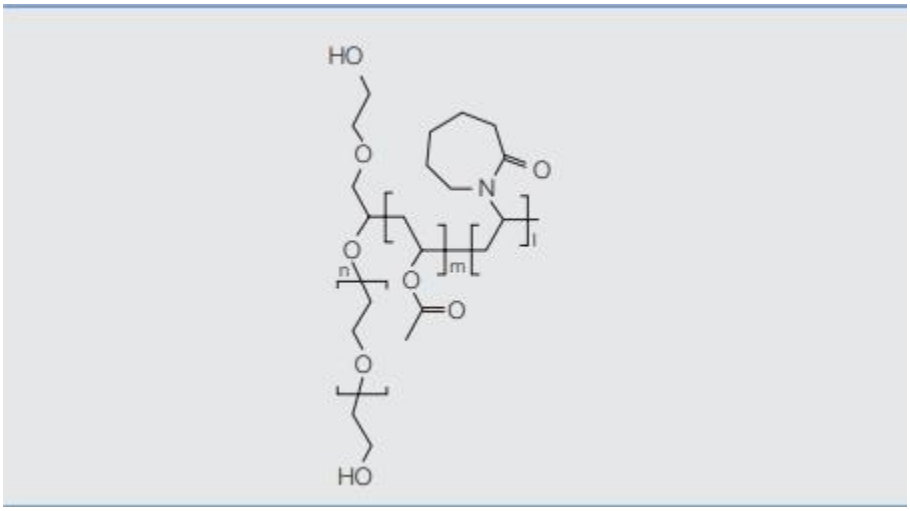

FIGURE: 4.4 CHEMICAL STRUCTURE OF SOLUPLUS®

Solubility: Soluble in Water, Methanol, Ethanol, Acetone and dimethylformamide

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Applications: Soluplus® was designed for solubilizing high concentrations of poorly water-soluble APIs in amorphous solid dispersions (ASDs) – these can be produced using a multitude of technologies

CHAPTER 5
MATERIALS AND METHODS

5. MATERIALS AND METHOD

5.1 Materials

5.1.1 Chemicals

TABLE: 5.1 LIST OF CHEMICALS

Sr. No.	Chemicals Name	Obtained From
1	Rifampicin	Lupin Pharmaceuticals
2	Duloxetine Hydrochloride	Atom Pharma
3	Abiraterone Acetate	Bulat Pharmaceuticals
4	Soluplus®	BASF
5	Potassium Dihydrogen phosphate	National Chem Labs
6	Disodium Hydrogen Phosphate	National Chem Labs
7	Sodium Chloride	National Chem Labs
8	Methanol	Lab pro inc.

5.1.2 Equipments

TABLE: 5.2 LIST OF EQUIPMENTS

Sr. No.	Equipment Used	Manufacturer
1	Pipette, Beakers, Volumetric Flasks, Funnel etc.	Borosil
2	Hot-air Oven	Labindia Instruments
3	UV-spectrophotometer	Shimadzu 1700
4	Dissolution Apparatus	Electro lab
5	pH Meter	Eutech
6	FT-IR	Perkin Elmer Spectrum GX

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7	DSC	Perkin Elmer DSC-8000
8	Xray Diffractometer	Bruker D8 Advance
9	Digital Weighing Machine	Citizon
10	Magnetic Stirrer	Remi
11	Hot Plate	Remi
12	Evaporating Dish	Randhawa Global

5.2 Methods:

5.3.1 Preparation of Solid Dispersion

Solvent evaporation: The solid dispersion was formed by precisely measuring the required quantities of the medication and polymer. Afterward, the determined amounts of the medicine and polymer were separately dissolved in methanol to achieve a homogeneous solution. A molecular dispersion of medication and polymer was achieved by introducing the drug solution into the polymer solution while stirring constantly. The solvent was then evaporated to create a solid dispersion, which was later dried and triturated.

Melt Evaporation: During this procedure, the solid dispersion is created by initially heating the polymer until it reaches a molten state. Simultaneously, a drug solution is made using methanol, following the formulation requirements. The drug solution is gradually introduced into the molten carrier as the mixture is being cooled in an ice bath. Subsequently, the solvent is evaporated, and the mixture is dried, pulverized, and sieved.

Rifampicin formulations

(TABLE: 5.3) COMPOSITION BATCHES OF RIFAMPICIN FORMULATIONS

Sr. No.	Code	Ratio	Method
1	R1	1:1	SE (RIF + SOLUPLUS)
2	R2	1:2	SE (RIF + SOLUPLUS)
3	R3	1:3	SE (RIF + SOLUPLUS)

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4	R4	1:1	ME (RIF + SOLUPLUS)
5	R5	1:2	ME (RIF + SOLUPLUS)
6	R6	1:3	ME (RIF + SOLUPLUS)

Duloxetine HCl formulations

(TABLE: 5.4) COMPOSITION BATCHES OF DULOXETINE HCl FORMULATIONS

Sr. No.	Code	Ratio	Method
1	D1	1:1	SE (D.HCL + SOLUPLUS)
2	D2	1:2	SE (D.HCL + SOLUPLUS)
3	D3	1:3	SE (D.HCL + SOLUPLUS)
4	D4	1:1	ME (D.HCL +SOLUPLUS)
5	D5	1:2	ME (D.HCL +SOLUPLUS)
6	D6	1:3	ME (D.HCL +SOLUPLUS)

Abiraterone Acetate formulations

TABLE: 5.5 COMPOSITION BATCHES OF ABIRATERONE ACETATE FORMULATIONS

Sr. No.	Code	Ratio	Method
1	A1	1:1	SE (A.A. + SOLUPLUS)
2	A2	1:2	SE (A.A. + SOLUPLUS)
3	A3	1:3	SE (A.A. + SOLUPLUS)
4	A4	1:1	ME (A.A. + SOLUPLUS)
5	A5	1:2	ME (A.A. + SOLUPLUS)
6	A6	1:3	ME (A.A. + SOLUPLUS))

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5.3.2 Evaluation Parameters

5.3.2.1 Solubility Studies: The solubility data for Rifampin, Duloxetine Hydrochloride, and Abiraterone Acetate, physical mixture, and solid dispersions prepared using the Solvent Evaporation method and Melt Evaporation method in distilled water, were determined. Quantities of the solid dispersion equivalent to 10 mg of the drug were added to 25 mL of distilled water in a beaker. The beaker contents were stirred for 2 hours at room temperature using a magnetic stirrer. The resulting solution was kept aside for 24 hours and then it was filtered, and diluted according to the requirement, and the filtrate was analyzed spectrophotometrically based on their respective lambda Max. [98]

5.3.2.2 Drug Content: 50 mg of solid dispersions were taken in a beaker and dissolved with 50 ml of methanol. The resulting solution was filtered, suitably diluted, and analyzed for drug content using a UV spectrophotometer at their respective Lambda max. Each sample was analyzed in triplicate.[98] Actual drug content was calculated for all batches using the equation as follows:

$$\text{DC \%} = \frac{\text{Actual API content in weighed quantity of solid dispersion}}{\text{Theoretical amount of API in Solid dispersion}} \text{ X 100}$$

5.3.2.3 %Yield: Solid Dispersion recovered at the end of the formulation was weighed and their %Yield was calculated.[99]

$$\text{\%Yield} = \frac{\textit{Total Weight of solid dispersion}}{\textit{Total weight of Drug and Polymer}} \text{ X 100}$$

5.3.2.4 In-vitro drug release studies: The in-vitro dissolution studies for all drugs (Rifampicin, Duloxetine Hydrochloride, and Abiraterone Acetate) were carried out in a USP paddle-type dissolution test apparatus.

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1. Rifampin

Preparation of dissolution medium: To create a phosphate buffer with a pH of 7.4, dissolve 2.38 grams of disodium hydrogen phosphate, 0.190 grams of potassium dihydrogen phosphate, and 8 grams of sodium chloride in enough distilled water to make 1000 milliliters of the buffer solution.[100]

Dissolution rate determination: Following the estimation of drug content in solid dispersions, we proceeded with dissolution testing to evaluate the release rate from the dispersions. The dissolution was conducted at 37.5°C and 75 rpm for two hours using pH 7.4 phosphate buffer as the dissolution medium [79]. The pure drug, PM, and SD in respective weights, based on content evaluation studies, were placed into corresponding baskets.

At intervals of 10 minutes, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, and 120 minutes, 5ml samples were withdrawn from each basket, and the same volume of fresh dissolution medium was added after each withdrawal. Each 5ml sample was then diluted to 10ml with 7.4 pH phosphate buffer solution.

2. Duloxetine Hydrochloride

Preparation of dissolution medium: To prepare a 6.8 pH phosphate buffer, dissolve 28.80 grams of disodium hydrogen phosphate and 11.45 grams of potassium dihydrogen phosphate in sufficient distilled water to produce 1000 milliliters of the buffer solution.[101]

Dissolution rate determination: Following the estimation of drug content in SDs, we proceeded with dissolution testing to determine the release rate from the dispersions. The dissolution was conducted at 37.5°C and 100 rpm for two hours using pH 6.8 phosphate buffer as the dissolution medium[83]. The Pure Drug, PM, and SD in respective weights, based on content evaluation studies, were placed into corresponding baskets.

At intervals of 10 minutes, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, and 120 minutes, 5ml samples were withdrawn from each basket, and the same volume of fresh dissolution medium was added after each withdrawal. Each 5ml sample was then diluted to 10ml with 6.8 pH phosphate buffer solution.

3. Abiraterone Acetate

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Preparation of dissolution medium: To prepare a 4.5 pH phosphate buffer, dissolve 6.80 grams of potassium dihydrogen phosphate in sufficient distilled water to produce 1000 milliliters of the buffer solution.[100]

Following the estimation of drug content in SDs, we proceeded with dissolution testing to determine the release rate from the dispersions. The dissolution was conducted at 37.5°C and 75 rpm for two hours using pH 4.5 phosphate buffer as the dissolution medium[86]. The pure drug, PM, and SD in respective weights, based on content evaluation studies, were placed into corresponding baskets.

At intervals of 10 minutes, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, and 120 minutes, 5ml samples were withdrawn from each basket, and the same volume of fresh dissolution medium was added after each withdrawal. Each 5ml sample was then diluted to 10ml with a 4.5 pH phosphate buffer solution.

FT-IR: The FT-IR spectrum was performed for all the 3 drugs, polymer, and their physical mixtures to determine the compatibility between drug and polymer.

DSC: Differential Scanning calorimetry was performed for the drug, polymer, physical mixture, and SDs formulation to determine their thermal characteristics, thermal transitions etc.

XRD: X-ray diffraction of the drug and the final formulation was performed to determine the crystallinity and quantification of percent crystallinity of drug and the final formulation.

CHAPTER 6
RESULTS AND DISCUSSION

6. RESULTS AND DISCUSSION

6.1 Preliminary Trials

Multiple trial batches were produced to assess certain criteria that might or might not affect the formulation of additional batches of SDs before beginning the development for them.

6.1.1 Method-selection: Among other techniques including melt fusion, melt agglomeration, or kneading method, solvent evaporation and melt evaporation techniques were selected. Comparative studies between melt evaporation and solvent evaporation were performed because in both techniques solvent system is removed to formulate the SDs and are somewhat similar.

Some of the main causes are versatility concerning choices of polymers, preventing thermal decomposition of drugs or carriers, and because evaporation occurs at low temperatures also ensuring solubility. Furthermore, a simple technique improving dissolution capacity helps drug absorption by solvent evaporation

Soluplus® has a melting point of 76°C while the Melt evaporation method requires a polymer or a carrier that can melt at lower temperatures. This is why Soluplus® can be used in both techniques SE and ME.

Now the reason for not choosing techniques like melt fusion or kneading method is because the melt fusion technique causes a decrease in yield percentage, changes in crystallinity over time, and also the development of dark lumps (Rifampicin) in the SDs which may affect the general condition of formulation.

Because of water evaporation and also compared to Solvent evaporation and melt evaporation the practical yield is less when passing the drug-carrier mass (dough-like) through a sieve. Formulation of SDs by the kneading method is much time-consuming. Also, there is a possibility of moisture entering the formulation causing formulation degradation.

6.1.2 Solvent-selection: Solubility of the API or medicine in the particular solvent helped to guide the choice of solvent for both techniques. Methanol, ethanol, DMSO, DMF, and Chloroform are organic solvents in which the drugs are soluble.

Because of its fast evaporation and great solubility of medication and polymer, methanol was selected as the solvent for SDs.

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Either heating the solvent to evaporate it or letting it evaporate at room temperature produced batches. The batch made by evaporating at room temperature came out preferred since it had somewhat more solubility and the yield Acquired was more. The color shade of rifampicin also changed in the SD batch; the room temperature batch had light red while the batch with heat had dark red color.

Formulations using ethanol were also conducted; however, it was not chosen later due to its high evaporation temperature at 70°C. Methanol allowed all three of the three medications selected for formulation (Rifampin, Duloxetine HCl, AbirateroneAcetate) to be soluble.

6.1.3 Carrier-selection: Soluplus® was selected as the polymer since of its low melting point and solubility power. Beacause of its bifunctional nature it can be matrix polymer on one hand and solubilizer on other.

Because of their amorphous form Rifampin, Duloxetine HCl and Abirateronewere dissolved in distilled water containing Soluplus® to ascertain whether it increased the solubility and it did enhance the solubility of drugs in water.

A research study was conducted to compare PEG 6000 and Soluplus® in terms of their ability to enhance the dissolution of a drug. Soluplus® demonstrated greater enhancement in the drug's dissolution compared to PEG 6000.

Soluplus® is chosen as a carrier in part because of its solubility in wide range of organic solvents

6.1.4 Solubility of medication: Solubility of drugs was enhanced when they were formulated into SDs. When the solubility of the SDs was compared with that of the pure drug, the SDs showed higher solubility. The increase in solubility of SDs was directly proportional to the concentration of the polymer.

6.1.5 % Yield: Although both Duloxetine HCL and Rifampin became highly soluble after being formulated into SDS, in some cases concentration batches had less yield because of stickiness caused by the increased concentration of polymer, which was the problem. Both Solvent evaporation and melt evaporation were appropriate for the drugs involved; some were good for a particular drug which can be considered to be used for manufacturing of that drug in the industrial level.

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6.2 Results:

6.2.1 Rifampicin

1. %Drug content, %Yield and Solubility studies:

TABLE: 6.1 CHARACTERIZATION OF RIFAMPICIN, ITS PHYSICAL MIXTURE, AND ITS SDs

Name	%Drug content	%Yield	Solubility (µg/ml)
Pure Drug	-	-	11.03 ± 0.08
Physical Mixture	80.23 ± 0.3	-	17.84 ± 0.065
(SE-SD 1:1) R1	82.23 ± 0.45	88.24	14.77 ± 0.053
(SE-SD 1:2) R2	81.40 ± 0.63	87.13	18.55 ± 0.046
(SE-SD 1:3) R3	88.87 ± 0.25	85.05	22.24 ± 0.060
(ME-SD 1:1) R4	79.65 ± 0.5	85.42	15.38 ± 0.074
(ME-SD 1:2) R5	86.57 ± 0.35	84.23	19.67 ± 0.059
(ME-SD 1:3) R6	89.25 ± 0.4	86.56	24.63 ± 0.036

*All values are in mean ± SD (n=3)

The drug content and %yield was found to be above 80%, which can be considered good. Amongst all the batches, batches R3 and R6 showed better results. This may be probable because of the increase in concentration of carrier. Two-fold increase can be seen in solubility when pure drug compared to Best formulations R3 and R6 Thus, the increase in the concentration of the carrier can lead to an increase in the solubility of the drug. Similar results were shown in a study performed by Theja D et al., (2012)[79]

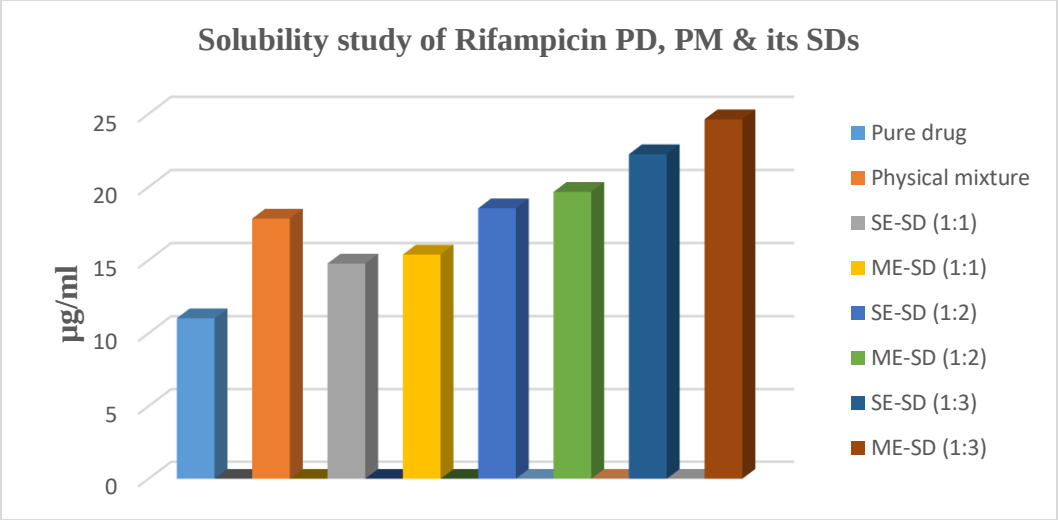

FIGURE: 6.1: SOLUBILITY STUDY OF RIFAMPICIN PD, PM & ITS SDs

2. In vitro-release Studies:

From the dissolution data, it was observed that the prepared SDs showed an enhanced dissolution rate when compared to pure drug. The probable reason is the crystalline drug was converted to the amorphous form. The amorphous solid has high free energy, due to which in the process of stabilization, they form hydrogen bonds with the water molecules and get converted into the solution form.

Among all the batches A3 and A6 showed greater dissolution rate releases up to 62.8% and 63.59% of the drug.

Other batches also show Increased dissolution compared to pure drug which proved that formulation of SDs with Soluplus® enhances the dissolution rate of this drug. Similar results were obtained in a study performed by Shamsuddin et al. (2016)[102]

TABLE: 6.2 DISSOLUTION PROFILE OF RIFAMPICIN, ITS PHYSICAL MIXTURE, AND ITS SDs

Time (Min)	Percentage Drug Release (%)							
	Pure Drug	Physical Mixture	SE-SD (1:1) (R1)	SE-SD (1:2) (R2)	SE-SD (1:3) (R3)	ME-SD (1:1) (R4)	ME-SD (1:2) (R5)	ME-SD (1:3) (R6)
10	2.34	10.138	9.39	11.421	13.287	7.4768	10.542	16.778
20	5.67	13.77	16.34	18.215	20.28	13.746	15.198	24.811
30	10.12	19.158	23.45	24.968	30.885	20.606	20.15	32.519
40	15.78	32.231	31.969	34.56	41.473	26.769	29.039	44.49
50	20.45	38.681	40.621	45.67	49.662	35.038	38.067	53.975
60	23.89	44.908	44.68	56.78	60.502	46.818	47.516	62.242
70	27.01	55.393	57.121	67.89	70.026	55.823	56.326	74.598
80	30.23	62.01	63.639	75.9	78.162	63.749	65.002	84.449
90	31.44	69.268	65.212	83.29	86.113	69.793	73.192	88.099
100	32.56	73.583	72.734	85.13	90.717	74.813	79.35	91.687
110	34.67	77.412	73.071	86.65	93.716	75.118	83.328	94.538
120	35.6	80.13	73.882	87.22	**96.59**	76.01	85.23	**97.8**

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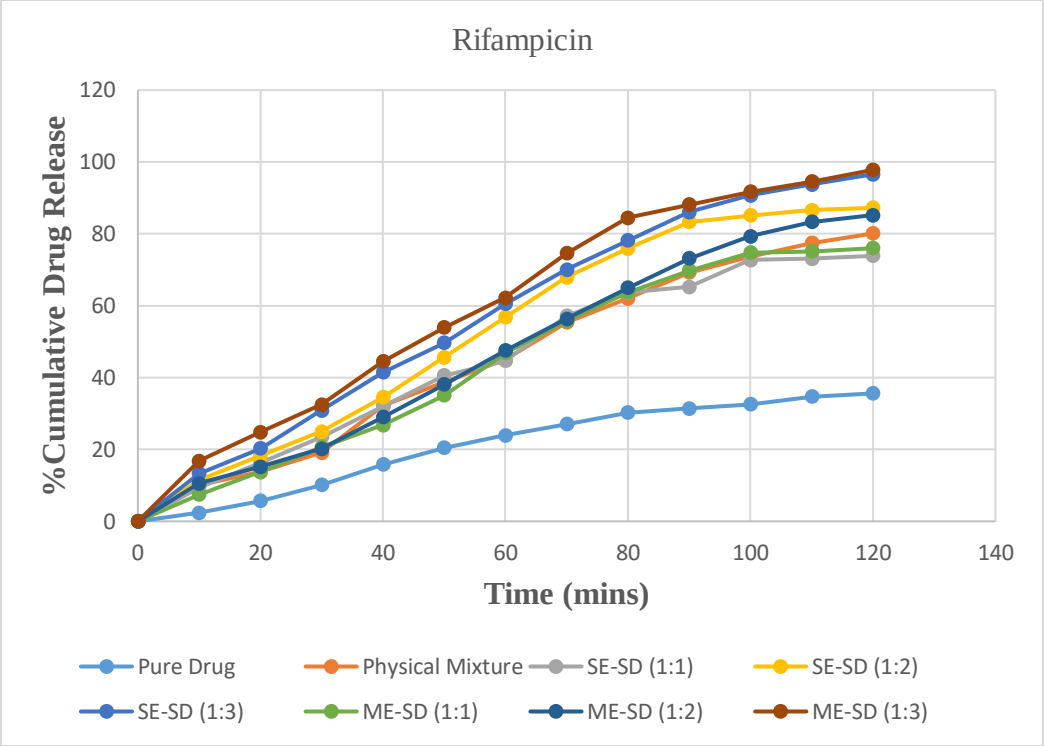

FIGURE: 6.2 CUMULATIVE % RELEASE STUDIES OF RIFAMPICIN, ITS PHYSICAL MIXTURE, AND ITS SDs

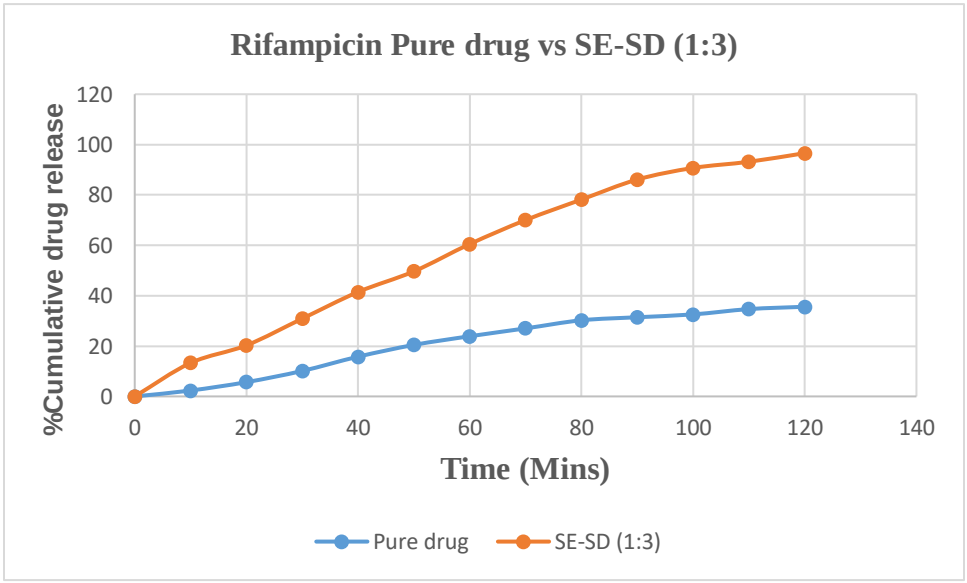

FIGURE: 6.3 RELEASE STUDIES OF RIFAMPICIN PURE DRUG VS FORMULATION (SE-SD 1:3)

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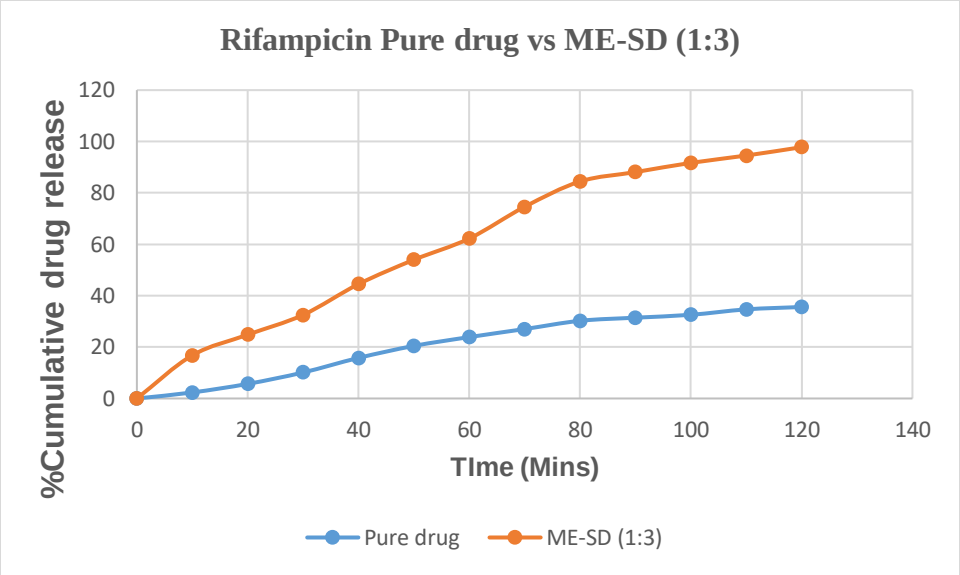

FIGURE: 6.4 RELEASE STUDIES OF RIFAMPICIN PURE DRUG VS FORMLATION (ME-SD 1:3)

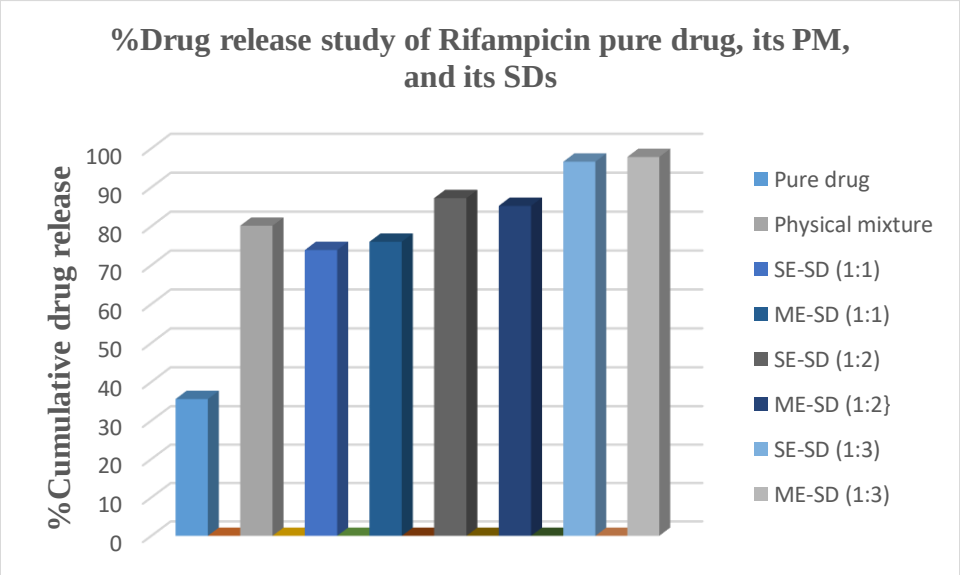

FIGURE: 6.5 %DRUG RELEASE OF RIFAMPICIN PURE DRUG, PM, AND ITS SDs

3. **FT-IR:** FT-IR studies were performed for the compatibility studies. The peaks of the drug from spectra (Figure 6.6) were compared with peaks of the physical mixture (Figure 6.8) as shown in Table 6.3 and no interaction or shifts were observed. The formulations (Figure 6.4 and 6.5) also showed all the peaks shown in Table 6.3. Similar results were shown in a study performed by Theja D et al., (2012) [79]

Rifampin shows all the respective peaks

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TABLE: 6.3 COMPARISON OF FTIR WAVELENGTHS OF RIFAMPICIN, ITS PHYSICAL MIXTURE, AND ITS SDs

Functional groups	Pure drug (cm^{-1})	Physical mixture (cm^{-1})	R3 (cm^{-1})	R6 (cm^{-1})
-C=N	1562.06	1562.06	1558.2	1558.2
C=O	1712.48	1731.76	1735.62	1730.62
C-H	2977.5	2977.55	2977.55	2938.98

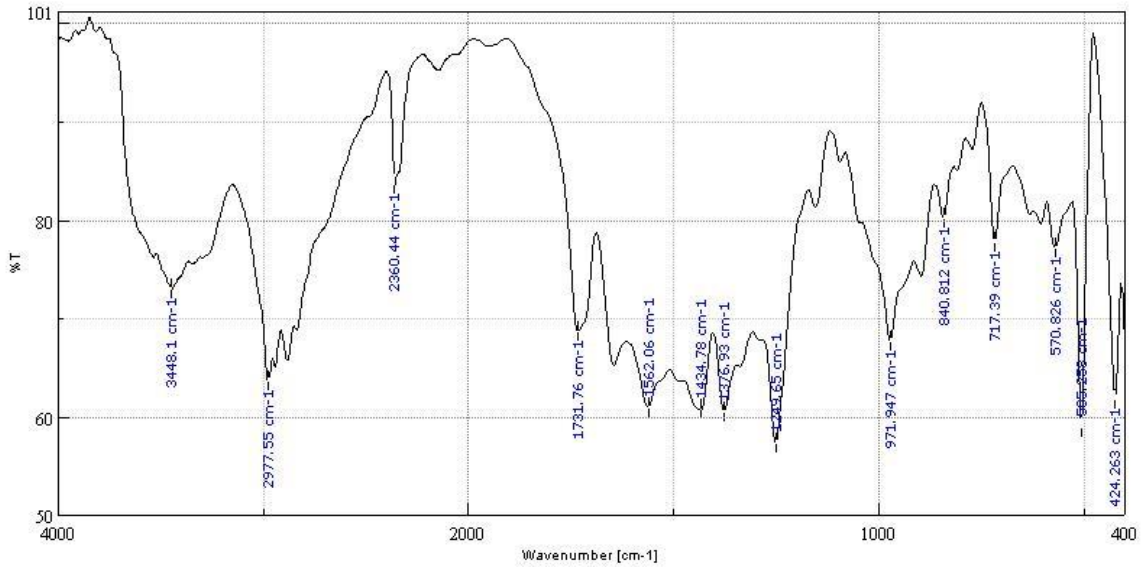

FIGURE: 6.6 FTIR SPECTRA OF RIFAMPICIN

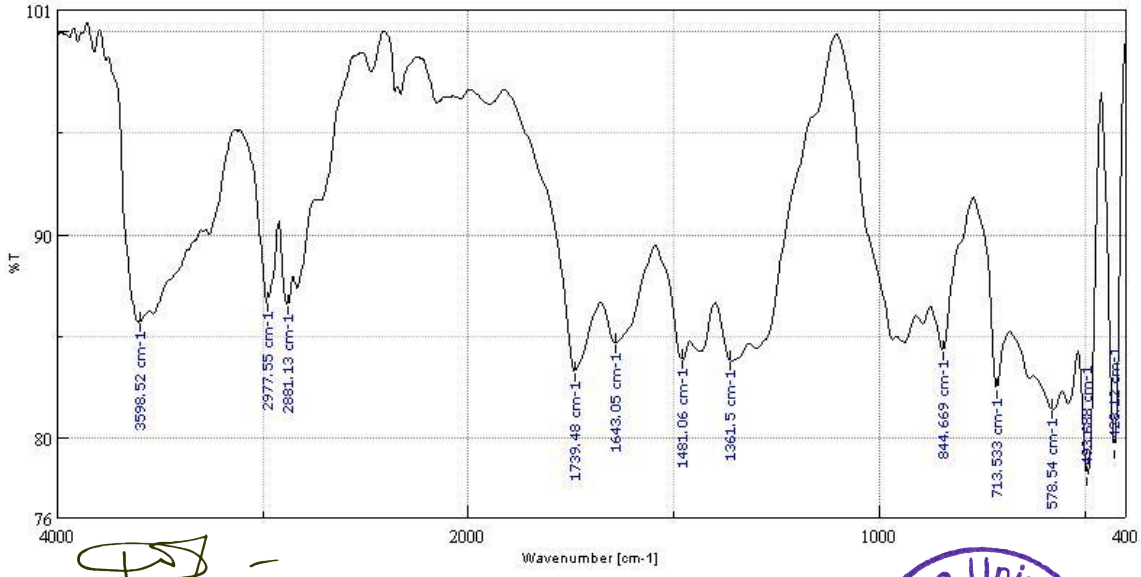

FIGURE: 6.7 FTIR SPECTRA OF SOLUPLUS®

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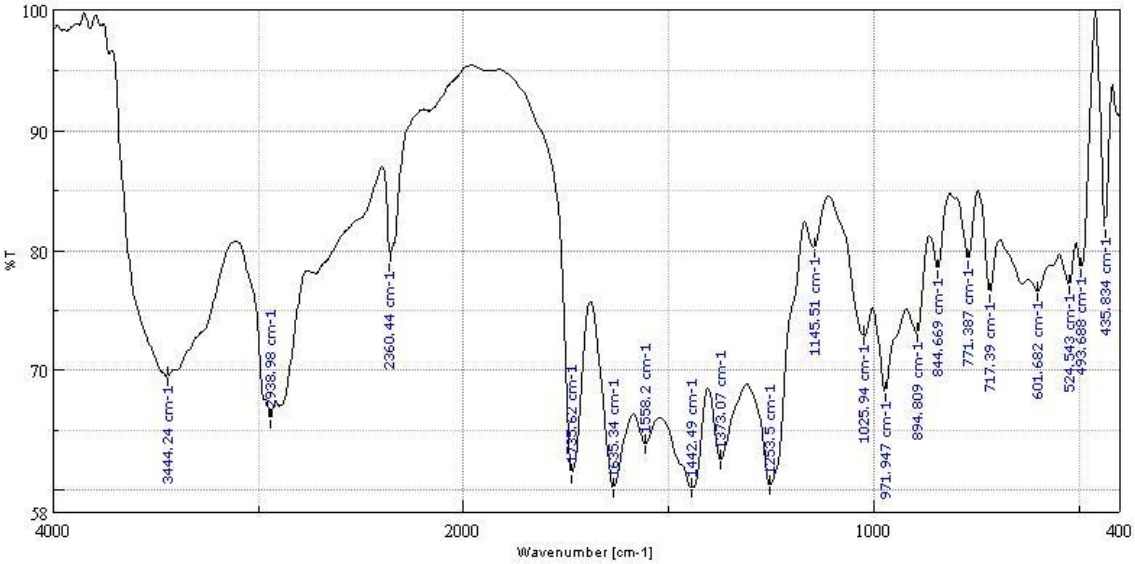

FIGURE: 6.8 FTIR SPECTRA OF RIFAMPICIN PHYSICAL MIXTURE

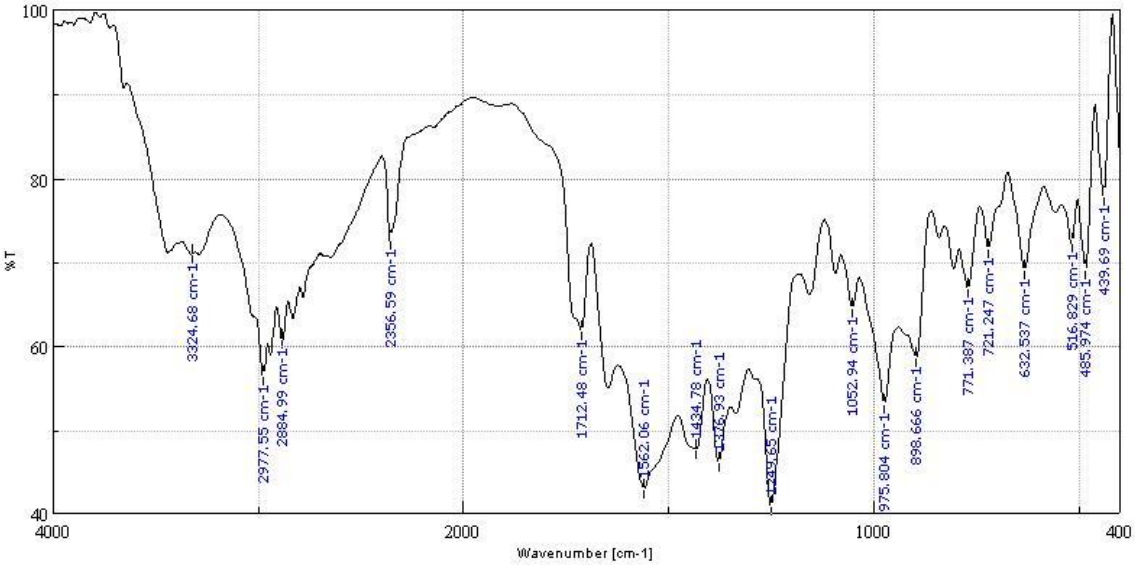

FIGURE: 6.9 FTIR SPECTRA OF RIFAMPICIN FORMULATION R3 (SE-SD 1:3)

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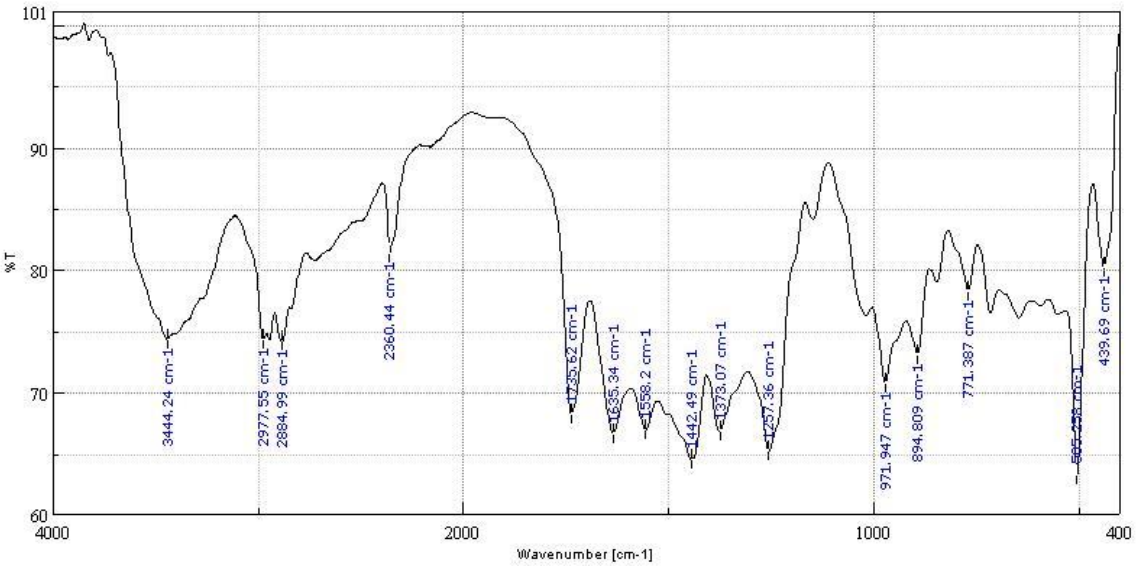

FIGURE: 6.10 FTIR SPECTRA OF RIFAMPICIN FORMULATION R3 (ME-SD 1:3)

DSC: Thermal characteristics of Rifampin along with the physical mixture and SDs were determined using DSC analysis. The endothermic peak shown in Figure 6.11 corresponds to the melting temperature of the drug. The Polymer showed an endothermic peak at 76°C as shown in Figure 6.12 which corresponds to its melting point. The formulation SE-SD 1:3 showed perfect encapsulation as shown in Figure 6.13 and formulation ME-SD 1:3 showed a reduction in exothermic peak as shown in Figure 6.14 which indicates a reduction in crystallinity. Similar results were shown in a study performed by Ramu A et al., (2024) [62]

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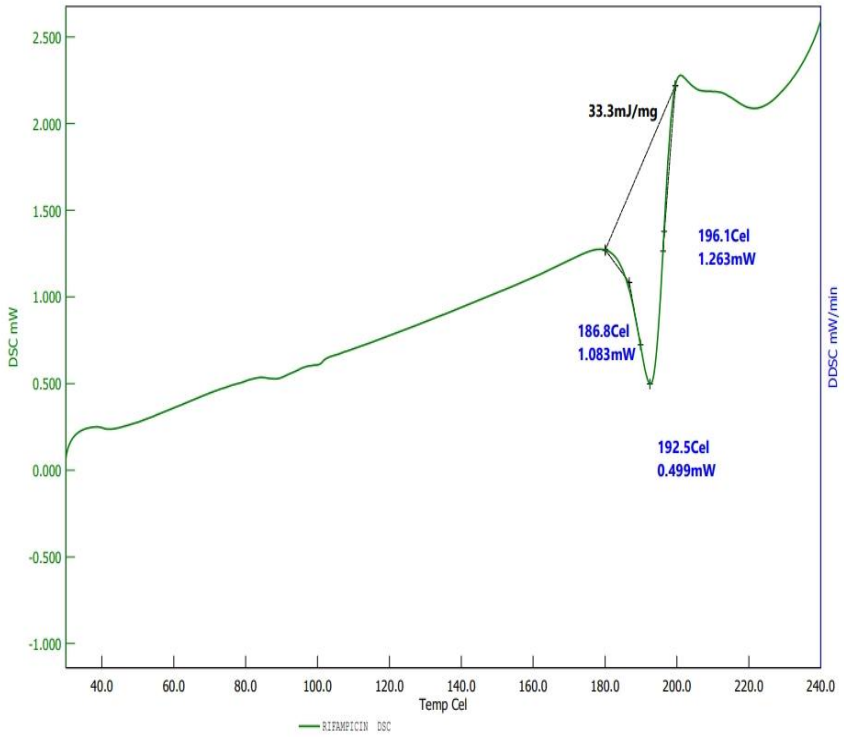

FIGURE: 6.11 DSC THERMOGRAM OF RIFAMPICIN

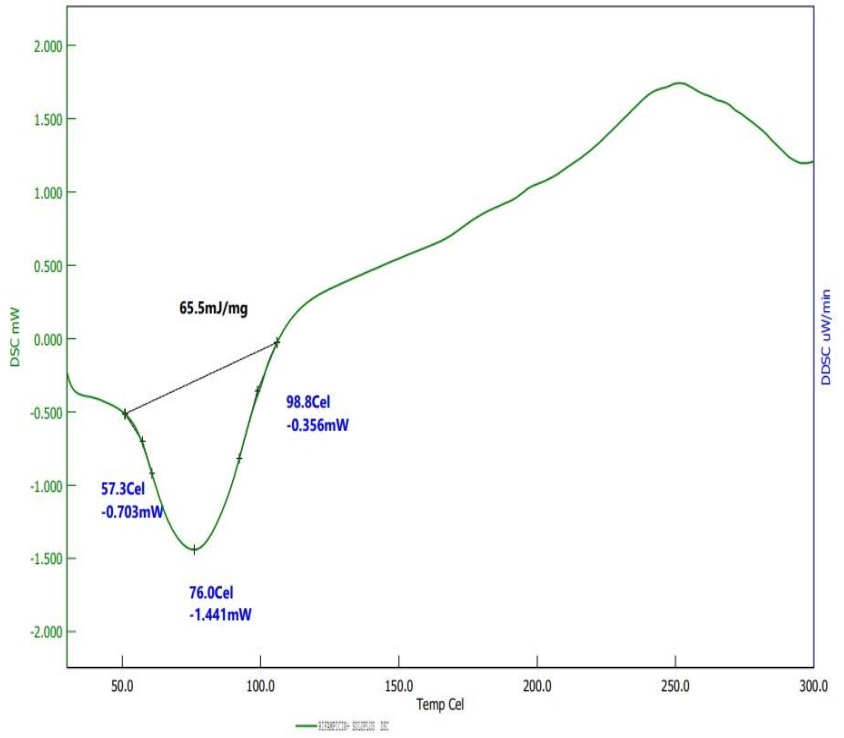

FIGURE: 6.12 DSC THERMOGRAM OF SOLUPLUS®

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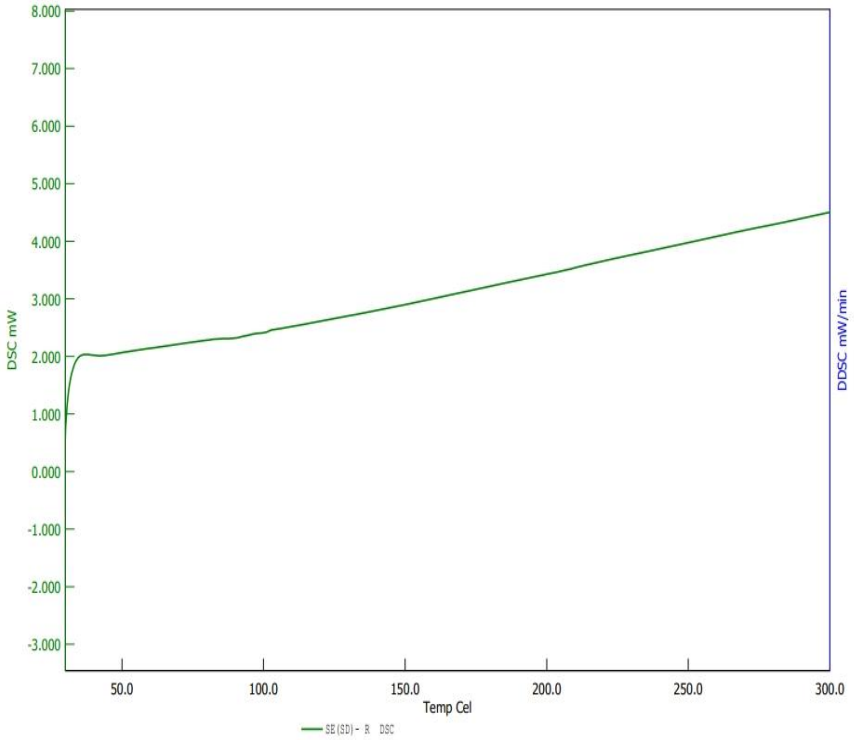

FIGURE: 6.13 DSC THERMOGRAM OF RIFAMPICIN FORMULATION R3 (SE-SD 1:3)

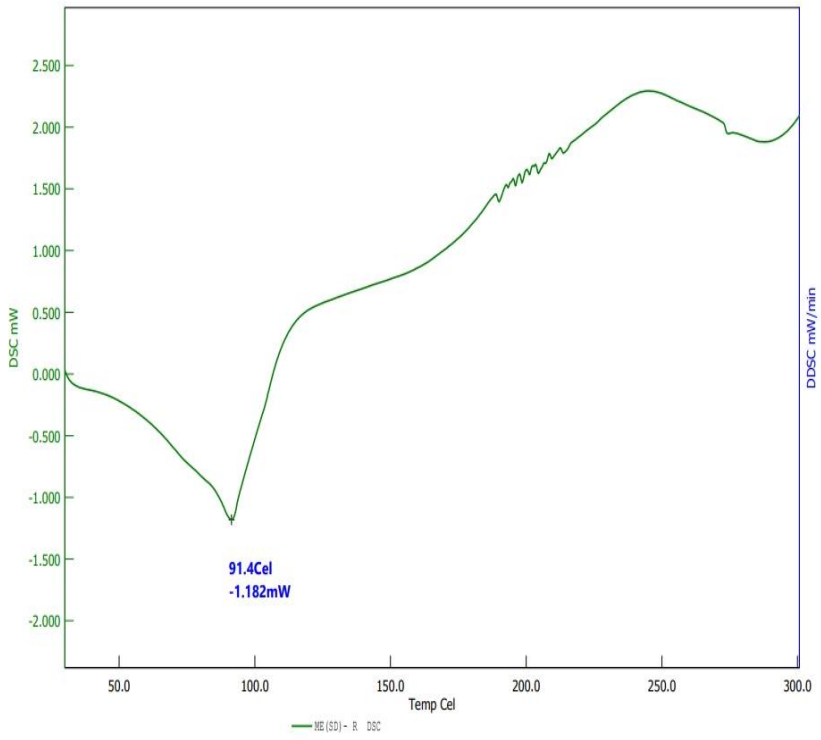

FIGURE: 6.14 DSC THERMOGRAM OF RIFAMPICIN FORMULATION R3 (ME-SD 1:3)

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XRD: XRD of Rifampicin was performed to assess the crystallinity of the formulations. The XRD of Rifampicin showed sharp peaks as seen in Figure 6.15 which can be attributed to its crystalline nature. The XRD of Soluplus® showed broad peaks which correspond to its amorphous nature as show in Figure 6.16. Compared to the XRD of pure drug, the formulations showed reduction and broadness in peaks as shown in Figures 6.17 and 6.18. Similar results were shown in a study performed by Ramu A et al., (2024) [62]

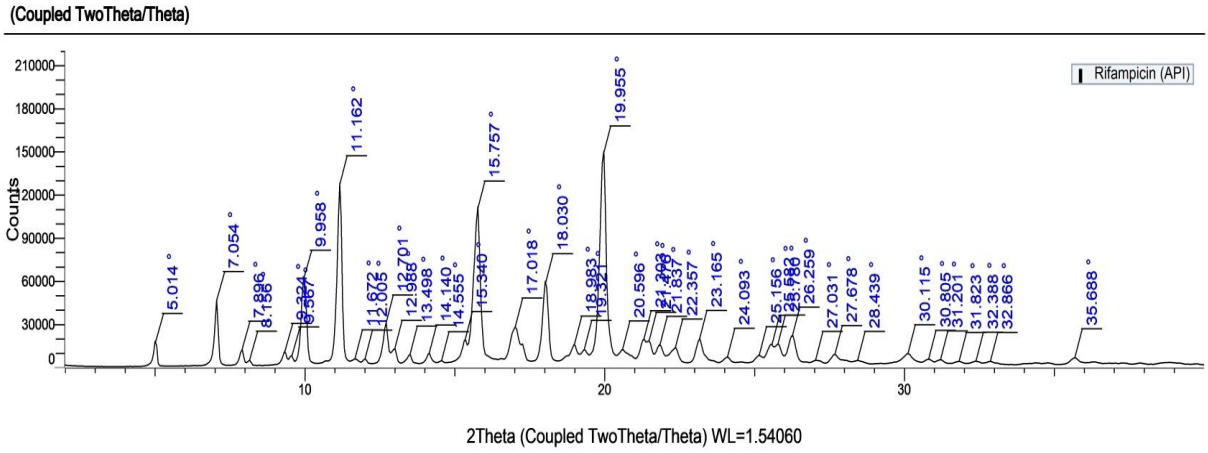

FIGURE: 6.15 XRD SPECTRA OF RIFAMPICIN

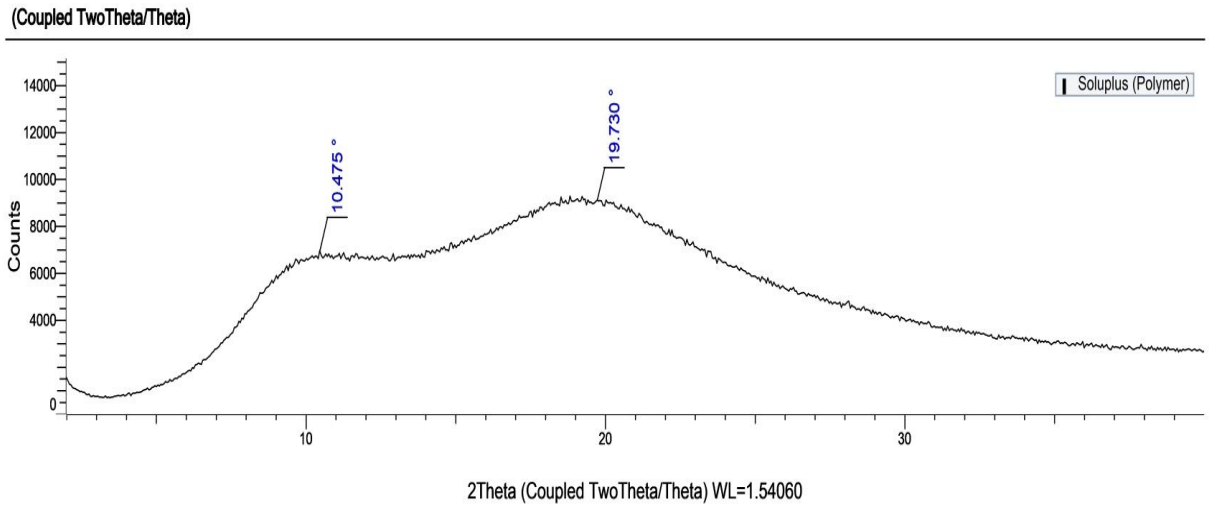

FIGURE: 6.16 XRD SPECTRA OF SOLUPLUS®

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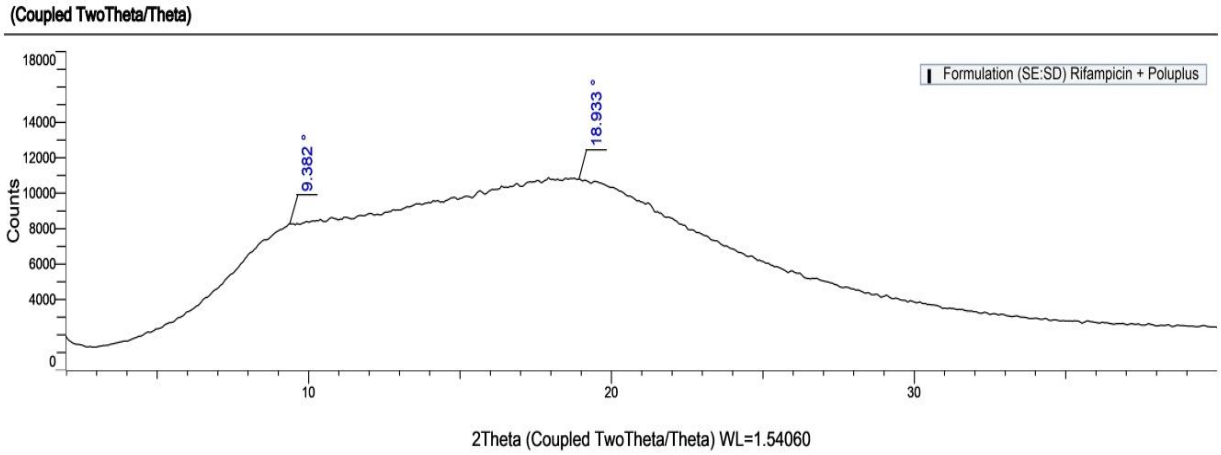

FIGURE: 6.17 XRD SPECTRA OF RIFAMPICIN FORMULATION R3 (SE-SD 1:3)

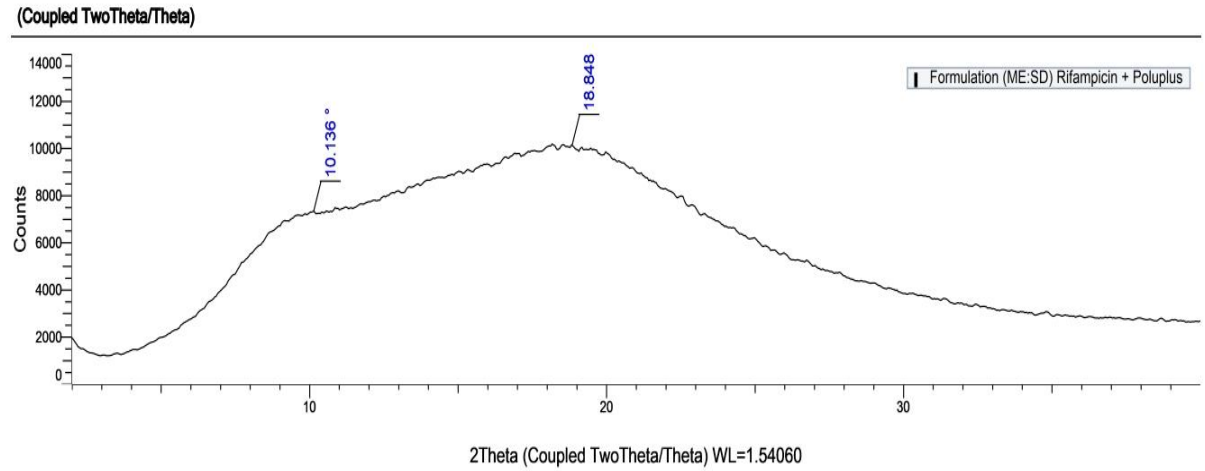

FIGURE: 6.18 XRD SPECTRA OF RIFAMPICIN FORMULATION R6 (ME-SD 1:3)

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6.1.2 Duloxetine HCL

1. %Drug Content, %yield and solubility:

(TABLE: 6.4) CHARACTERIZATION OF DULOXETINE HCL, ITS PHYSICAL MIXTURE, AND ITS SDs

Name	%drug content	%yield	Solubility (µg/ml)
Pure drug	-	-	10.36 ± 0.067
Physical mixture	83.85 ± 0.62	-	17.02 ± 0.091
(SE-SD 1:1) D1	80 ± 0.9	60.31	14.16 ± 0.059
(SE-SD 1:2) D2	78.4 ± 0.76	58.4	18.24 ± 0.13
(SE-SD 1:3) D3	88.98 ± 0.56	57.20	23.61 ± 0.088
(ME-SD 1:1) D4	82.14 ± 0.40	62.54	13.45 ± 0.074
(ME-SD 1:2) D5	84.63 ± 0.68	59.12	16.23 ± 0.085
(ME-SD 1:3) D6	91.25 ± 0.45	61.48	22.75 ± 0.096

*All values are in mean ± SD (n=3)

The percentage drug content obtained from the six batches was in the range of 78.4-91.2 among which D6 showed good content as well as solubility. The solubility shows two-fold enhancement when best formulations D3 and D6 compared to pure drug. The solubility can be seen increasing with the concentration of polymer which shows the enhancing ability of Soluplus®. Similar results were shown in a study performed by Elmubarak et al. (2021)[103]

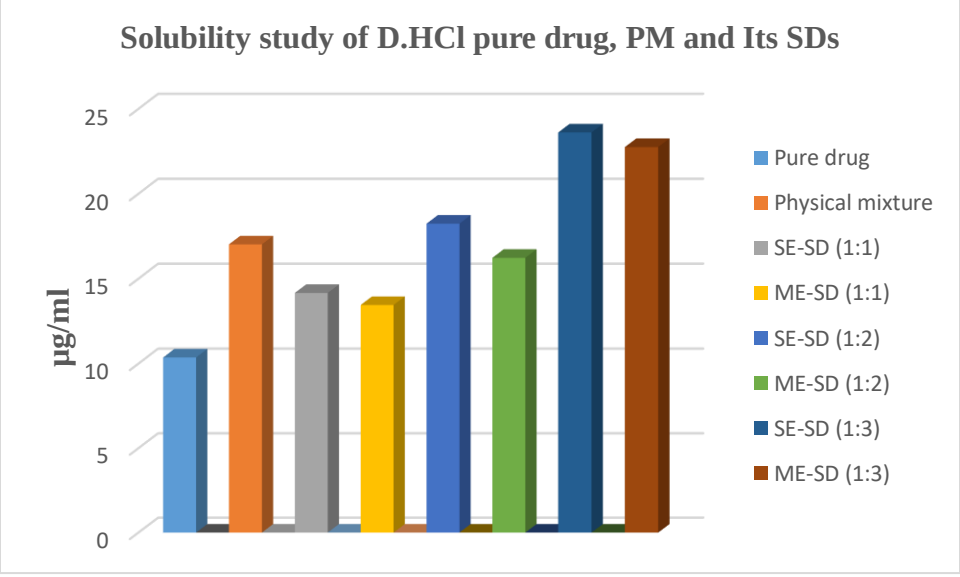

FIGURE: 6.19 SOLUBILITY STUDY OF D.HCL PURE DRUG, PM AND ITS SDs

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2. In-Vitro Dissolution Studies:

Drug release studies conducted in a laboratory setting demonstrate a significant enhancement in the rate at which Duloxetine Hydrochloride dissolves when it is in the form of SDs, as compared to the pure drug. The dissolution rate increases in the following order: 1:3 > 1:2 > 1:1 > pure drug. Depending on the concentration ratio of Soluplus®, the dissolution rate of Duloxetine Hydrochloride in SDs can vary greatly. The rate of solubility increased as the carrier concentration in the SDs was raised.

Batch D3 showed the best results among all the other batches with a drug release of 97%. Similar results were shown in a study performed by Aroon A et al., (2023) [83]

(TABLE: 6.5) DISSOLUTION PROFILE OF DULOXETINE HCL, ITS PHYSICAL MIXTURE, AND ITS SDS

Time (min)	Percentage drug released (%)							
	Pure drug (%)	Physical mixture (1:3)	SE-SD (1:1) (D1)	SE-SD (1:2) (D2)	SE-SD (1:3) (D3)	ME-SD (1:1) (D4)	ME-SD (1:2) (D5)	ME-SD (1:3) (D6)
0	0	0	0	0	0	0	0	0
10	1.74	10.1515	6.25	8.27	14.67	5.95	9.1	12.45
20	4.94	14.671	10.67	12.65	21.72	9.53	13.43	19.34
30	9.73	23.45	14.83	20.11	28.51	12.38	21.64	26.56
40	16.52	29.312	19.91	25.05	36.90	17.63	28.49	34.67
50	24.51	37.015	26.02	32.2	44.49	24.32	36.24	42.78
60	29.71	45.23	33.37	39.45	52.88	30.83	43.35	50.89
70	38.90	54.245	40.58	47.59	59.68	38.61	51.89	57.19

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80	44.49	65.951	47.58	56.36	68.47	44.74	60.03	65
90	50.49	70.1052	55.12	65.49	76.86	52.86	68.2	71.22
100	58.88	78.69	63.85	74.26	84.05	61.36	76.14	79.31
110	63.27	82.3	71.45	78.11	95.24	68.47	80.67	86.44
120	64.51	86.12	73.35	82.31	**97.24**	70.1	83.66	**93.91**

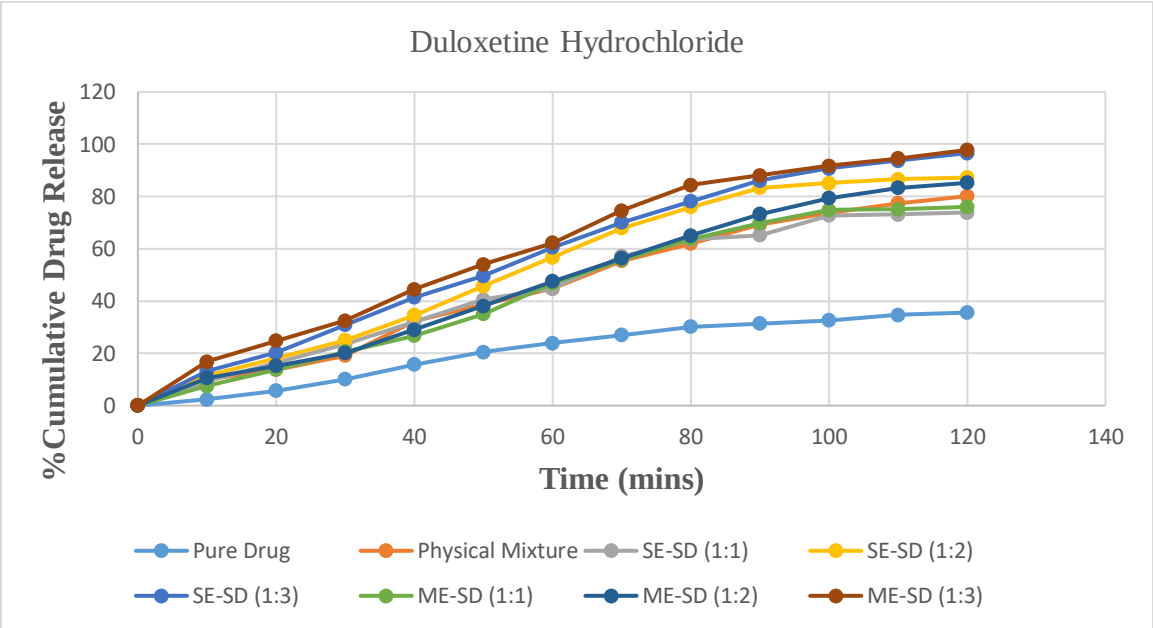

FIGURE: 6.20 CUMULATIVE % RELEASE STUDIES DULOXETINE HYDROCHLORIDE, ITS PHYSICAL MIXTURE, AND ITS SDS

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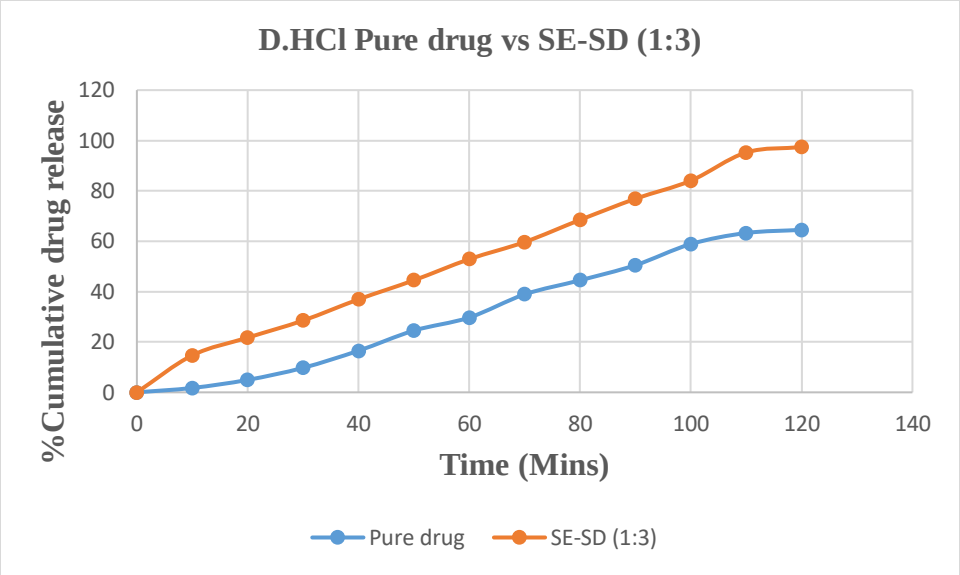

FIGURE: 6.21 RELEASE STUDIES OF D.HCl VS FORMULATION (SE-SD 1:3)

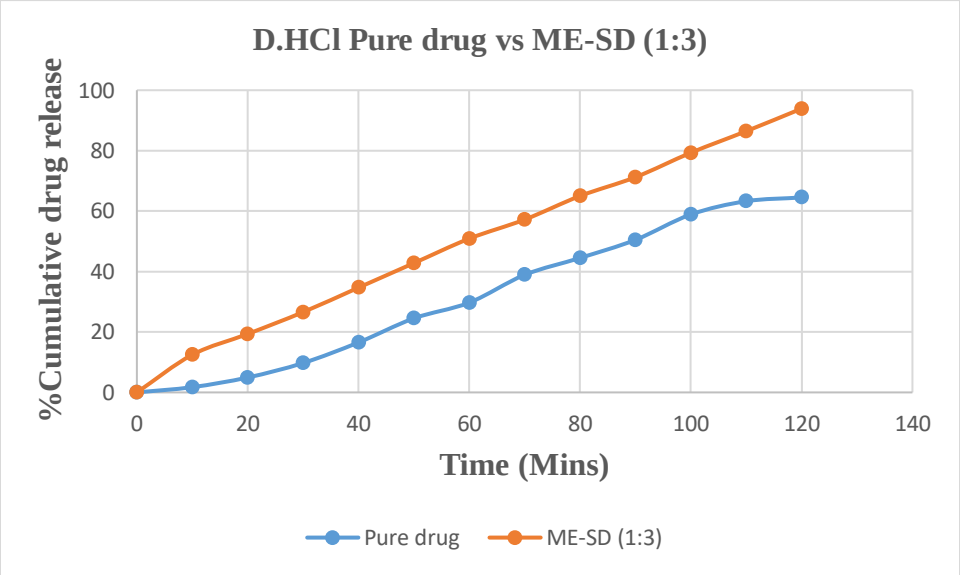

FIGURE: 6.22 RELEASE STUDIES OF D.HCl VS FORMULATION (ME-SD 1:3)

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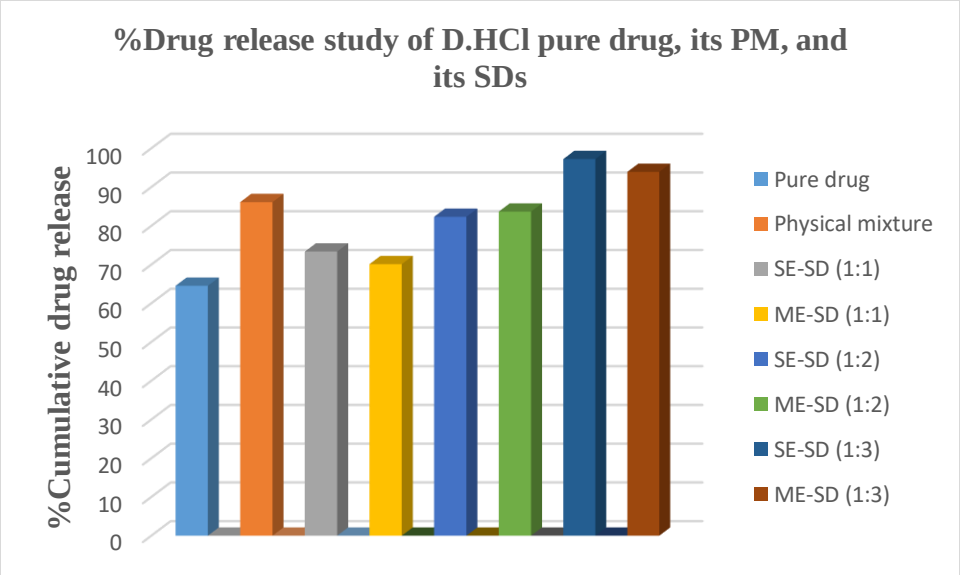

FIGURE: 6.23 %DRUG RELEASE STUDY OF D.HCL PURE DRUG, ITS PM, AND ITS SDs

3. **FT-IR:** There was no interaction between polymer and drug when the peaks of the drug (Figure 6.24) and physical mixture (Figure 6.25) were compared as shown in Table 6.6. However, as shown in Figure 6.26 & 6.27 some peaks were missing from the formulations due to the formation of bonds. Similar results were shown in a study performed by Aroon A et al., (2023) **[83]**

TABLE: 6.6 COMPARISON OF FTIR WAVELENGTHS OF DULOXETINE HCL AND ITS PHYSICAL MIXTURE

Functional groups (cm^{-1})	Pure drug(cm^{-1})	Physical mixture(cm^{-1})
C=O (1760-1605)	1735.62	1735.62
C-S (1450-1375)	1396.21	1396.21
N-H (1640-1550)	1581.34	1585.2
C-H (2850-3000)	2977.55	2973.7

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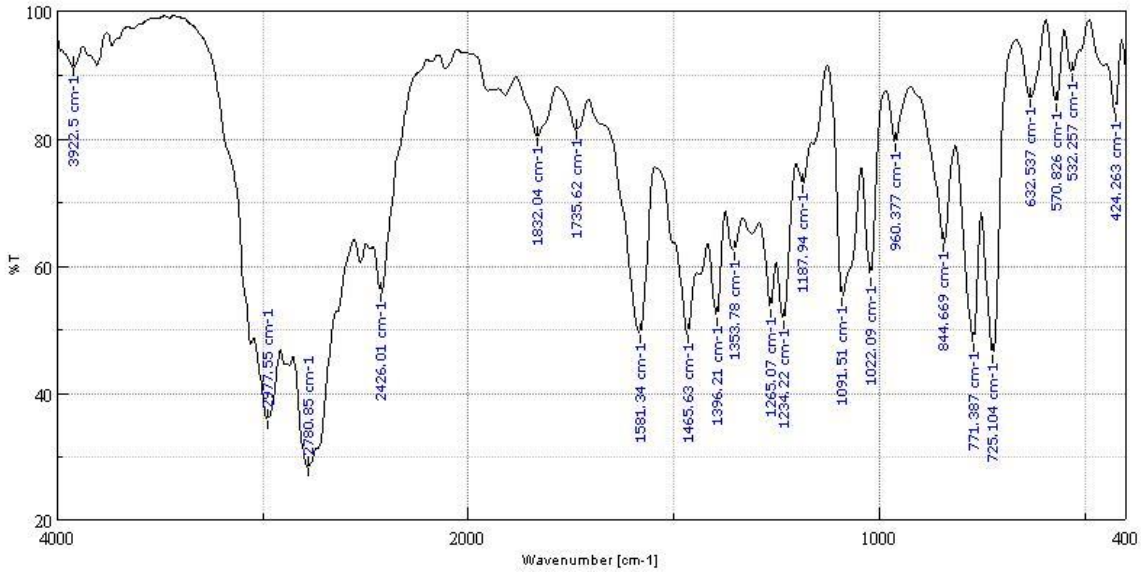

FIGURE: 6.24 FTIR SPECTRA OF DULOXETINE HYDROCHLORIDE

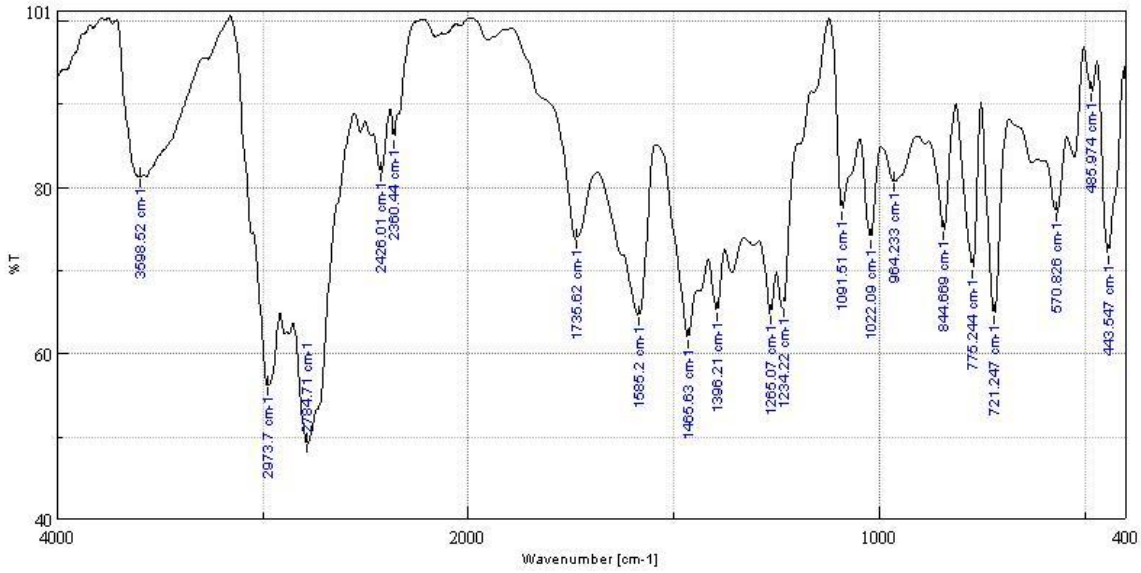

FIGURE: 6.25 FTIR SPECTRA OF DULOXETINE HYDROCHLORIDE PHYSICAL MIXTURE

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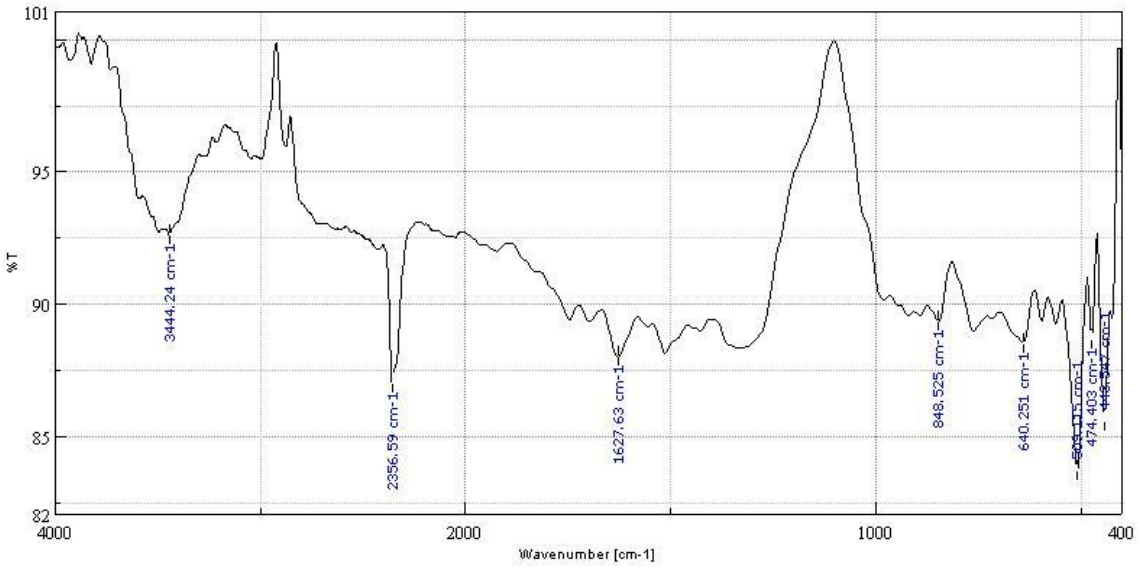

FIGURE: 6.26 FTIR SPECTRA OF DULOXETINE HYDROCHLORIDE FORMULATION D3 (SE-SD 1:3)

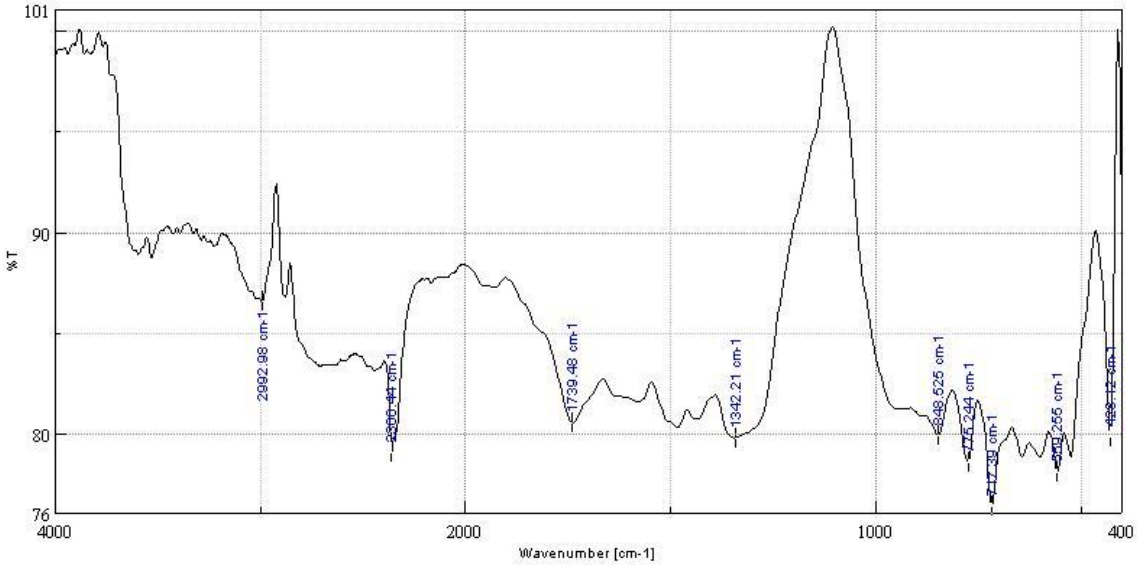

FIGURE: 6.27 FTIR SPECTRA OF DULOXETINE HYDROCHLORIDE FORMULATION D3 (ME-SD 1:3)

4. **DSC:** Thermal analysis of Duloxetine Hydrochloride and its SDs was done. The endothermic peak shown in Figure 6.28 corresponds to its melting point. The physical mixture and formulations showed the disappearance of the exothermic peak and shifting of the endothermic peak towards higher temperatures as shown in Figures 6.29, 6.30, and 6.31. Similar results were shown in a study performed by Nijhawan M et al., (2024) [72]

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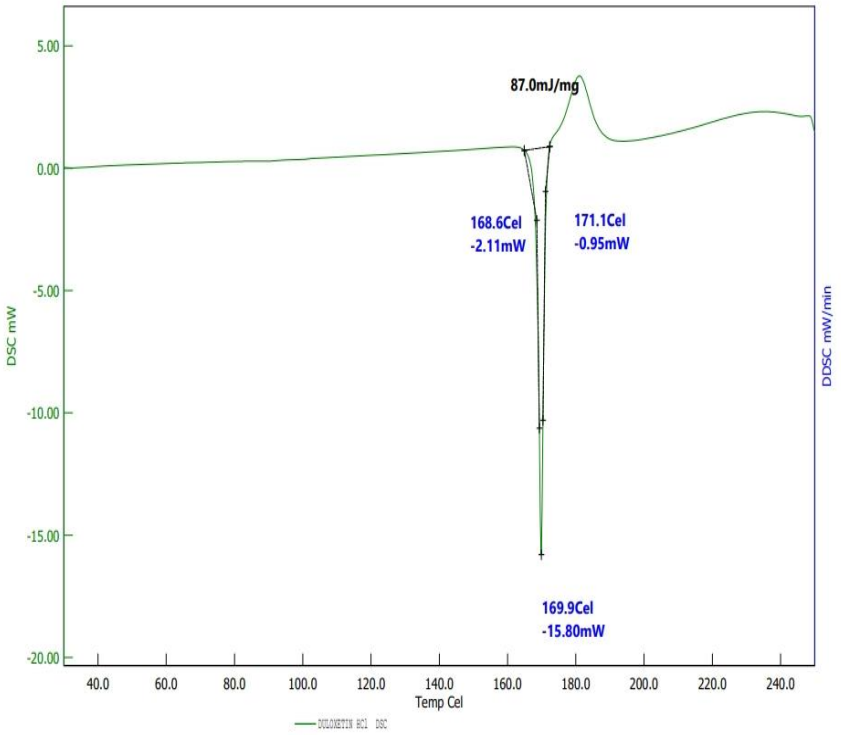

FIGURE: 6.28 DSC THERMOGRAM OF DULOXETINE

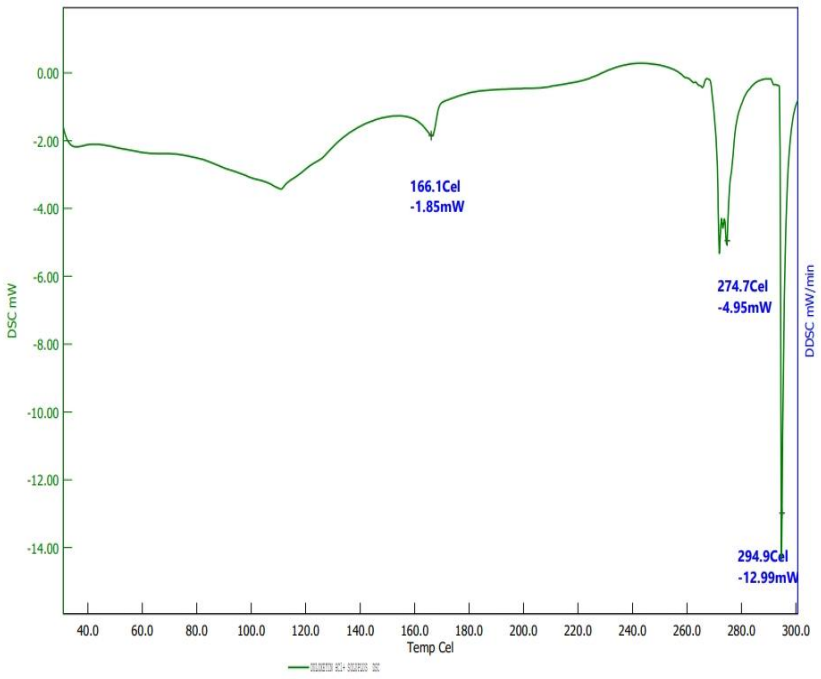

FIGURE: 6.29 DSC THERMOGRAM OF DULOXETINE HYDROCHLORIDE PHYSICAL MIXTURE

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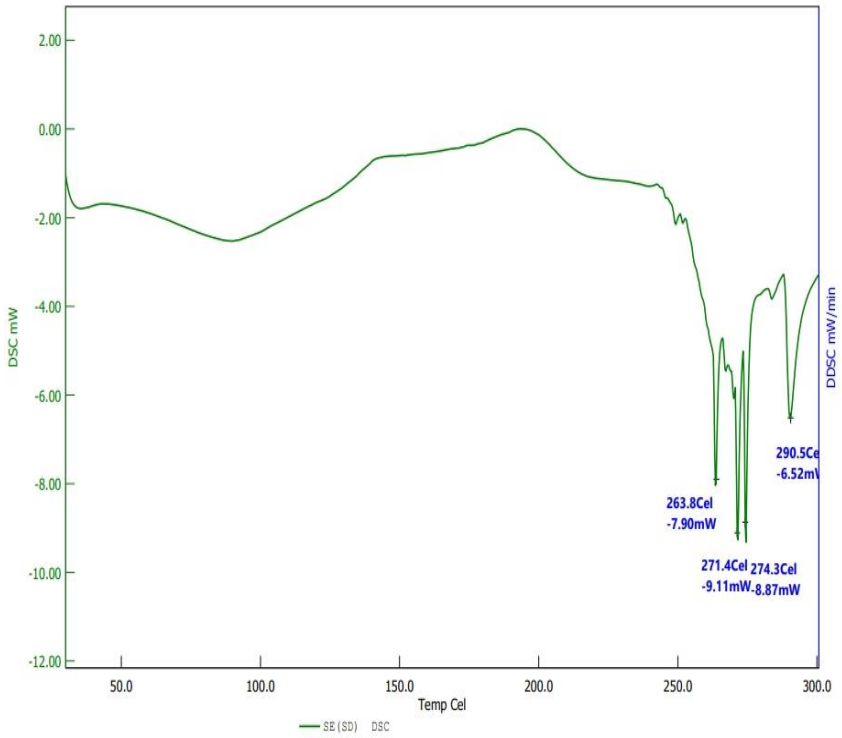

FIGURE: 6.30 DSC THERMOGRAM OF DULOXETINE HYDROCHLORIDE FORMULATION D3 (SE-SD 1:3)

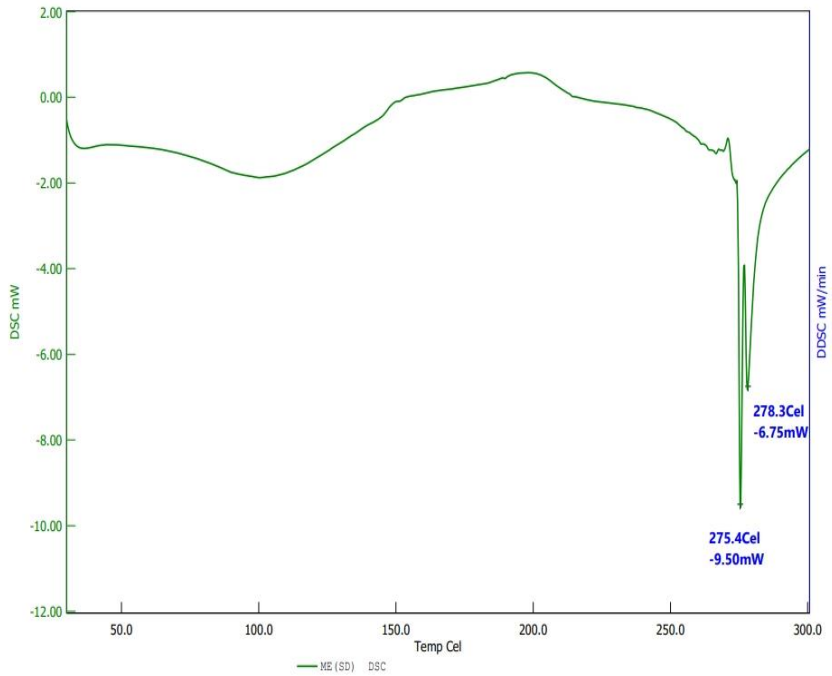

FIGURE: 6.31 DSC THERMOGRAM OF DULOXETINE HYDROCHLORIDE FORMULATION D6 (ME-SD 1:3)

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5. **XRD:** The peaks of Duloxetine Hydrochloride are sharp as shown in Figure 6.32 while most of these peaks are absent, the present peaks appear to be broad in formulations as shown in Figure 6.33 and 6.34. Similar results were shown in a study performed by Aroon A et al., (2023) **[83]**

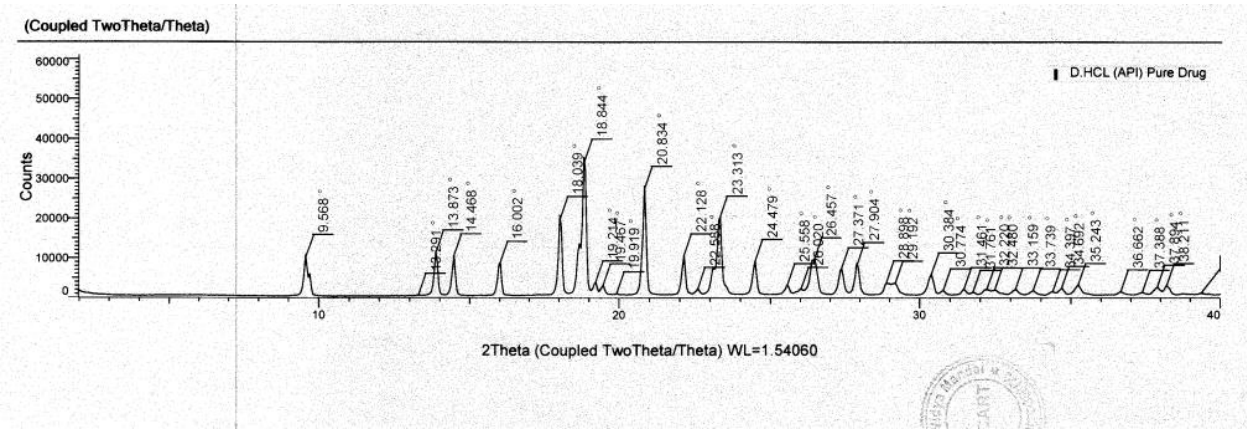

FIGURE: 6.32 XRD SPECTRA OF DULOXETINE HYDROCHLORIDE

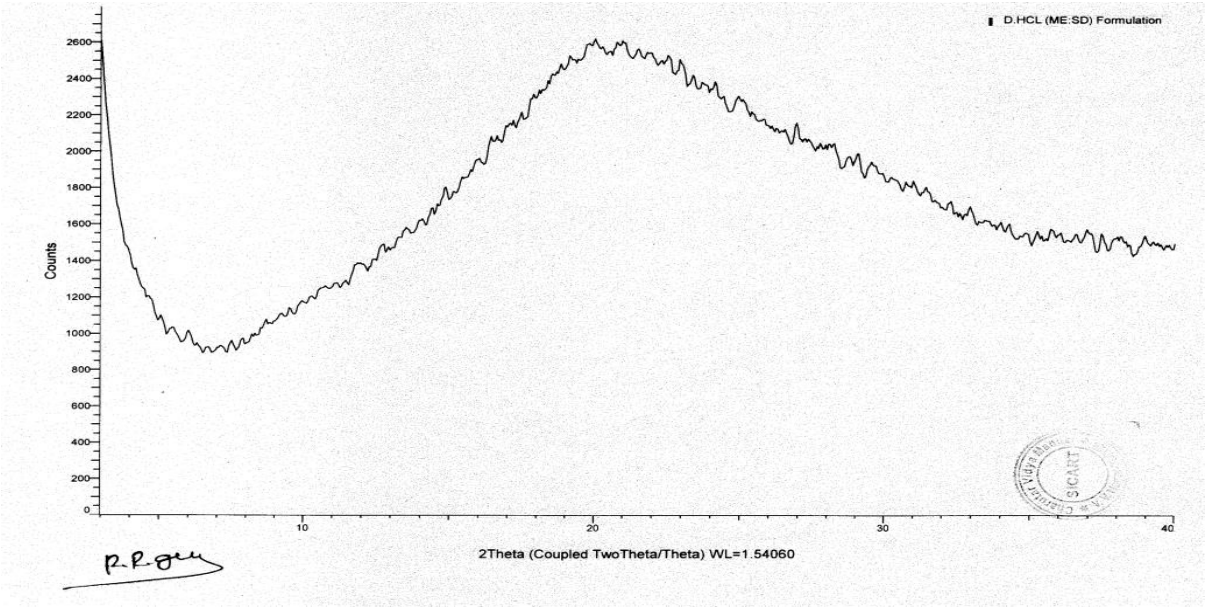

FIGURE: 6.33 XRD SPECTRA OF DULOXETINE HYDROCHLORIDE FORMULATION D3 (SE-SD 1:3)

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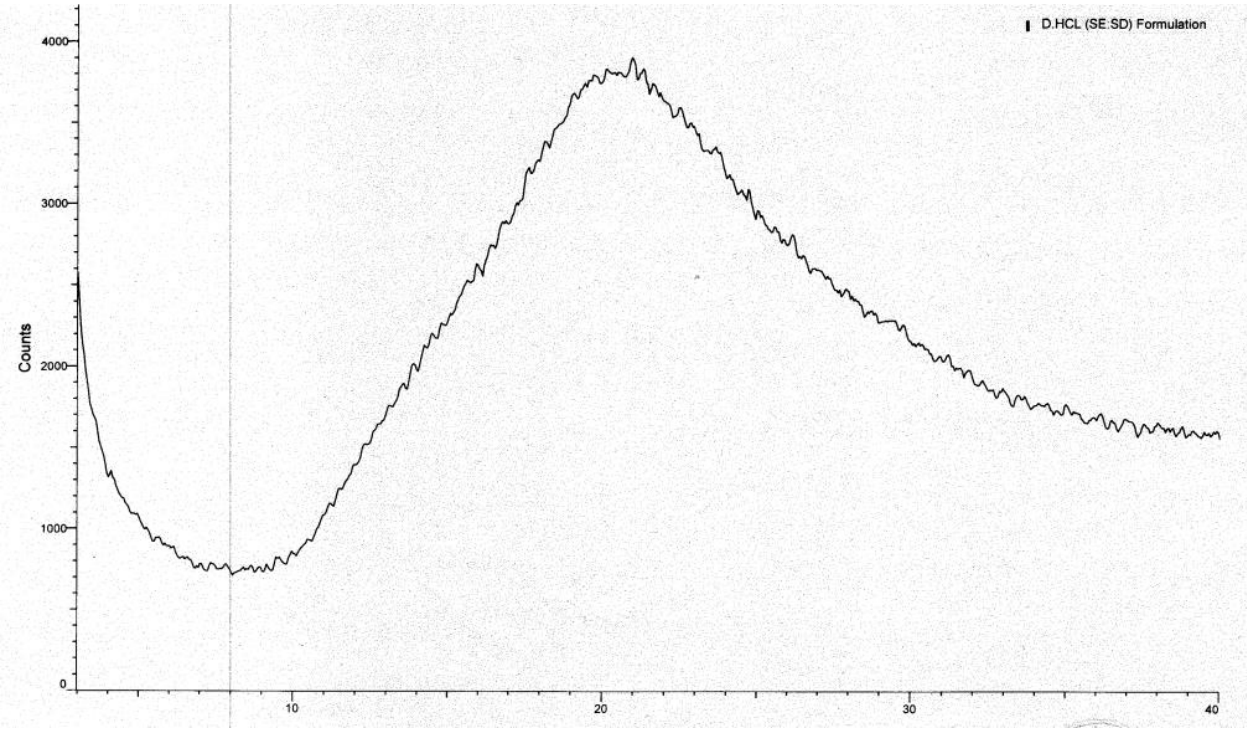

FIGURE: 6.34 XRD SPECTRA OF DULOXETINE HYDROCHLORIDE FORMULATION D6 (ME-SD 1:3)

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6.1.3 Abiraterone Acetate

1. %Drug Content, %Yield and Solubility:

TABLE: 6.7 CHARACTERIZATION OF ABIRATERONE ACETATE, ITS PHYSICAL MIXTURE, AND ITS SDs

Name	%Drug content	%Yield	Solubility (µg/ml)
Pure drug	-	-	5.23 ±0.15
Physical mixture	81.57 ±0.9	-	37.45 ±0.36
(SE-SD 1:1) A1	76.88 ±0.65	84.25	24.3 ± 0.54
(SE-SD 1:2) A2	82.15 ±0.78	86.61	40.75 ± 0.26
(SE-SD 1:3) A3	89.24 ±0.59	85.17	60.12 ± ±0.30
(ME-SD 1:1) A4	85.63 ±0.47	86.43	27.63 ± 0.18
(ME-SD 1:2) A5	86.63 ±0.88	85.68	41.95 ± 0.23
(ME-SD 1:3) A6	90.44 ±0.68	88.04	65.54 ± 0.12

*All values are in mean ± SD (n=3)

The drug content of all the batches was found between 76-90% and out of those batches A6 and A3 showed the best results. Batch A6 showed an increase in solubility along with drug content (90.44) and yield (89.04%). The solubility of formulation showed multiple folds of increase, A1 & A4 showed 5 times increase in solubility while the best batches showed more than 10 times increase in solubility which shows that the carrier Soluplus® has the capability of enhancing the solubility of this drug.

Solubility increased with the increase in polymer concentration: 1:3>1:2>1:1. Similar results were obtained from study conducted by Gala et al. (2020)[104]

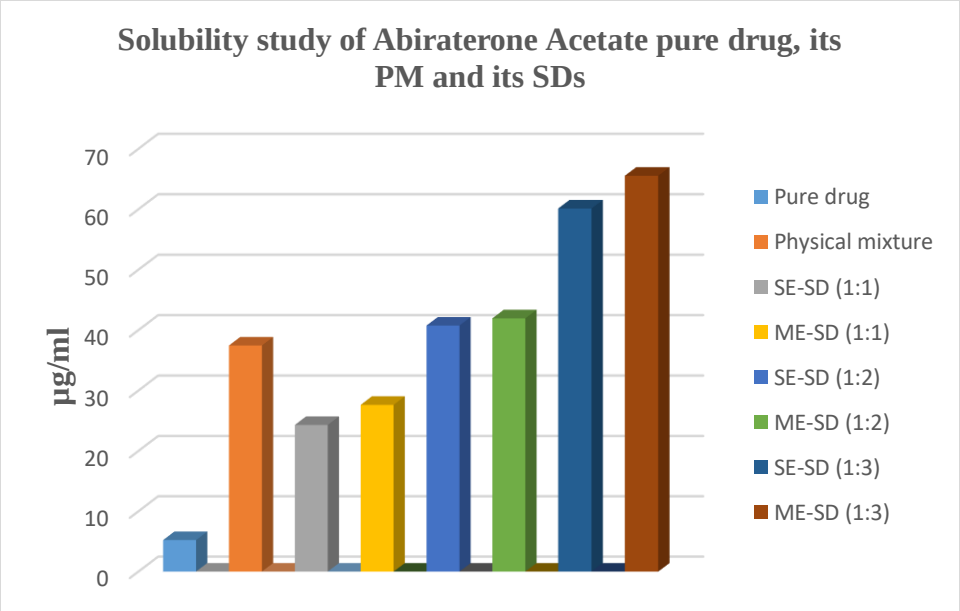

FIGURE: 6.35 SOLUBILITY STUDY OF ABIRATERONE ACETATE PURE DRUG, ITS PM AND ITS SDs

2. In-Vitro Drug Release

From the dissolution data, it was observed that the prepared SDs showed an enhanced dissolution rate when compared to pure drug. The probable reason is the crystalline drug was converted to the amorphous form. The amorphous solid has high free energy, due to which in the process of stabilization, they form hydrogen bonds with the water molecules and get converted into the solution form.

Among all the batches A3 and A6 showed greater dissolution rate release up to 62.8% and 63.59% of the drug.

Other batches also show increased dissolution compared to pure drug which proves that formulation of SDs with Soluplus® enhances the dissolution rate of this drug. Similar results were obtained from a study conducted by Nakka VN et al., (2024) [77]

TABLE: 6.8 DISSOLUTION PROFILE OF ABIRATERONE ACETATE, ITS PHYSICAL MIXTURE AND ITS SDS

Time (min)	Percentage drug released (%)							
	Pure drug (%)	Physical mixture (1:3)	SE-SD (1:1) A1	SE-SD (1:2) A2	SE-SD (1:3) A3	ME-SD (1:1) A4	ME-SD (1:2) A5	ME-SD (1:3) A6
0	0	0	0	0	0	0	0	0
10	2.05	6.29	5.839	5.848	8.16	4.692	6.787	7.25
20	3.14	11.15	8.593	8.421	15.24	9.604	8.136	13.36
30	5.37	16.38	10.261	14.087	19.37	12.563	12.180	19.87
40	7.82	22.5	14.575	21.428	25.61	15.781	16.806	27.61
50	8.91	26.41	21.569	27.437	32.78	18.611	21.452	34.75
60	11.47	31.96	23.579	32.096	36.97	22.714	26.782	39.98
70	12.59	34.37	26.715	36.775	44.32	23.892	32.159	46.47
80	14.23	38.24	30.435	40.62	48.74	26.253	38.45	51.63
90	16.85	41.05	33.64	44.466	53.49	29.004	42.68	55.41
100	17.23	45.63	37.23	50.026	57.54	33.571	47.310	57.35
110	17.31	47.97	39.10	53.853	60.21	36.23	50.005	59.84
120	17.38	49.78	40.35	54.63	**62.82**	38.95	52.807	**63.59**

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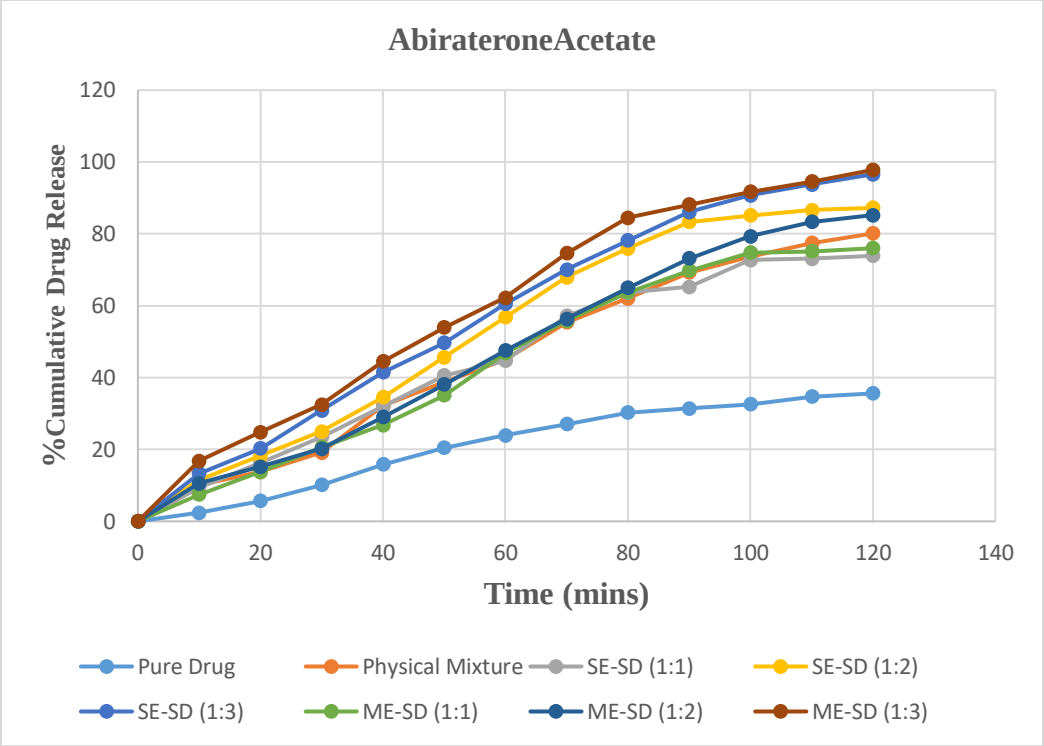

FIGURE: 6.36 CUMULATIVE % RELEASE STUDIES OF ABIRATERONE ACETATE, ITS PHYSICAL MIXTURE, AND ITS SDs

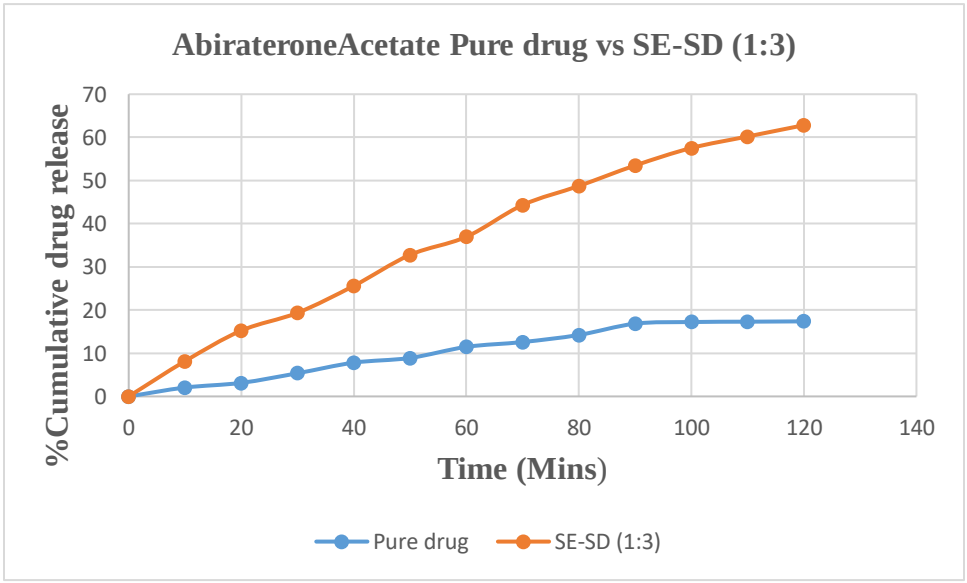

FIGURE: 6.37 RELEASE STUDIES OF ABIRATERONE ACETATE VS FORMULATION (SE-SD 1:3)

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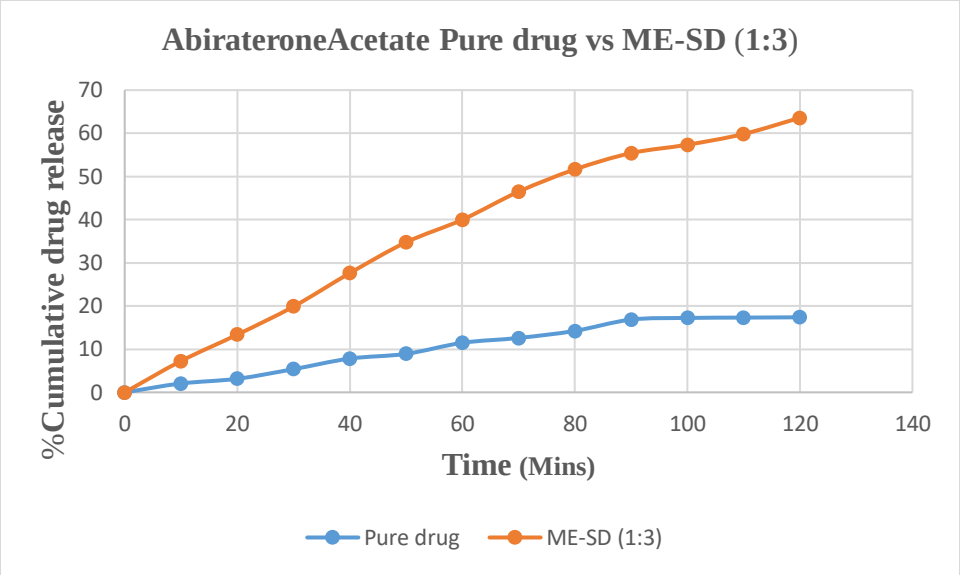

FIGURE: 6.38 RELEASE STUDIES OF ABIRATERONE ACETATE VS FORMULATION (ME-SD 1:3)

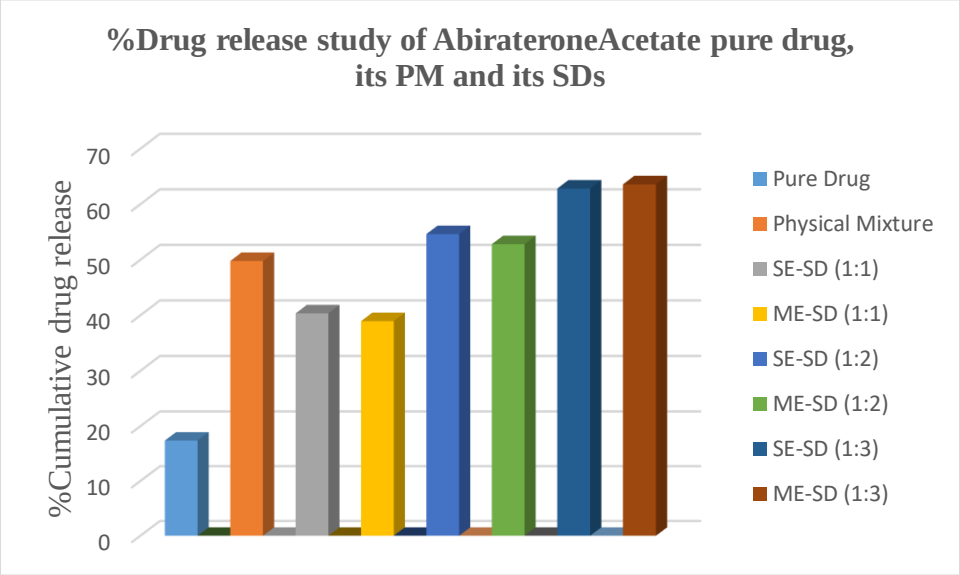

FIGURE: 6.39 %DRUG RELEASE STUDY OF ABIRATERONE ACETATE PURE DRUG, ITS PM AND ITS SDS

3. FTIR: Upon comparing Figures 6.40 and 6.41, no interaction was observed that indicated compatibility between the drug and polymer. The formulations also show respective functional

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group wavelengths when compared with the wavelength of the pure drug as shown in Table 6.9. Similar results were obtained from a study conducted by Thawani LM, (2023) [73]

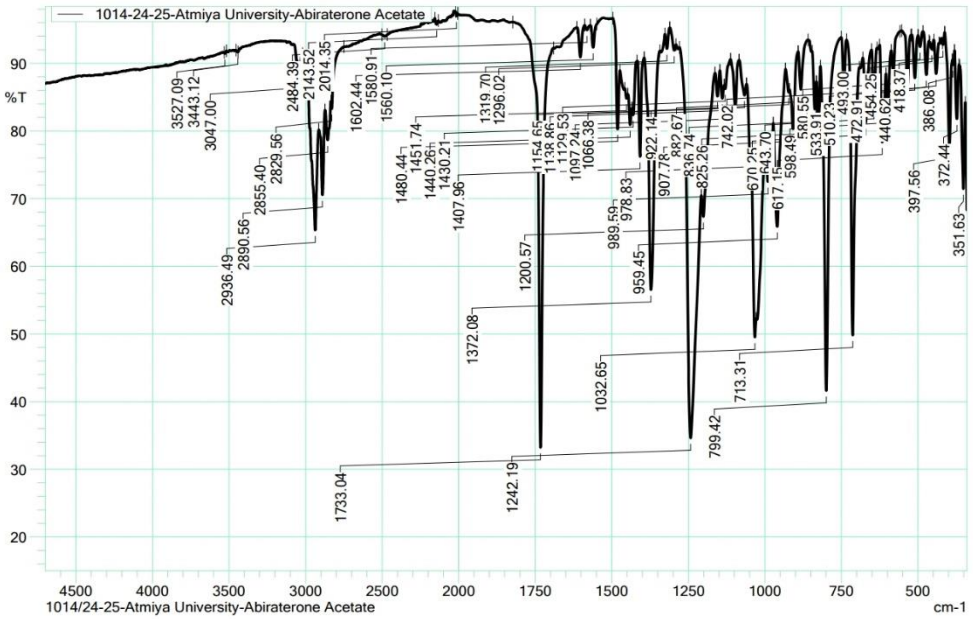

FIGURE: 6.40 FTIR SPECTRA OF ABIRATERONEACETATE

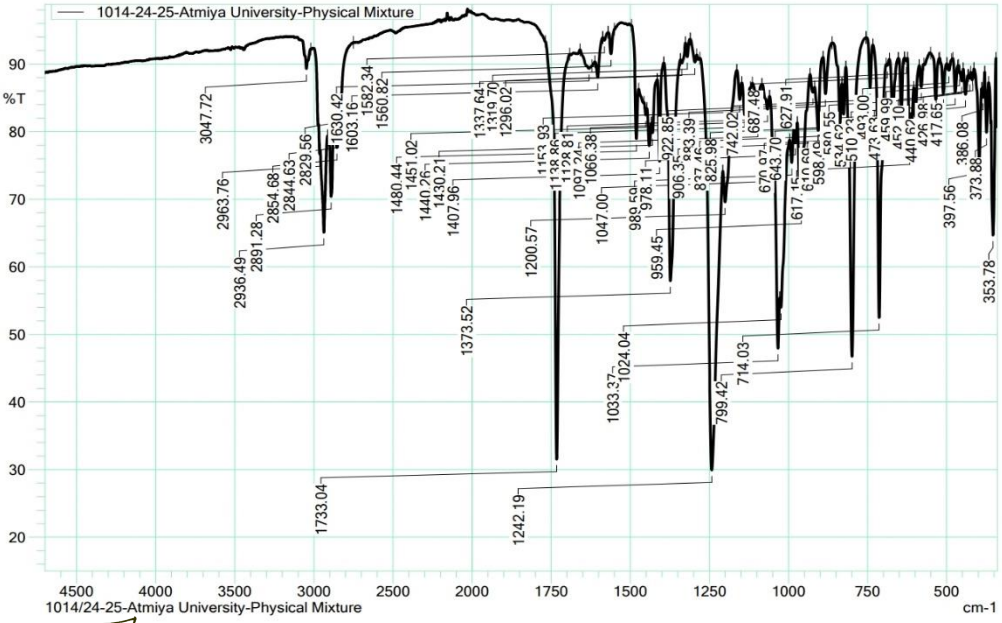

FIGURE: 6.41 FTIR SPECTRA OF ABIRATERONE ACETATE PHYSICAL MIXTURE

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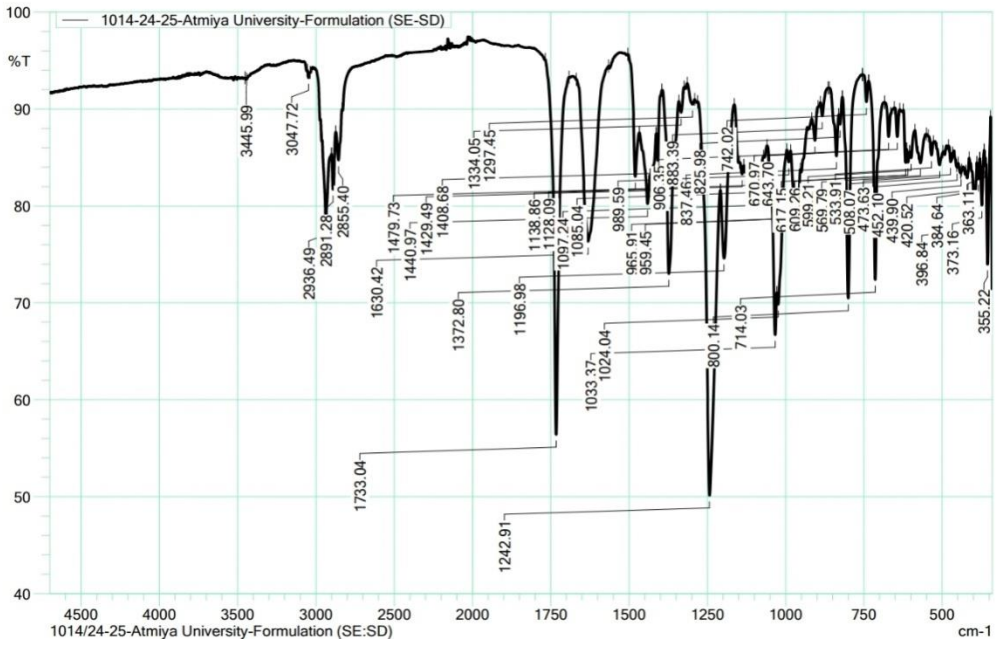

FIGURE: 6.42 FTIR SPECTRA OF ABIRATERONE ACETATE FORMULATION A3 (SE-SD 1:3)

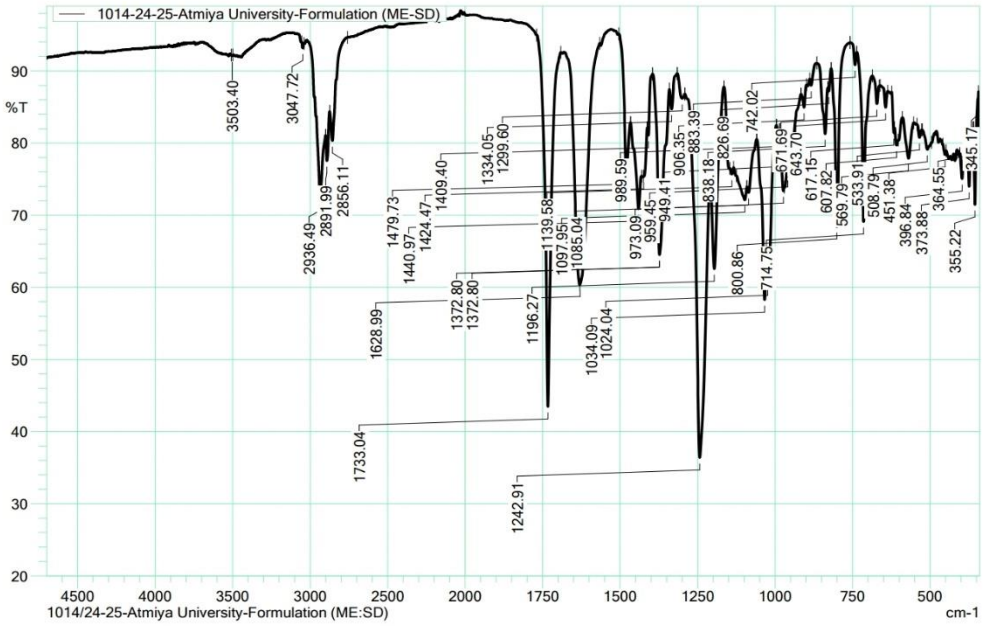

FIGURE: 6.43 FTIR SPECTRA OF ABIRATERONE ACETATE FORMULATION A6 (ME-SD 1:3)

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TABLE: 6.9 COMPARISON OF FTIR WAVELENGTHS OF ABIRATERONE ACETATE, ITS PHYSICAL MIXTURE, AND ITS SDS

Functional groups with wavelength	Pure drug (cm^{-1})	Physical mixture (cm^{-1})	A3 (cm^{-1})	A6 (cm^{-1})
(SB) C-H Stretching 2850-3000 cm^{-1}	2855.40	2854.68	2855.40	2856.11
	2890.56	2891.28	2891.28	2891.99
	2936.49	2936.49	2936.49	2936.49
(SB) C=O Stretching 1700-1750 cm^{-1}	1733.04	1733.04	1733.04	1733.04
(PR)C-H Stretching 3020-3100cm^{-1}	3047.00	3047.72	3047.72	3047.72
(PR) C=C Stretching 1600-1680 cm^{-1}	1602	1603.16	1630.42	1628.99
(AE) C=O Stretching Around 1240 cm^{-1}	1242.19	1242.19	1242.91	1242.91
(TBDMS) Si-C Stretching 1250-1300 cm^{-1}	1296.02	1296.02	1297.45	1299.60

SB- Steroidal Backbone

PR- Pyridine ring

AE- Acetate Ester group

TBDMS- Tert-Butyldimethylsilyl

4. **DSC:** The DSC of pure Abiraterone Acetate showed the endothermic peak at 144.98°C as shown in Figure 6.44, which corresponds to the reported melting point of the drug. There is a reduction in the exothermic peak of the physical mixture as shown in Figure 6.45 which indicates that there is a reduction in crystallinity. The formulation showed a reduction in the intensity of the exothermic peak as shown in Figure 6.46. Similar results were obtained from a study conducted by Liu et al. (2022) [86]

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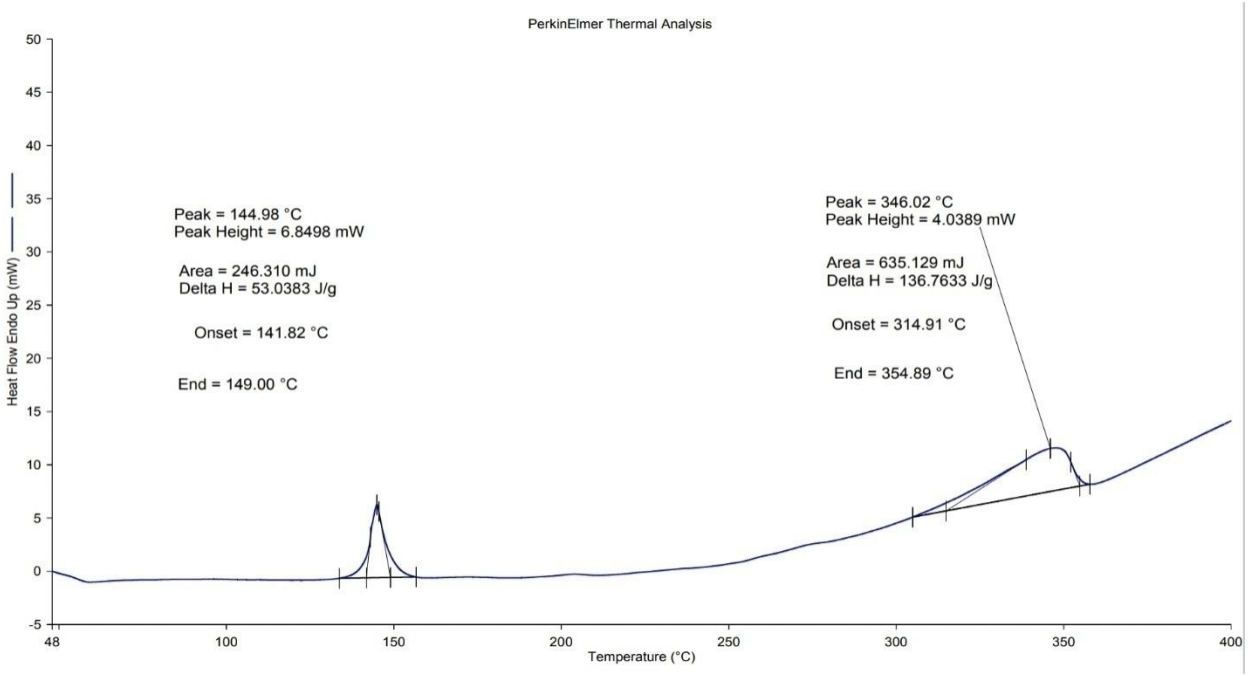

FIGURE: 6.44 DSC THERMOGRAM OF ABIRATERONE ACETATE

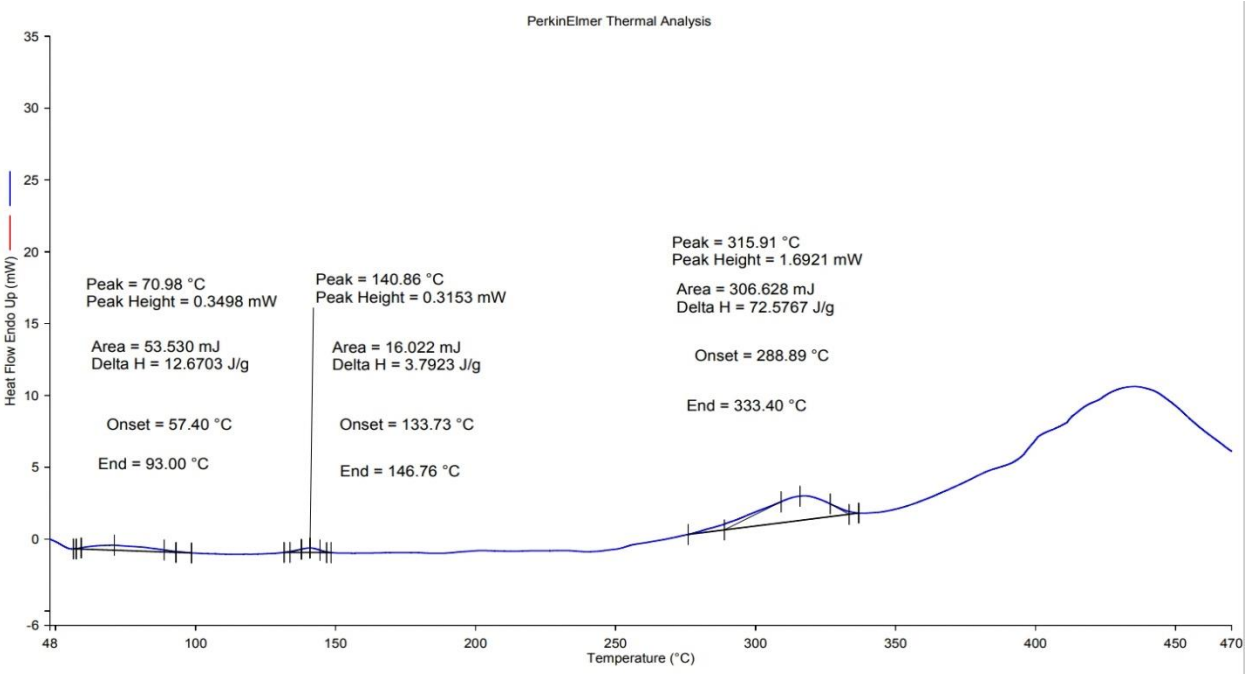

FIGURE: 6.45 DSC THERMOGRAM OF ABIRATERONE ACETATE PHYSICAL MIXTURE

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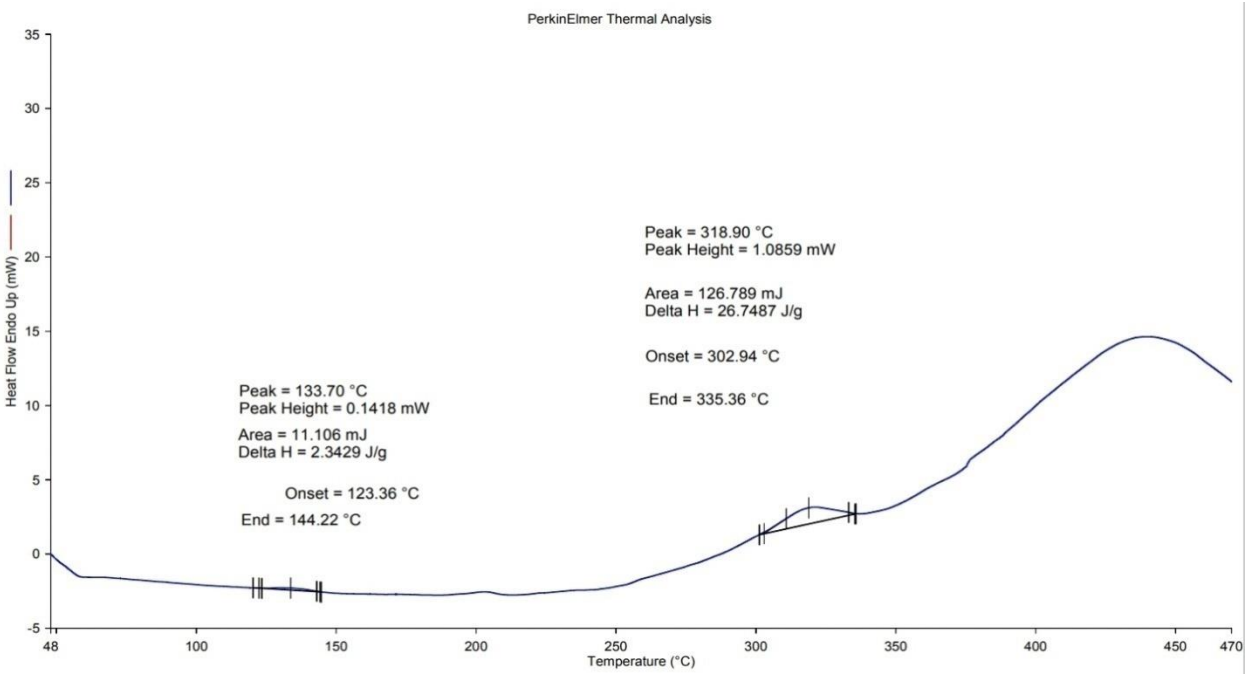

FIGURE: 6.46 DSC THERMOGRAM OF ABIRATERONE ACETATE FORMULATION A6 (ME-SD 1:3)

5. **XRD:** The pure drug showed sharp peaks in XRD as shown in Figure 6.47 which corresponds to its crystalline nature. The formulation showed a reduction in intensity of peak when compared with pure drug as shown in Table 6.10). There is a drop in the intensity of the peak, indicating a loss in crystallinity. Out of the two batches, A3 (Figure 6.48) and A6 (Figure 6.49), A6 has superior results in reducing peak intensity. The reduction in the magnitude of peaks indicates the amorphous characteristics of the created SDs. Similar results were obtained from a study conducted by Liu et al. (2022) **[86]**

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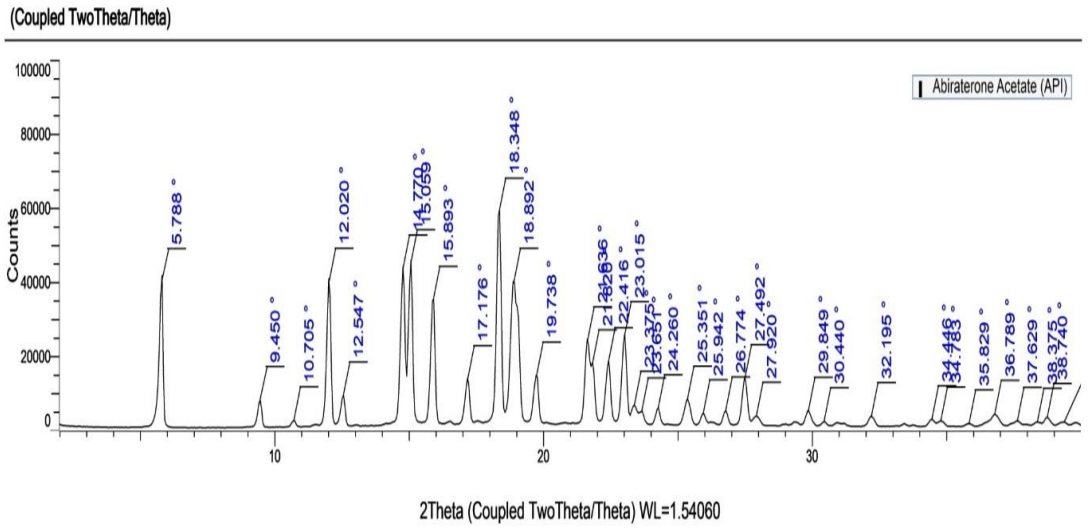

FIGURE: 6.47 XRD SPECTRA OF ABIRATERONE ACETATE

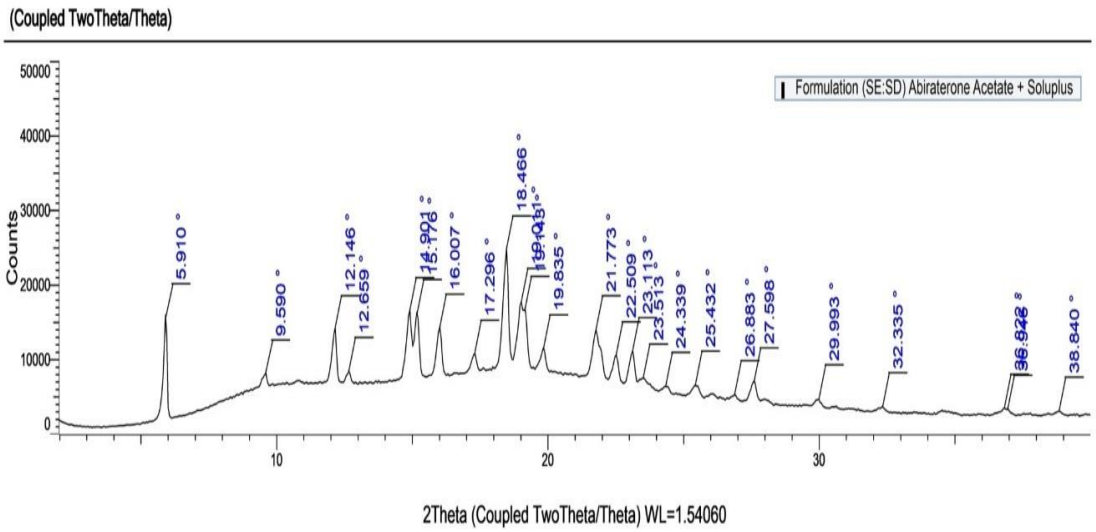

FIGURE: 6.48 XRD SPECTRA OF ABIRATERONE ACETATE FORMULATION A6 (SE-SD 1:3)

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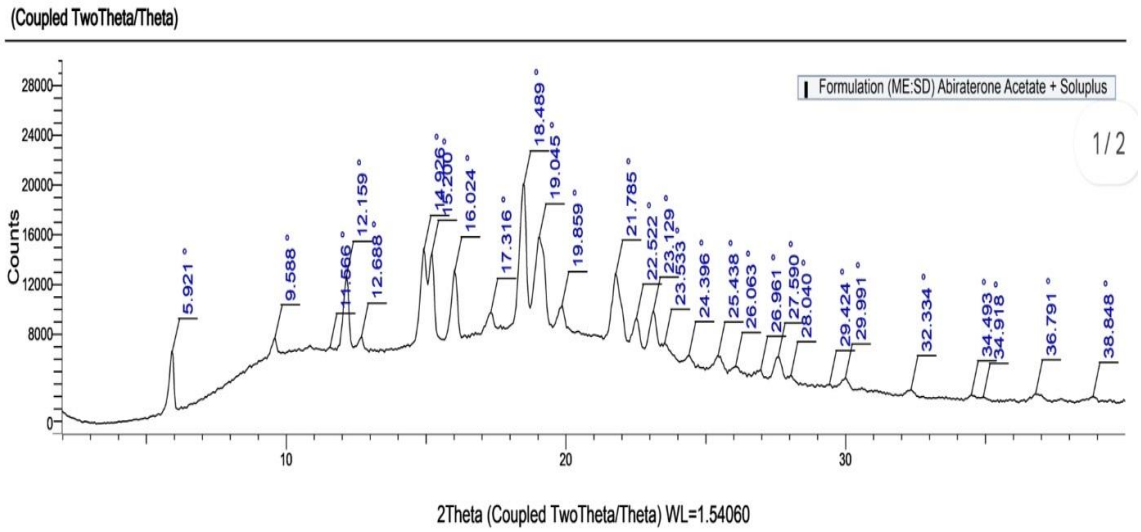

FIGURE: 6.49 XRD SPECTRA OF ABIRATERONE ACETATE FORMULATION A6 (ME-SD 1:3)

TABLE: 6.10 XRD PEAK INTENSITY COMPARISON OF ABIRATERONE ACETATE AND ITS SDs

Angle° 2Ɵ	Pure drug (intensity)	Angle° 2Ɵ	A3 Intensity	Angle° 2Ɵ	A6 (intensity)
5.788	39136.890	5.910	13788.340	5.921	4873
12.020	38884.290	12.146	9959.945	12.159	8996
14.770	42100.910	14.901	11835.300	14.926	10488
15.059	43478.340	15.176	11538.720	15.200	10083.420
15.893	33531.370	16.007	9434.891	16.025	8610.174
18.348	57186.800	18.466	19697.470	18.489	15295.730
18.892	38199.080	19.011	12656.630	19.045	1019.820

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CHAPTER 7
SUMMARY AND CONCLUSION

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7. SUMMARY AND CONCLUSION

Nowadays, various routes of administration have been explored for the effective delivery of the drug. The oral route is considered the most convenient for the administration of the medications to patients. Poor water solubility is widely recognized as the main reason for the poor oral absorption of many new chemical entities. Many new approaches have been developed to enhance the solubility of poorly soluble drugs and among them SDs are considered to be quite an effective method.

The present investigation aimed to develop SDs of Rifampicin (BCS Class-2), Duloxetine Hydrochloride (BCS Class-2), and Abiraterone Acetate (BCS Class-4). Rifampicin is a drug used in the treatment of tuberculosis, Duloxetine Hydrochloride in major depressive disorder, and Abiraterone acetate in treatment of Prostate cancer. So, by formulating SDs of these drugs solubility can be increased.

SDs are defined as group of solid products consisting of a hydrophobic drug dispersed in at least one hydrophilic carrier, resulting in increased surface area and, enhanced drug solubility and dissolution rate.

Preliminary trials were performed to determine the methods and solventthat were used for further research work. The drugs and polymer were evaluated with FT-IR to determine the compatibility of the drug and polymer, with DSC the melting point of the drug was determined along with its thermal behavior.

The FT-IR of the drug and physical mixture were compared, and no interaction was found. The DSC performed for the drugs shows the endothermic peak at temperatures which corresponds with their melting point.

All the drugs were formulated into SDs using solvent evaporation and melt evaporation technique with each drug having 6 batches of formulation. Each method had 3 batches with the drug to polymer ratio of 1:1, 1:2, and 1:3. The formulated batches were then subjected to different evaluation parameters.

Formulated batches were evaluated for %drug content, %yield, solubility studies, and in vitro-dissolution studies. Among those batches, the batches with good solubility and in vitro dissolution were then evaluated with FT-IR, DSC, and XRD.

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For Rifampicin: The DSC of formulation SE-SD (1:3) showed a reduction in melting point and formulation ME-SD (1:3) showed perfect encapsulation of the drug in the polymer

The XRD report showed favorable results in both formulations with no sharp peaks observed which were found in the XRD of Pure drug

For Duloxetine Hydrochloride: The DSC formulation SE-SD (1:3) and ME-SD (1:3) showed a reduction of melting peak and shifting of endothermic peak to a higher temperature which shows changes in composition and formation of a complex.

The XRD shows no sharp peak in both formulations which shows they changed from crystalline to amorphous state

For Abiraterone Acetate: The DSC of formulation shows perfect encapsulation of the drug in polymer and for another formulation shows a reduction in melting peak which corresponds to a reduced crystalline nature.

Conclusion:

The polymer Soluplus® was utilized to create a SDs formulation, increasing the solubility of the drugs and thus improving the dissolving rate. The solubility of drugs rises with the increase in concentration of polymer, as demonstrated by the batch SE-SD (1:3) and ME-SD (1:3) in each drug formulation [Rifampicin (R3 and R6), Duloxetine Hydrochloride (D3 and D6), and Abiraterone acetate (A3 and A6)]. Between the two techniques, melt evaporation is slightly superior to solvent evaporation. However, both procedures were successful in producing batches that may be subsequently used for solid or liquid formulation. The solubility enhanced by the polymer Soluplus Showed more than Two-fold in Rifampicin and Duloxetine HCl and more than 10-fold in Abiraterone Acetate

The research study determined that Soluplus® can increase the solubility of Rifampicin, Duloxetine Hydrochloride, and Abiraterone acetate in water.

The dissolving rate of SDs was improved when compared to pure medicines through the formulation of SDs using Soluplus®. The drug release percentage was greater than 90% for Rifampicin, greater than 90% for Duloxetine HCL, and greater than 60% for Abiraterone Acetate.

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ANNEXURE

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9. ANNEXURE

9.1 Standard curves of drugs: The standard curves of drugs (Rifampicin, Duloxetine Hydrochloride, and Abiraterone Acetate) were prepared in distilled water, methanol, and phosphate buffer (7.4, 6.8, 4.5) respectively.

9.1.1 Rifampin

The standard curves for Rifampicin were prepared in distilled water, methanol, and phosphate buffer (6.8)

1. **Distilled water:** The **λmax** of the Rifampicin was found to be 472nm as shown in Figures 9.1 and 9.2. Different concentrations of Rifampicin from 10 to 50µg/ml were prepared and the absorbance was taken at 472 nm using a UV spectrophotometer. The graph was plotted between Concentration vs Absorbance

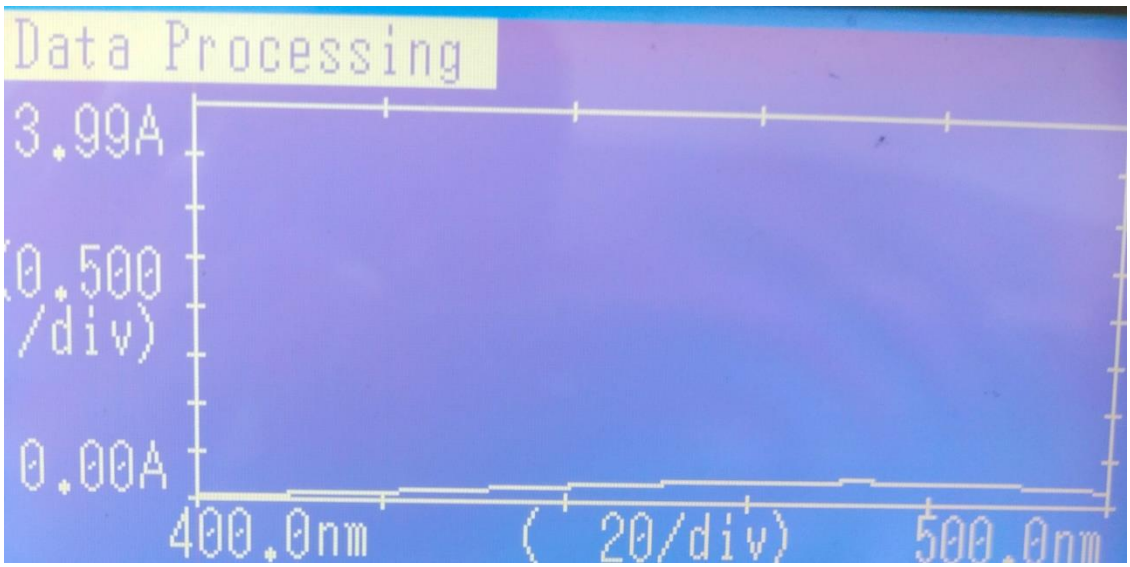

FIGURE: 9.1 λmax OF RIFAMPICIN

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FIGURE: 9.2 λmax OF RIFAMPICIN

TABLE: 9.1 STANDARD CURVE OF RIFAMPICIN IN WATER

S. No.	Concentration (µg/ml)	Absorbance
1	0	0
2	10	0.132 ± 0.021
3	15	0.192 ± 0.041
4	20	0.274 ± 0.012
5	25	0.356 ± 0.063
6	30	0.428 ± 0.054
7	35	0.524 ±0.045
8	40	0.624 ±0.036
9	45	0.715 ± 0.021
10	50	0.829 ± 0.031

*All values are in mean ± SD (n=3)

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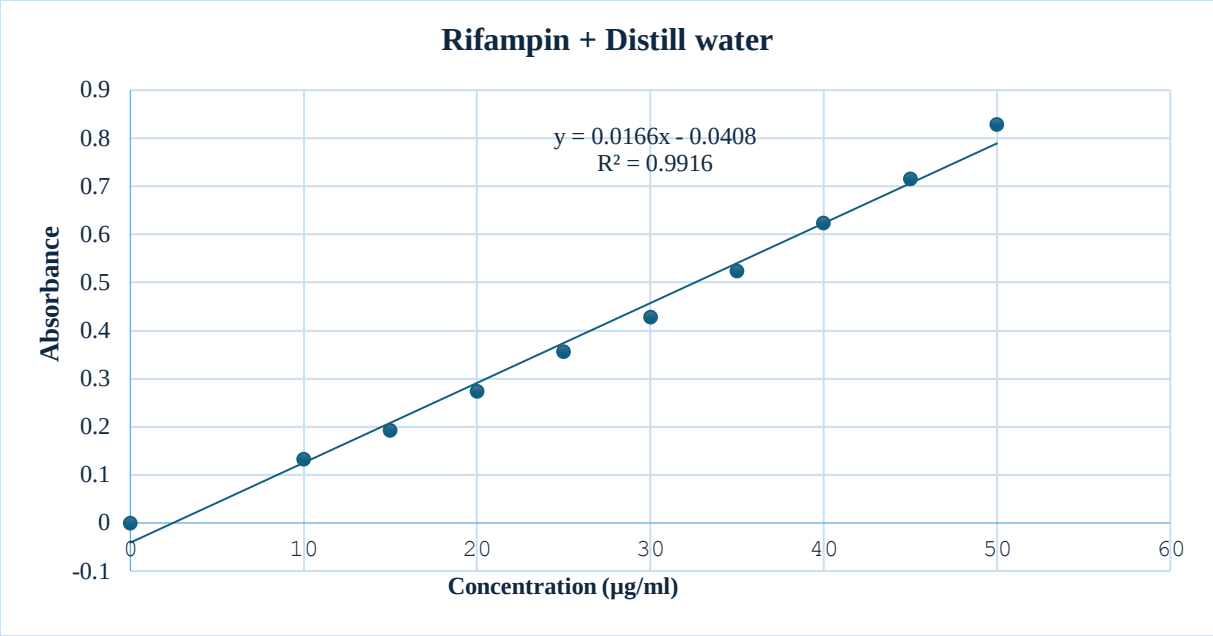

FIGURE: 9.3 STANDARD CURVE OF RIFAMPICIN IN WATER

2. **Methanol**: The **λmax** of the Rifampicin was found to be 472nm as shown in Figures 9.1 and 9.2. Different concentrations of Rifampicin from 10 to 100µg/ml were prepared and the absorbance was taken at 472 nm using a UV spectrophotometer. The graph was plotted between Concentration vs Absorbance.

TABLE: 9.2 STANDARD CURVE OF RIFAMPICIN IN METHANOL

S. No.	Concentration (µg/ml)	Absorbance
1	0	0
2	10	0.253 ± 0.015
3	20	0.465 ± 0.021
4	30	0.653 ± 0.046
5	40	0.875 ± 0.054
6	50	1.181 ± 0.041
7	60	1.341 ± 0.21
8	70	1.62 ± 0.36
9	80	1.919 ± 0.39
10	90	2.21 ± 0.41
11	100	2.45 ± 0.048

*All values are in mean ± SD (n=3)

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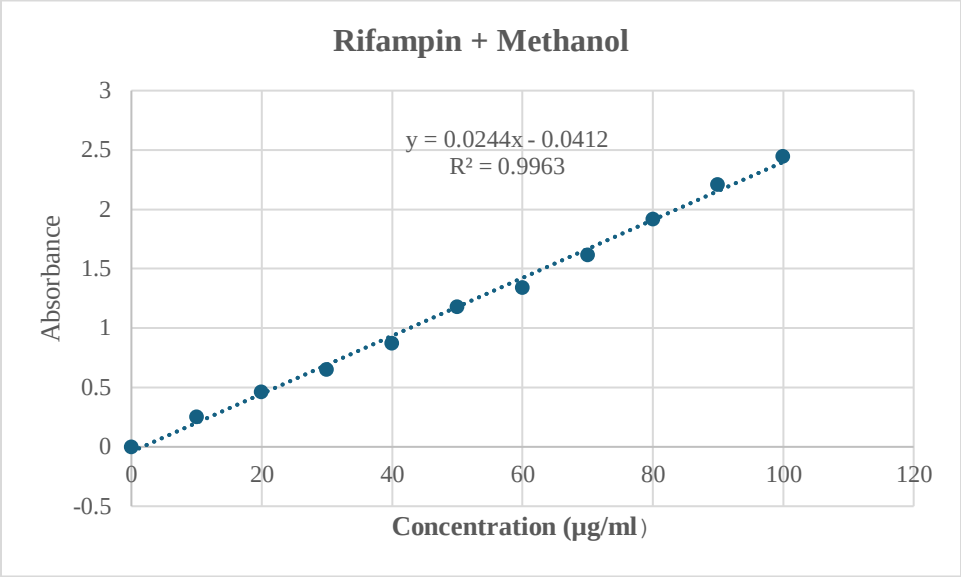

FIGURE: 9.4 STANDARD CURVE OF RIFAMPICIN IN METHANOL

3. **Phosphate buffer (7.4):** The **λmax** of the Rifampicin was found to be 472nm as shown in Figures 9.1 and 9.2. Different concentrations of Rifampicin from 10 to 100µg/ml were prepared the absorbance was taken at 472 nm using a UV spectrophotometer. The graph was plotted between Concentration vs Absorbance.

TABLE: 9.3 STANDARD CURVE OF RIFAMPICIN IN PHOSPHATE BUFFER

Sr. No.	Concentration (µg/ml)	Absorbance
1	0	0
2	10	0.157 ± 0.031
3	20	0.311 ±0.014
4	30	0.442 ±0.055
50	40	0.587 ±0.032
6	50	0.761 ±0.016
7	60	0.972 ±0.025
8	70	1.078 ±0.041
9	80	1.185 ±0.039
10	90	1.354 ± 0.023
11	100	1.536 ± 0.019

*All values are in mean ± SD (n=3)

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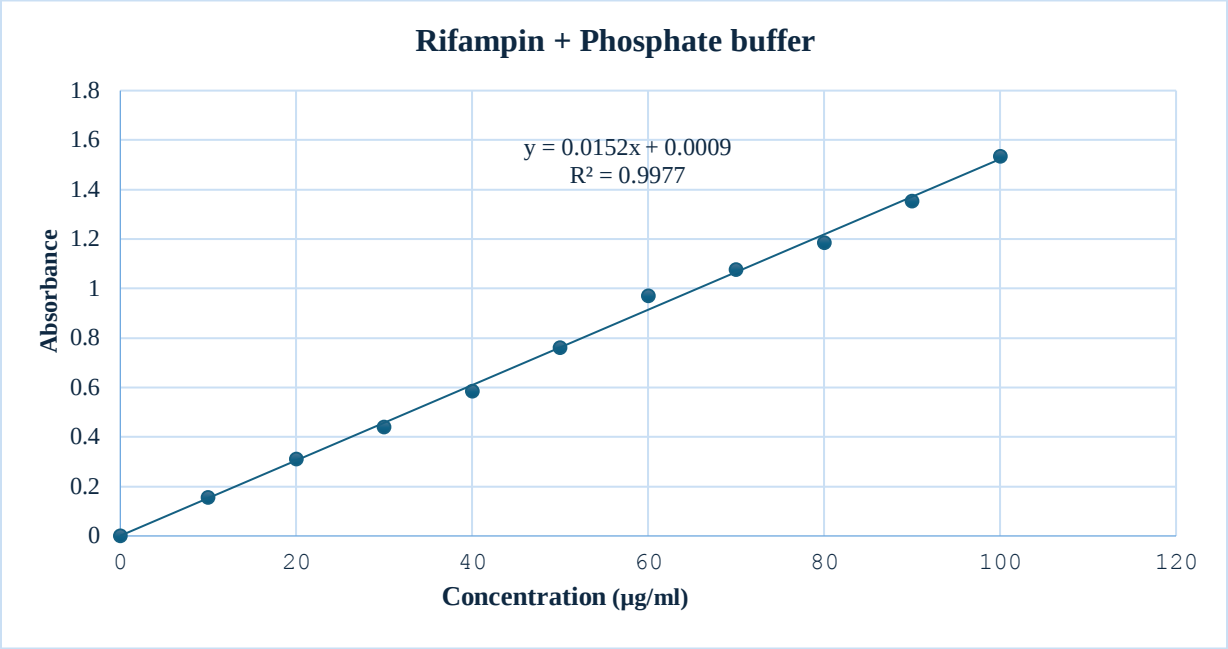

FIGURE: 9.5 STANDARD CURVE OF RIFAMPICIN IN PHOSPHATE BUFFER

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9.1.2 Duloxetine Hydrochloride

The standard curves for Duloxetine HCl were prepared in Distilled water, Methanol, and Phosphate Buffer (6.8)

1. **Distilled water:** The **λmax** of Duloxetine HCl was found to be 289.6 nm as shown in Figures 9.6 and 9.7. Different concentrations of Duloxetine HCl from 10 to 100µg/ml were prepared and the absorbance was taken at 289.6 nm using a UV spectrophotometer. The graph was plotted between Concentration vs Absorbance.

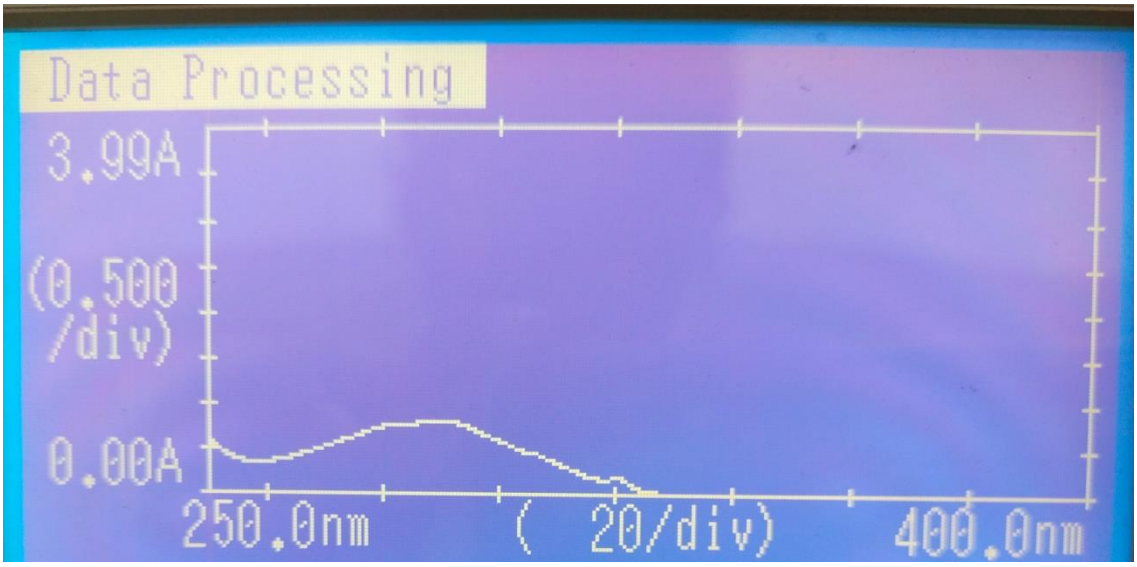

FIGURE: 9.6 λmax OF DULOXETINE HYDROCHLORIDE

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FIGURE: 9.7 λmax OF DULOXETINE HYDROCHLORIDE

TABLE: 9.4 STANDARD CURVE OF D.HCl IN WATER

Sr. No.	Concentration (µg/ml)	Absorbance
1	0	0
2	10	0.165 ± 0.016
3	20	0.333 ± 0.0010
4	30	0.434 ± 0.028
50	40	0.686 ± 0.031
6	50	0.816 ± 0.028
7	60	0.959 ± 0.033
8	70	1.094 ± 0.043
9	80	1.246 ± 0.031
10	90	1.336 ±0.025
11	100	1.483 ± 0.044

*All values are in mean ± SD (n=3)

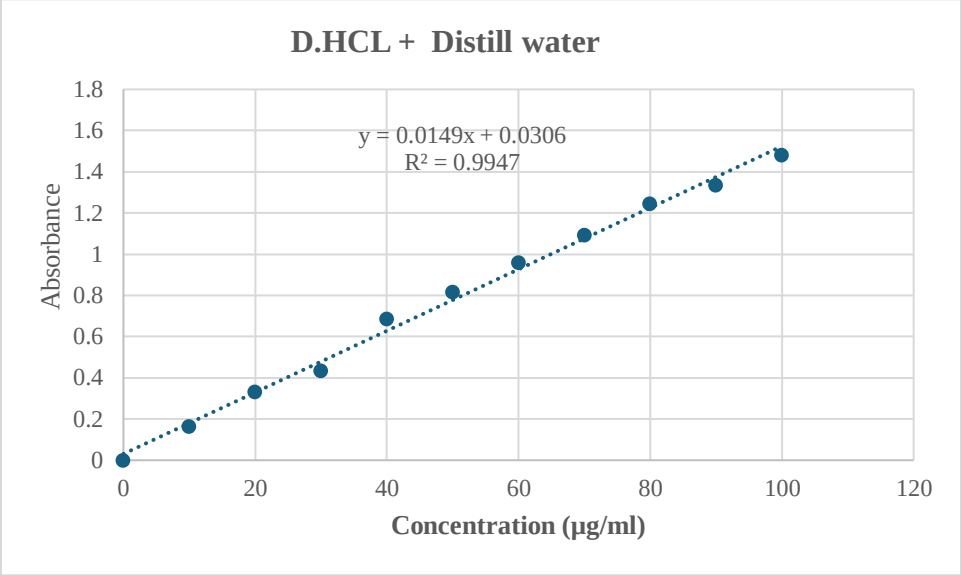

FIGURE: 9.8 STANDARD CURVE OF D.HCl IN WATER

2. **Methanol:** The **λmax** of Duloxetine HCl was found to be 289.6 nm as shown in Figures 9.6 and 9.7. Different Concentrations of Duloxetine Hydrochloride from 5 to 50µg/ml were

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prepared and the absorbance was taken at 289.6 nm using a UV spectrophotometer. The graph was plotted between Concentration vs Absorbance.

TABLE: 9.5 STANDARD CURVE OF D.HCL IN METHANOL

Sr. No.	Concentration(µg/ml)	Absorbance
1	0	0
2	5	0.095 ± 0.005
3	10	0.201 ± 0.002
4	15	0.299 ± 0.009
5	20	0.410 ± 0.003
6	25	0.508 ± 0.004
7	30	0.619 ± 0.013
8	35	0.705 ± 0.007
9	40	0.811 ± 0.008
10	45	0.915 ± 0.015
11	50	1.010 ± 0.007

*All values are in mean ± SD (n=3)

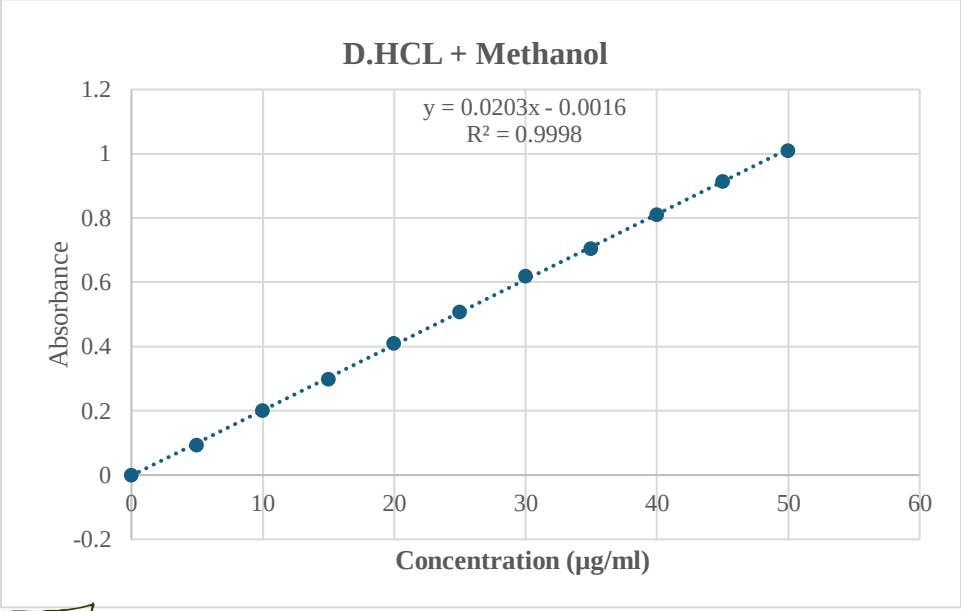

FIGURE: 9.9 STANDARD CURVE OF D.HCL IN METHANOL

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3. **Phosphate buffer (6.8):** The **λmax** of Duloxetine HCl was found to be 289.6 nm as shown in Figures 9.6 and 9.7 Different concentrations of Duloxetine HCl from 10 to 100µg/ml were prepared and the absorbance was taken at 289.6 nm using a UV spectrophotometer. The graph was plotted between Concentration vs Absorbance.

TABLE: 9.6 STANDARD CURVE OF D.HCL IN PHOSPHATE BUFFER

Sr. No.	Concentration (µg/ml)	Absorbance
1	0	0
2	10	0.162 ± 0.010
3	20	0.348 ± 0.011
4	30	0.515 ± 0.016
5	40	0.664 ± 0.015
6	50	0.852 ± 0.028
7	60	1.024 ± 0.031
8	70	1.232 ± 0.028
9	80	1.441 ± 0.04
10	90	1.651 ± 0.033
11	100	1.924 ± 0.043

*All values are in mean ± SD (n=3)

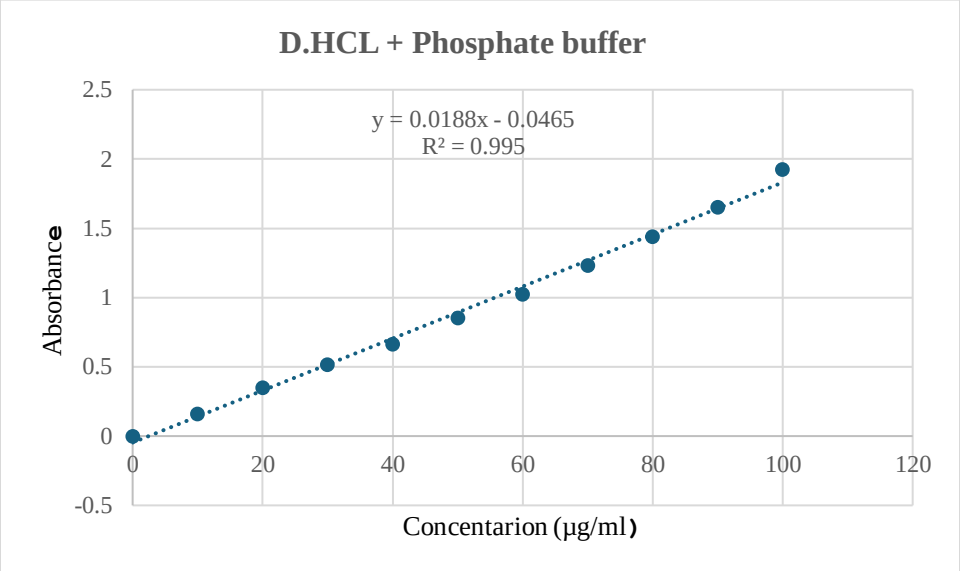

FIGURE: 9.10 STANDARD CURVE OF D.HCL IN PHOSPHATE BUFFER

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9.1.3 Abiraterone Acetate

The standard curves for Abiraterone Acetate were prepared in Methanol, Distilled Water, and Phosphate Buffer (4.5)

Methanol: The **λmax** of Abiraterone Acetate was found to be 254 nm as shown in Figures 9.11 and 9.12. Different concentrations of Abiraterone Acetate from 10 to 50µg/ml were prepared and the absorbance was taken at 254 nm using a UV spectrophotometer. The graph was plotted between Concentration vs Absorbance.

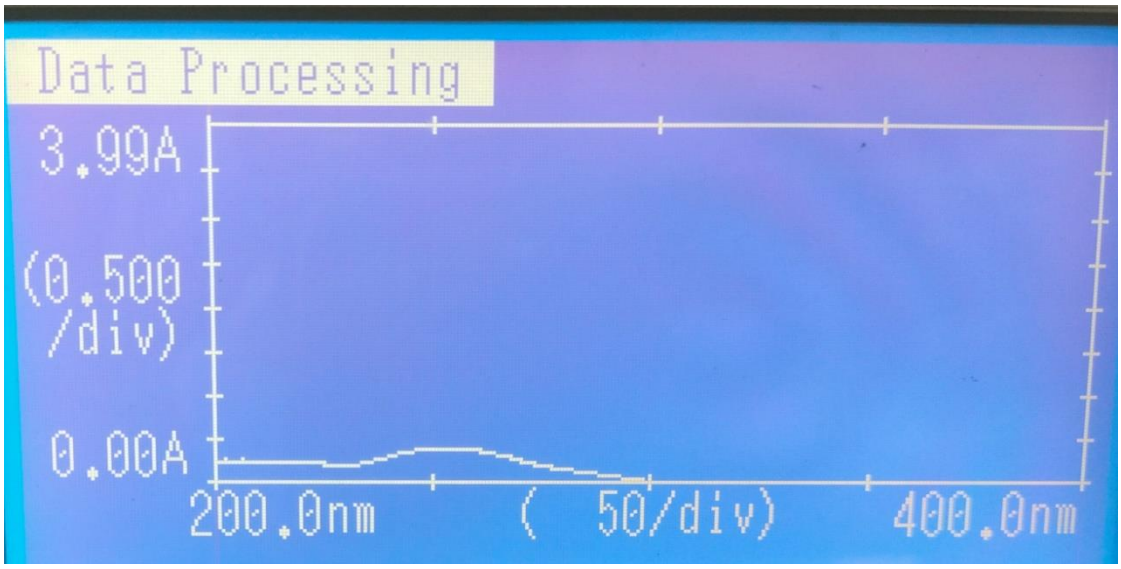

FIGURE: 9.11 λmax OF ABIRATERONE ACETATE

FIGURE: 9.12 λmax OF ABIRATERONE ACETATE

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Table: 9.7 standard curve of abiraterone acetate in methanol

Sr. No.	Concentration(µg/ml)	Absorbance
1	0	0
2	10	0.263 ± 0.005
3	15	0.395 ± 0.002
4	20	0.549 ± 0.001
5	25	0.701 ± 0.009
6	30	0.8745 ± 0.003
7	35	1.011 ± 0.012
8	40	1.2 ± 0.008
9	45	1.326 ± 0.007
10	50	1.573 ± 0.013

*All values are in mean ± SD (n=3)

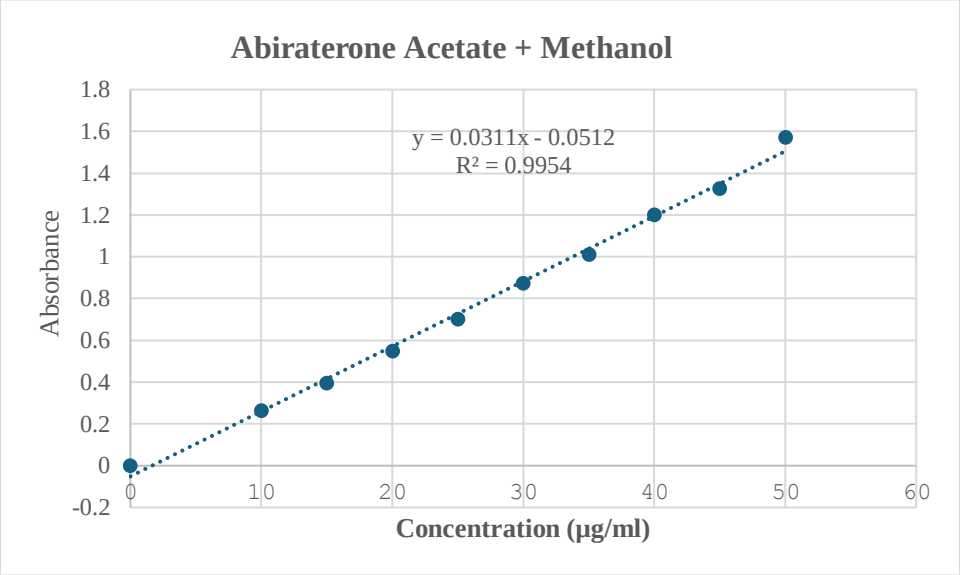

FIGURE: 9.13 STANDARD CURVE OF ABIRATERONE ACETATE IN METHANOL

2. **Distilled water:** The **λmax** of Abiraterone Acetate was found to be 254 nm as shown in Figures 9.11 and 9.12 Different concentrations of Abiraterone Acetate from 20 to 200µg/ml were

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prepared and the absorbance was taken at 254 nm using a UV spectrophotometer. The graph was plotted between Concentration vs Absorbance.

TABLE: 9.8 STANDARD CURVE OF ABIRATERONE ACETATE IN WATER

Sr. No.	Concentration (µg/ml)	Absorbance
1	0	0
2	20	0.054 ± 0.003
3	40	0.092 ±0.005
4	60	0.125 ± 0.01
5	80	0.168 ± 0.002
6	100	0.210 ± 0.008
7	120	0.251 ± 0.02
8	140	0.308 ± 0.01
9	160	0.359 ± 0.02
10	180	0.412 ± 0.03
11	200	0.476 ± 0.02

*All values are in mean ± SD (n=3)

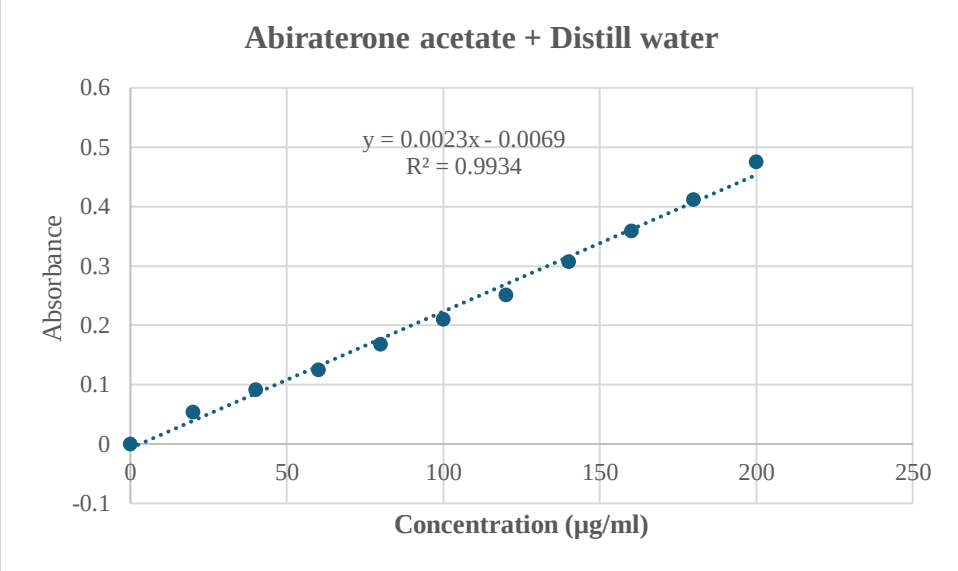

FIGURE: 9.14 STANDARD CURVE OF ABIRATERONE ACETATE IN WATER

3. Phosphate buffer (4.5): The **λmax** of Abiraterone Acetate was found to be 254 nm as shown in Figures 9.11 and 9.12 Different concentrations of Abiraterone Acetate from 20 to 200µg/ml

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were prepared and the absorbance was taken at 254 nm using a UV spectrophotometer. The graph was plotted between Concentration vs Absorbance.

TABLE: 9.9 STANDARD CURVE OF ABIRATERONE ACETATE IN PHOSPHATE BUFFER

Sr. No.	Concentration (µg/ml)	Absorbance
1	0	0
2	20	0.069 ±0.02
3	40	0.145 ± 0.05
4	60	0.225 ± 0.03
5	80	0.284 ± 0.04
6	100	0.367 ± 0.03
7	120	0.462 ± 0.06
8	140	0.564 ± 0.03
9	160	0.641 ± 0.04
10	180	0.759 ± 0.01
11	200	0.868 ± 0.05

*All values are in mean ± SD (n=3)

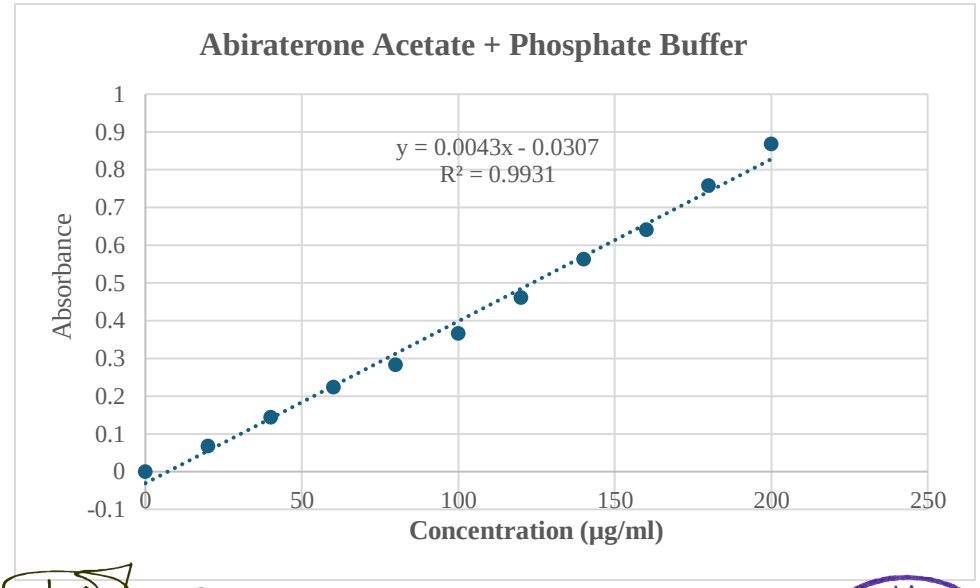

FIGURE: 9.15 STANDARD CURVE OF ABIRATERONE ACETATE IN PHOSPHATE BUFFER

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Evaluation of pharmacological property of *Vitex negundo* on HEK-293 cell line and *Vigna radiata* germination

A Dissertation Report submitted

for the partial fulfilment of the Degree of Master of Science

By

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[M.Sc. Biotechnology]

Under the supervision of

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CERTIFICATE

This is to certify that this dissertation report entitled **"Evaluation of pharmacological property of *Vitex negundo* on HEK-293 cell lines and *Vigna radiata* germination"** was successfully carried out by Miss **Sonal Davda** towards the partial fulfilment of requirements for the degree of Master of Science in Biotechnology of Atmiya University, Rajkot. It is an authentic record of her own work, carried out by her under the guidance of **Dr. Praveen S. Gupta** for a during the academic year of 2023-24. The content of this report, in full or in parts, has not been submitted for the award of any other degree or certificate in this or any other University.

19/4/24

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DECLARATION

I hereby declare that the work incorporated in the present dissertation report entitled "**Evaluation of pharmacological property of *Vitex negundo* on HEK-293 cell line and *Vigna radiata* germination**" is my own work and is original. This work (in part or in full) has not been submitted to any University for the award of any Degree or a Diploma.

Date: 16th April,2024

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Abstract:

Vitex negundo (Lamiaceae) commonly known as Nirgundi and locally known as Nagode Common, by riverbanks, along roadsides as hedges. Plains from the coast to 1000m, India, Himalaya, Burma, Afghanistan, China, Indo-China, Sri Lanka, Malaysia. plant species finds use for treatment of a wide spectrum of health disorders in traditional and folk medicine; some of which have been experimentally validated. All compounds extracted from all the parts of the plant exhibited various bioactivities, including anti-nociceptive, anti-inflammatory, anti-tumor, anti-oxidant, anti-androgenic, anti-microbial activity etc. Parts of the plant extract can be used for many purposes. Phytochemical investigation carried out of dried root of plants after solvent extraction. A wide range of phytochemicals were identified in the test result, including alkaloids, carbohydrates, amino acids, terpenoids, flavonoids, saponins, steroids, tannins, and phenol. Mung bean root cells showed cytotoxic activity; the average Mitotic Index (MI), when compared to water and the reference medication Methotreaxate (0.01 mg/ml), was determined to be 30.82%. Three distinct samples were plotted as part of a statistical analysis that was conducted using Graphpad Prism 10. Additionally, the study was conducted using the HEK-293 cell line. Trypan blue assay and MTT assay were also performed at different concentrations, such as 5 µg/ml, 10 µg/ml, 25 µg/ml, and 50 µg/ml, and the p-value was determined to be below 0.05. A graph was also created.

Introduction:

The usage of plants for a variety of purposes dates back thousands of years. One of plants main uses is in the production of phytochemicals, among other diverse compounds. In terms of the medical profession, plants also have a big impact. Many known plants are used in ayurveda, which has been referenced in numerous historical books. Ayurveda, or traditional Indian medicine, and traditional Chinese medicine both originated in their respective geographical areas and are based on traditional medicinal systems. Around 3,000 years have passed since the practice of ayurveda began to treat illnesses *(Kumar & Gustav J. Dobos, et al., 2016).*

Plants are rich in bioactive chemicals, including phenolics, flavonoids, alkaloids, terpenes, steroids, and saponins, which give them antimitotic, antidiuretic, antidiabetic, antiarthritic, antidepressant, analgesic, antipyretic, antioxidant, and antibacterial qualities, among others. Plants have been utilised for thousands of years as a source of medicine because their phytochemicals contain therapeutic properties. A large number of contemporary medications have been developed in large part because of the structural variety of natural goods. The discovery of cancer drugs has always been a promising field in recent times, as cancer is the leading cause of mortality among all diseases and is a complex illness. Both in wealthy and developing nations, research on anticancer drugs is being conducted globally *(Gupta & Patel 2020).*

Vitex negundo belongs to the Lamiaceae family and is commonly known as Nirgundi and locally known as Nagode. Countries it is indigenous to include Afghanistan, Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Japan, Korea, Kenya, Madagascar etc. The leaves of *Vitex negundo* are antibacterial, antitumor, astringent, febrifuge, sedative, tonic and vermifuge. They are useful in dispersing swellings of the joints from acute rheumatism and of

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the testes from suppressed gonorrhea. The juice of the leaves is used for removing worms from ulcers, whilst oil prepared with the leaf juice is applied to sinuses and scrofulous sores. Extracts of the leaves have shown bactericidal and antitumor activity. Leaves are antiparasitical, alterative, aromatic, vermifuge, pain reliever. Leaves are insect repellents. Extracts of the leaves have insecticidal activity. The fresh leaves are burnt with grass as a fumigant against mosquitoes. Decoction of leaves may improve eyesight. *(Devi ,2021).*

Taxonomical classification:

- **Kingdom**: Plantae
- **Class**: Magnoliopsida
- **Order**: Lamiales
- **Family**: Lamiaceae
- **Genus:** *Vitex*
- **Species:** *negundo*
- **Common name**: Nirgundi , Nisinda
- **Gujarati name:** Nagoda

Historical applications for therapy :

Throughout ancient times, people have discovered and employed therapeutic plants, often known as medicinal herbs, in traditional medical procedures. Plants are able to produce hundreds of different kinds of chemicals that they use for defence and protection against herbivorous mammals, fungus, insects, and illnesses, among other purposes. Pharmacologically active compounds are sometimes found through ethnobotany, a method that has produced hundreds of important compounds in the field of drug research. The majority of the many chemicals that are present in plants belong to four biochemical classes: terrenes, glycosides, polyphenols, and alkaloids. Both common dangers to medicinal plants, such habitat destruction and climate change, exist. Clay tablets dating back to approximately 3000 BC in Sumeria list hundreds of therapeutic herbs, including opium and myrrh. Around 800 plant remedies, including aloe, cannabis, castor bean, garlic, juniper, and mandrake, are included in the ancient Egyptian Ebers Papyrus**.** For example, salicylic acid functions as a hormone in plant defences, and other chemical substances produced by all plants provide them with an evolutionary advantage when defending against herbivores. In the event that their use in modern medicine is validated by science, the phytochemicals' potential for use as pharmaceuticals stems from their presence and established pharmacological action in medicinal plants. The alkaloids found in daffodils (Narcissus) include galantamine, which is approved for use in the treatment of Alzheimer's disease. Concentrated in the portions of the plant that herbivores are most likely to eat, such the stem, the alkaloids are toxic and have a bitter taste. They may also offer protection against parasites. In 2011, the Medicinal Plant Transcriptomics Database offered a sequence reference for the transcriptome of around thirty different species, contributing to the systematic organisation of current information about medicinal plants. These are some examples of plants that include the major groups of phytochemicals found in plants. The production and application of aromatic and therapeutic plants have only been to an almost inconceivable degree since the earliest recorded times in the

known history of plants. Herbal medicine, in particular, has endured as a significant healthcare provider in an attempt to give high-quality care to everyone, mostly in rural and isolated places. Contemporary study has recognised the long history and efficacy of the Indian traditional medical system. A significant source for the creation of novel drugs is regarded to be Indian traditional medicine or medicinal herbs. High-quality healthcare is made possible for everyone by the evidence-based integration of Indian traditional medicine into clinical practice. In light of this, this chapter offers an overview of several fundamental elements of aromatic and medicinal plants that cover the whole spectrum of products, starting with the commerce, cultivation, and sustainable sourcing of raw materials *(Petrovska , 2012)*.

Morphology:

Fig 1 : *Vitex negundo* (a) leaves **(b) Morphology structur**

Phytochemical analysis:

Varios phytochemicals are obtained from the plant parts and has wide applications. The selection of the solvent is crucial for determining the bioactive components of the plants utilised in the extractions. An ideal extraction solvent should have minimal toxicity, quick evaporation at low temperatures, good target compound solubility, and sufficient volatile matter. Factors influencing the solvent selection include extraction rate, range of chemicals extracted, ease of handling extracts, and cost-effectiveness of both the targeted compounds and extraction solvents. Plants are composed of several bioactive substances that have varying polarities. Various techniques have been developed and implemented to obtain pure compounds and determine their structure and biological activity. There have been several solvent extractions done to get phytochemical compounds for their effectiveness against infections. The numerous structural traits, individual phytochemical components, and corresponding action mechanisms of each phytochemical are detailed below: With antibacterial, anthelmintic, and antidiarrheal properties, phenols and polyphenols, such as catechol, epicatechin and cinnamic acid, are extracted using acetone and ethanol solvents. These compounds also have hydroxyl groups and a C3 sidechain. Polyphenols work through a variety of mechanisms, including binding to proteins (adhesins), preventing enzyme-substrate deprivation, forming

protein complexes with cell walls, increasing the amount of protein that animals can digest by forming protein complexes in the rumen, and reducing the metabolism of the gastrointestinal tract and colon mucosa. The principal solvents used for quinones extraction include chloroform, methanol, and ethanol. A pair of ketone substitutions, such as the antibacterial hypericin, are present together with aromatic rings. The quinones' modes of action include binding to proteins (adhesins), complexing with the cell wall, and inactivating enzymes.
The primary extracts of tannins from ethanol and water include polymeric phenols such ellagitannin, which has antibacterial, anthelmintic, and antidiarrheal properties. The mechanism of action of tannins includes the following: they make intestinal mucosa more resistant and reduce secretion; they inhibit enzyme-substrate deprivation; they bind proteins (adhesins); they form protein complexes in the rumen, increasing the supply of digestible proteins by animals; and they lower gastrointestinal-tract metabolism. Most flavonoids are extracted using chloroform solvents. These compounds include flavones, a +3-hydroxyl group with antibacterial, anthelmintic, and antidiarrheal properties, hydroxylated phenols (C3–C5) connected to an aromatic ring, and phenolic structure. Inhibiting the release of prostaglandins binding to proteins (adhesins), and complexing with the cell wall are the mechanisms by which flavonoids work. They also prevent spasm-induced contractions. Warfarin, which is a phenol composed of fused benzenes, is one example of a phenol with antibacterial activity that is primarily extracted by ether solvent. Interaction with eukaryotic DNA is made possible by the coumarins' mode of action. Terpenoids, which are primarily fatty acid and acetate units with antibacterial activity, are extracted using ether, water, ethanol, and chloroform solvents. By blocking the release of prostaglandins and autocoids, terpenoids work as a mechanism. The main components of lectins and polypeptides that may be removed with water are proteins, such as fabatin, which has antibacterial properties, and mannose-specific agglutinin. Viral fusion or adhesion is prevented by the mechanism of action of polypeptides and lectins.Ethanol and ether solvents are useful for extracting alkaloids, which are heterocyclic nitrogen compounds with antibacterial, anthelmintic, and antidiarrheal properties, such as berberine, piperine, palmatine, and tetrahydropalmatine. Glycosides are primarily extracted using an ethanol solvent, which is a mixture of sugar and a non-carbohydrate moiety, such as amygdalin, which has antidiarrheal properties. Glycosides work by preventing the release of prostaglandins and autocoids. An amphipathic glycoside, such as vina-ginsenosides R5–R6, which have antidiarrheal properties, can be extracted from saponins using methanol, water, and hydro-alcoholic 70% methanol. By inhibiting histamine release in vitro, saponins work. A crucial aspect of phytochemical investigations is the identification, collection, and selection of plants. A plant specialist's identification of the plants is essential. A great deal of plants are chosen by humans using conventional methods or by research projects based on biological data. Similar-polarity chemicals dissolve when solvents diffuse through the plant material during extraction. Plant origin, growing or cultivated conditions, moisture content, and particulate size all affect the bioactive compounds in the plant. The secondary metabolites of the extracts will also be influenced by the various extraction techniques, which include solvent type, solvent concentration, solvent polarity, temperature, and extraction duration. Depending on the type of solvent utilised, it is essential to identify physiologically active chemicals from plant materials. The selection of solvents is determined by factors such as their accessibility, minimal toxicity, boiling point, evaporation ease, and solvent polarity. Seventeen solvents that are deemed safe and approved for use in food and personal hygiene products were reported by the WHO Expert Committee *(Nortjie & Basitere et al., 2022).*

Graphpad prism 10:

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ANOVA technique is a statistical tool used to produce a graph. Prior to being purchased by Insight Partners in 2017, GraphPad Software Inc. was a privately held company that developed software. Insightful Science was the name of the corporation, which in 2021 amalgamated with Dotmatics. In 1989, Motulsky co-founded the company with Earl Beutler, and wrote the original software. California is the company's operating region. The software it offers includes GraphPad Prism, a 2D scientific graphing application for biostatistics and curve fitting, and GraphPad QuickCalcs, a free web-based statistical computation tool.

Methotrexate mechanism:

When used as a chemotherapeutic drug or to inhibit the immune system in autoimmune illnesses, methotrexate has a unique mode of action. As an antifolate antimetabolite, methotrexate functions in cancer. Human reduced folate carriers (SLC19A1) are responsible for absorbing methotrexate into cells, where it combines with polyglutamate to create methotrexate-poly. Dihydrofolate reductase is an enzyme that catalyses the conversion of dihydrofolate into tetrahydrofolate, the active form of folic acid. Methotrexate and methotrexate-polyglutamate both block this enzyme. For the production of DNA and RNA nucleotides, tetrahydrofolate is required. Inhibiting DNA synthesis, methotrexate-polyglutamate also prevents thymidylate synthase and purine from synthesising purines from scratch. Its cytotoxic action makes this mechanism useful in the treatment of cancer. Selecting methotrexate as the preferred medication in autoimmune disorders involves many mechanisms. Drugs other than methotrexate used showing anti-cancer properties are as follows: Taxotere, Halaven, Taxol, Abraxane, Vincasar PFS, Vumon, VePesid, Velban etc. *(Hanoodi & Mittal , 2023)*

Cytotoxic effect:

Certain substances have the capacity to harm or kill cells, especially cancerous ones. This phenomenon is known as the cytotoxic effect. The goal of cytotoxic therapy is to destroy or inhibit the proliferation of cancer cells using anticancer treatments such as chemotherapy and herbal remedies. This therapy reduces tumour size, eliminates cancer cells left behind after surgery, and is frequently employed in the treatment of cancer and the discovery of new drugs *(Bajrami, Hoxha et al. 2014)*. Research from the past has shown that cytotoxic phytochemicals can cause necrosis and apoptosis, or they can block certain cell-signaling pathways, which can cause cell death or cell cycle arrest *(Mazumder & Biswas et al.,2020).*

HEK – 293 Cell Line:

The 293 cells, also known as HEK 293, HEK-293, or 293 cells, are human embryonic kidney cells that were immortalised in the 1970s by isolating HEK cells from a female foetus. Because of its transfection propensity and steady, rapid development, the HEK 293 cell line has been extensively employed in research for many years. The biotechnology sector uses the cell line for safety testing of a wide range of substances as well as the production of therapeutic proteins and viruses for gene therapy. An immortalised cell line is a group of cells from a multicellular creature that, although they would not ordinarily be able to multiply eternally, are able to do so because of a mutation that has prevented them from experiencing normal cellular senescence.

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Thus, the cells can be cultivated in vitro for extended periods of time. The mutations needed for immortality can arise spontaneously or be purposefully created in experiments. Research into the biochemistry and cell biology of multicellular creatures benefits greatly from the use of immortal cell lines. Biotechnology has also benefited from the use of immortalised cell lines. Stem cells are a normal component of the growth of a multicellular organism and can also divide indefinitely; they should not be confused with immortalised cell lines *(Kavsan & Iershov et al. 2011), (Austriaco ,2020).*

Numerous secondary metabolites that are important in granting diverse functions for distinct plant sections are screened as a result of the phytochemical study. This study evaluated the potential medicinal use of *Vitex negundo* by calculating the plant's Mitotic Index (MI), analyzing several secondary metabolites using phytochemical inquiry, and studying anti-mitotic activity in mung bean root cells. Additionally, research is conducted on manipulating cancer cell lines.

Materials and Method:

Chemicals and Reagents

An organic solvent called methanol is used to extract the leaves of the selected plant. The plant extract needs to be cultured for three days at room temperature in a dark place in order to be extracted. Next, the plant extract is extracted in an evaporation vacuum using a solvent. Several reagents and chemicals were used to explore various phytochemicals, such as distilled water, 10% NaOH, Dil. HCl, 10% Lead Acetate, chloroform, Conc. H_2SO_4, $CuSO_4$, Ethanol, Glacial Acetic Acid, $FeCl_3$, Napthol solution, Mercuric chloride, KI, Iodine, and Picric acid, DMSO , PBS, Complete medium , Tripsin , D/W

Collection of plant materials and preparation of extracts :

We obtained the leaves of *Vitex nagundo* from ayurvedic stores and then after proper wash and drying, a powdered sample was perpared. Three days of dark incubation at room temperature are followed by the solvent extraction in the evaporation vap of a powdered plant extract sample dissolved in the polar solvent methanol. Plant extract that is semi-solid is also dissolved using distilled water.

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❖ Phytochemical screening: *(Gupta & Patel 2020).*

The various phytoconstituents in extracts were confirmed by phytochemical tests such as

(1) Test for Flavonoids:

(a) Alkaline reagent test:

10% NaOH, if yellow color observed add few drops of diluted HCl, if yellow color disappeared, it mean test is positive.

(b) Lead Acetate test:

Add 0.5 ml of plant extract with few drops of 10% lead acetate solution. If yellow color observed it mean test is positive.

(2) Test for Terpenoids:

Salkowski test:

Mix 0.5 ml of plant extract with 0.2 ml of chloroform. Add 0.3 ml conc. H_2SO_4, if reddish brown coloration was observed it mean test is positive.

(3) Test for Amino Acids:

Biuret test:

Treat the 0.5ml of plant extract with few drops of 2% of copper sulphate solution. Add 1ml of ethanol followed by excess of potassium hydroxide pellets, formation of pink color in the extract layer indicates the presence of amino acids.

(4) Test for Cardiac Glycosides:

Killer Killani Test:

Add 0.5 ml plant extract with 0.08 ml glacial acetic acid along with 1-2 drops of Fecl3, if brown ring in interface & greenish ring may gradually throughout thin layer it mean test is positive.

(5) Test for Saponins:

Foam test:

Mix 0.5 ml of plant extract with small amount of ethanol. Shake in graduated cylinder after adding small amount of D/W for 15 min. If stable foam is observed it mean test is positive.

(6) Test for Steroids:

The crude plant extracts (1 mg) was taken in a test tube and dissolved with chloroform (10 ml), then added equal volume of concentrated sulphuric acid to the test tube by sides. The upper layer in the test tube was turns into red and sulphuric acid layer showed yellow with green fluorescenc.

(7) Test for Tannins:

Ferric chloride test:

Add 0.5 ml plant extract with few drops of 1% Ferric chloride, intense green or black color indicate presence of tannins.

(8) Test for phenols:

Ferric chloride test:

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Add 0.5ml plant extract with 3-4 drops of 5 % Ferric chloride solution. Formation of bluish color indicates the presence of phenols.

(9) Test for Carbohydrate

Molisch's test:

Add 0.5ml plant extract with 2-3 drops of 1% Alcoholic α- Napthol solution in test tube, formation of violet ring at junction indicate the presence of carbohydrate.

(10) Alkaloid test:

(a) Dragendroff's reagent (Potassium-bismuth-iodide solution):

Pour 0.5g of bismuth nitrate into empty beaker. Add 10ml of concentrated hydrochloric acid. Pour 4g of potassium iodide into another beaker, add a little water and stir until KI is completely dissolved. Observe the formation of a dark orange solution.

(b) Mayer's reagent (Potassium-mercuric-iodide solution):

Freshly prepared by dissolve a mixture of mercuric chloride (1.36g) and of potassium iodide (5.00g) in 100ml of water, if cream colored precipitation observe test is positive.

(c) Wagner's reagent (iodine-potassium-iodide solution):

Dissolve 2g of iodine and 6g of potassium-iodide in 100ml of water.

(d) Hager's reagent (Saturated solution of picric acid):

Dissolve 1g of picric acid in 100ml of water. 5ml plant extract with 3-4 drops of 5 % Fecl3 solution. Formation of bluish color *(Gupta &Patel 2020).*

❖ Study of Anti-mitotic activity in mung bean root cells:

Vigna radiata is readily available, easily handled, and grows well in any season, *Vigna radiata* is utilised as the model plant for cytotoxic activity assessments. The individual phases of the cell cycle are readily discernible, and the efficacy of the medication under investigation can be verified in conjunction with the standard medication. Three duplicates of the normal medication, water, and a sample of the plant are collected, the hypocotyl of the plant is produced, and the mixture is left to grow overnight. Concerning this, more observations are made.

- Requirements:

  2-3 days soaked Mung bean with hypocotyls, Methotrexate (standard drug), Distilled water, dil.HCl, Acetocarmine, slides, coverslip, Microscope and 24-well Microtiter plate.

- Method:

  1. Put the handful of mung beans in distilled water and let them soak for two to three days.
  2. Assemble a 24-well microtiter plate after selecting beans with fully developed hypocotyls.

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3. After that, separate the microtiter plate into three rows: one for the water sample, one for the prescription drug methotrexate, and one for the plant extract.
4. After soaking three or four mung beans in each region, they are grown overnight in the PTC laboratory in order to be harvested the next day.
5. The next day, the root cells need to be looked at under a light microscop
6. The root is sliced using a knife and forceps, then washed with water and treated with Dil. HCl for a duration of two to three minutes.
7. Now, using forceps, lay the roots on the slide, and place a coverslip on top of a drop of acetocarmine dye.
8. Apply light pressure to the roots to cause them to swell and break so that the transparent part of the cells can be seen under a microscope.
9. Once the slide has stained for ten to fifteen minutes, take out any extra dye and examine it under a microscope.
10. The cells at different phases of mitosis can be seen with the 10X and 40X lenses.
11. Furthermore, to calculate the Mitotic Index (MI), five separate circular sections are obtained and the total number of cells dividing and non-dividing is tallied. Three consecutive readings are taken for each category, and the average is then computed to determine the drug's mitotic index.
12. A stronger medication will inhibit mitosis, resulting in a smaller percentage of dividing cells in comparison to non-dividing cells. This relationship between drug potency and the mitotic index is inverse.

$$\text{Mitotic Index (MI) [in \%]} = \frac{\text{Number of cells under division}}{\text{Total number of cells}} \times 100$$

Fig 2: Anti-mitotic assay on mung bean roots

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❖ Cell Revival and Subculturing :

(A) Priparation of medium:

complete medium is prepared by basal medium, 10% foetal bovine serum, growth supplements *(Yao & Asayama, 2017)*.

(B) Thawing:

Thawing is the process of getting frozen cells to room temperature so they may go from an entirely dormant to metabolically active state with little to no harm *(ResearchTweet ,2023)*.

(C) Seeding :

1. To prepare adherent cells, aspirate the culture media from an 80–90% confluent culture flask. Then, carefully add 5 ml of room temperature (R.T.) phosphate buffered saline (PBS) without calcium and magnesium to the cell culture plate's inside wall. Swirl the plate until it is completely covered. Then, aspirate again and add 5 mL of PBS for a second wash.
2. Remove the PBS solution from the plate, then gradually swirl in 2 ml of 0.25% Trypsin-EDTA until the trypsin covers the whole surface.
3. After the cell culture plate is placed in an incubator with 5% CO2 and a temperature of 37°C, the cells should separate off the plate after 3 minutes.
4. Take out the cell culture plate from the incubator. Fill it with 3 millilitres of foetal bovine serum (FBS)-supplemented warning media. Gently stir the mixture with a pipette to further separate the cells from the plate and create a single cell suspension. Spoon 5 ml of the cell solution into a conical centrifuge tube (15 mL capacity).
5. To pellet the cells, centrifuge the conical tube for five minutes at 1700 RPM.
6. After aspirating the fluid, which leaves the cell pellet intact, flip the conical tube to release the cell pellet

❖ Trypan blue assay:

Finding out how many live cells are in a cell solution is done using the dye exclusion test. The underlying idea is that whereas dead cells lack cell membranes that block certain dyes like propidium, eosin, or trypan blue, live cells do. This assay determines whether cells absorb or reject dye by mixing a suspension of cells with dye and observing the results visually. As per the methodology outlined below, a live cell's cytoplasm will be transparent, while that of a nonviable cell will be blue. *(Strober , 2019)*

1. Harvest cells
2. Re-suspend cells in fresh medium and the total volume of the 10ml
3. Take 50µl of cell suspension.
4. Add 50µl Trypan Blue to the cell suspension.

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5. Prepare haemocytometer with coverslip.
6. Fill chamber with cell suspension.
7. Count cells.
8. Calculate concentration

❖ MTT Assay :

An indicator of cell metabolic activity, the MTT assay is a colorimetric test. Under specific circumstances, NAD(P)H-dependent cellular oxidoreductase enzymes may indicate the quantity of live cells in the sample *(Berridge & Herst et al. 2005)*. The tetrazolium dye MTT, or 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide, can be reduced by these enzymes to its purple insoluble formazan. 1-methoxy phenazine methosulfate (PMS), an intermediate electron acceptor, is employed in conjunction with other closely related tetrazolium dyes, such as XTT, MTS, and the WSTs. Reduction takes place outside the cell via electron transport across the plasma membrane in cell-impermeable WST-1. This widely accepted theory is presently contested, though, as evidence of MTT reduction to formazan in lipidic cellular structures has also been discovered—and without the apparent involvement of oxidoreductases. Tetrazolium dye tests are also useful for assessing the cytostatic activity (the transition from proliferation to quiescence) and cytotoxicity (the loss of live cells) of hazardous substances and possible medications. Due of the MTT reagent's sensitivity to light, MTT experiments are typically conducted in darkness *(Stockert & Castro et al. 2018)*.

Procedure *(Gerlier & Thomasset, 1986; Mosmann, 1983):*

1. Take a titer plate with 96 wells.
2. Consequently, we require 5.18×10^6 cells/well based on the hematocytometer's cell counts.
3. We shall take 10 µl cell suspension and 190 µl complete medium because each well can only now hold 200 µl of water.
4. Four concentrations 5,10, 25 and 5 µg/ml taken into consideration for every sample.
5. Triplicates are made appropriately for each concentration.
6. To create the blank, dissolve 5µl DMSO and 195 µl complete media; to create the control, dissolve 190 µl complete medium and 10 µl cell suspension, respectively.
7. Additionally, they are made in triplicate.
8. After that, the 96-well titer plate is incubated for a further night at 37°C with 5% CO2.
9. Transfer 50 µl of MTT solution and 50 µl of serum-free medium into every well.
10. Tent the plate for three hours at 37°C.
11. 115 µl DMSO is added to each well after incubation.

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12. Plate should be covered with foil and shaken for fifteen minutes using an orbital shaker.
13. Calculate the absorbance at OD= 590 nm. In an hour, read the plate.

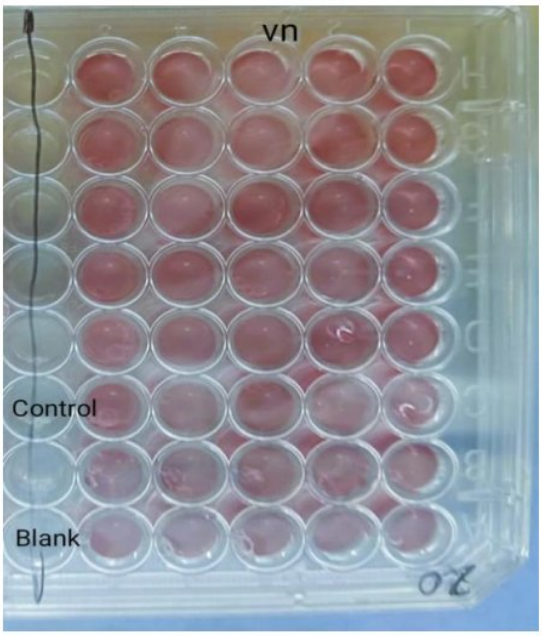

Fig 3: MTT Assay

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Result and Discussion:

❖ Phytochemical analysis result :

❖ Table-1: Phytochemical constituents

Sr No.	Phytoconstitute	Name of Test	*Vitex negundo*
1.	Flavonoid	(a)Alkaline test	+
		(b)Lead acetate	+
2.	Terpenoids	Salkowaski test	-
3.	Saponins	Foam test	+
4.	Steroids	Libermann-Burchared test	++
5.	Tannins	Ferric chloride test	+
6.	Phenol	Ferric chloride test	-
7.	Carbohydrates	Molisch's test	+
8.	Amino acid	Biuret test	-
9.	Cardiac glycoside	Killer Killani test	-
10.	Alkaloid	(a) Dragendroff's test	+
		(b) Mayer's test	+
		(c)Wagner's test	++
		(d) Hager's test	++

+ Slightly present ,++ Moderately present , +++ Highly present , - Absent Methanolic extract of *Vitex negund leaves*

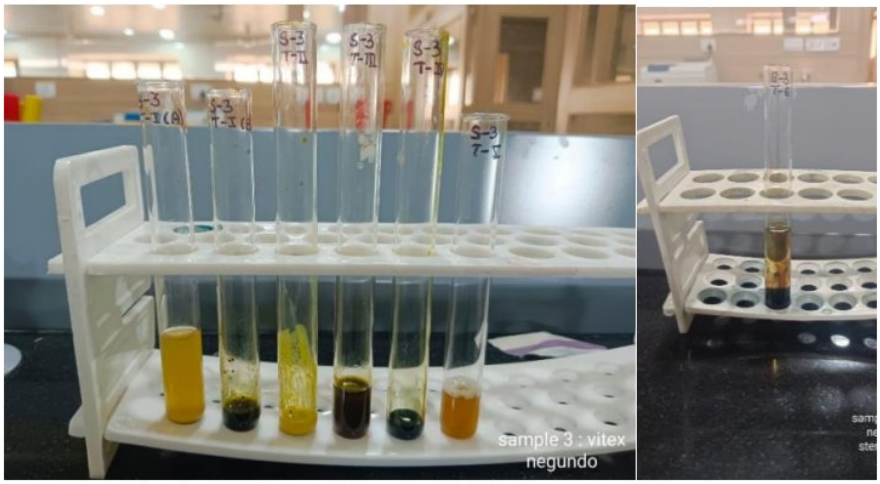

Fig 4 : 1) Flavonoid test: (a)Alkaline test (b)Lead acetate test
2) Terpenoid test: Salkowski test
3) Saponins test: Foam test
4) Steroids test: Libermann- Burchared test
5) Tannins test: Ferric chloride test
6) Phenol test: Ferric chloride test

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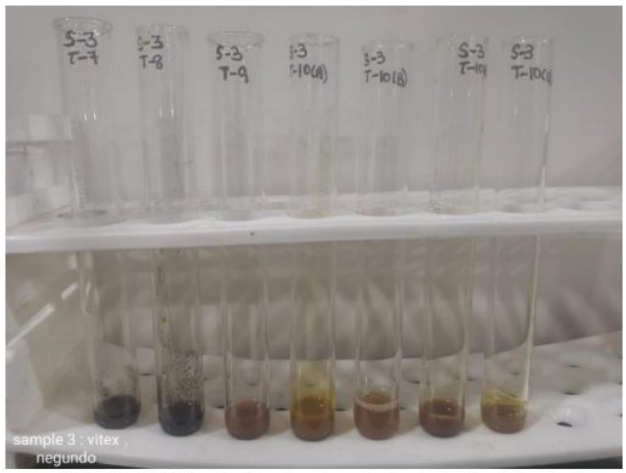

Fig 5 :7) Carbohydrates test: Molisch's test
8) Amino acid test: Biuret test
9) Cardiac glycoside: Killer Killani test
10) Alkaloids test : (a)Dragendroff's test
(b) Mayer's test
(c)Wagner's test
(d)Hager's test

There is a significant amount of alkaloid but no phenol, amino acid, or cardiac glycoside. Additionally, there is a moderate presence of the other phytochemical components.The selection of the solvent is crucial for determining the bioactive components of the plants utilised in the extractions. An ideal extraction solvent should have minimal toxicity, quick evaporation at low temperatures, good target compound solubility, and sufficient volatile matter. Factors influencing the solvent selection include extraction rate, range of chemicals extracted, ease of handling extracts, and cost-effectiveness of both the targeted compounds and extraction solvents. Plants are composed of several bioactive substances that have varying polarities. Various techniques have been developed and implemented to obtain pure compounds and determine their structure and biological activity. *Vitex negundo* has complex leaves that have one at the end and five in opposing pairs. Flavonoids, terpenoids, and alkaloids are among the bioactive substances found in these leaves that give them their therapeutic qualities

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❖ Anti-mitotic Assay result:

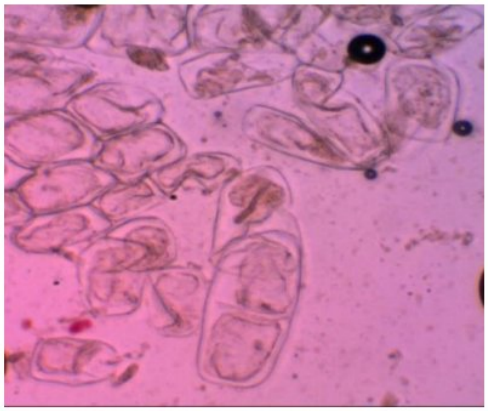

Fig 6: Water medium

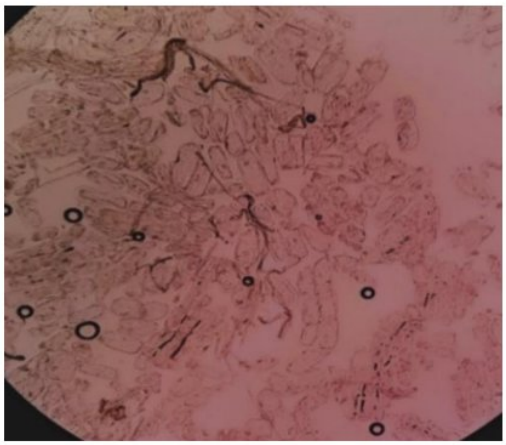

Fig 6: Methotrexate effect on plant cell

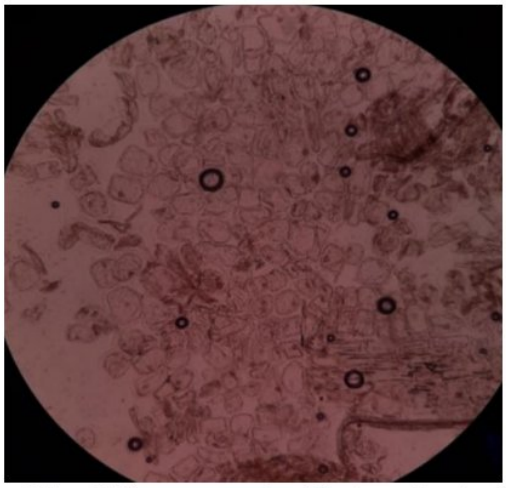

Fig : 7 *Vitex negundo* effect on plant cell

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❖ Table-2: Mitotic index (MI) of the plant:

Sample	Total no of cell	Non dividing cell	Dividing cell	MI%
Water -1	85	6	79	92.94%
Water -2	62	6	56	90.32%
Water -3	70	8	62	88.57%
Methotrexate-1	75	60	15	20.00%
Methotrexate -2	49	37	12	24.75%
Methotrexate -3	53	42	11	20.75%
Vitex negundo -1	85	59	26	30.58%
Vitex negundo -2	76	53	53	30.26%
Vitex negundo -3	79	54	54	31.64%

❖ Graph by Graphpad prism 10.2.1

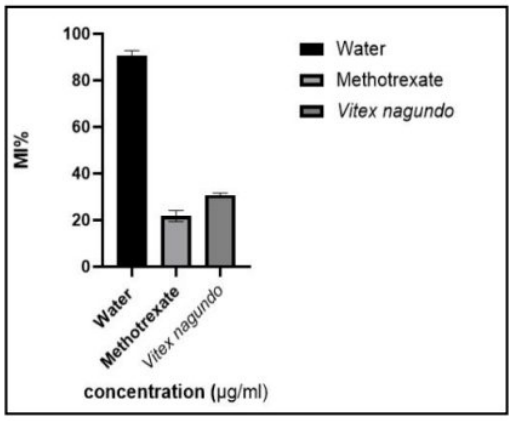

Fig 8 : **Mitotic Index (MI) of *Vitex negundo***

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ANOVA table	SS	DF	MS	F (DFn, DFd)	P value
Treatment (between columns)	8415	2	4207	F (2, 6) = 1173	P<0.0001
Residual (within columns)	21.52	6	3.587		
Total	8436	8			

Plant cells divide and enlarge when there is water present. The size of the nucleus increases because the genetic volume doubles before to division. This will result in a high mitotic index in the root cells grown in the water sample, which means that there will be more dividing cells than non-dividing ones. Next, roots cultivated in a solution of the well-known anti-mitotic drug methotrexate inhibit the division of mung bean roots. As a result, although we can see them under a microscope, cells with larger nuclei have ceased dividing. The mitotic index is relatively low as compared to water. Furthermore, overnight cultivated roots in *Vitex negundo* demonstrate anti-mitotic activity and the capacity to inhibit the proliferation of root cells. Because the Mitotic Index (M.I.) inversely corresponds with drug potency the most effective drug will have a lower index the drug's efficacy is justified.

- **MTT Assay results :**

Fig 9 : (a) 5 µg/ml Concentraion

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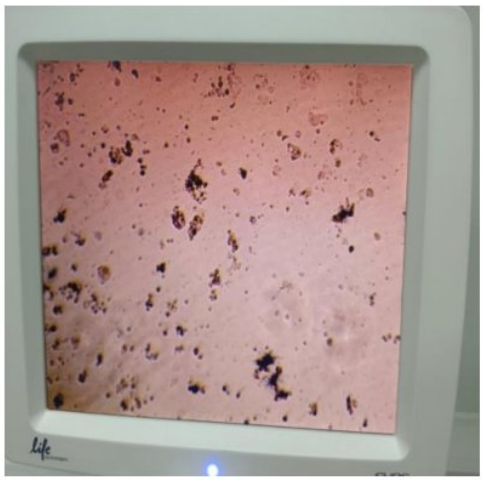

Fig 9 : (b) 10 µg/ml Concentraion

Fig 9 : (c) 25 µg/ml Concentraion

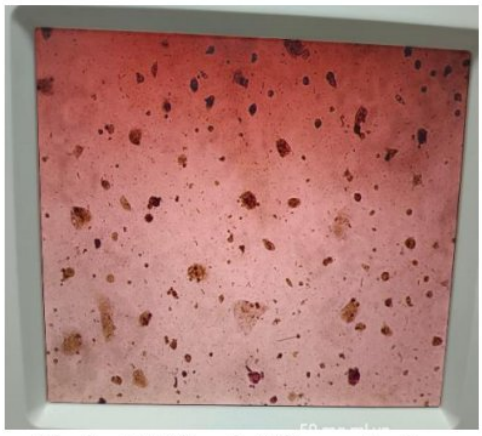

Fig 9 : (d) 50 µg/ml Concentraion

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❖ MTT assay O.D :

Sample	Blank	Control	5µg/ml	10µg/ml	25µg/ml	50µg/ml
VNL-1	1.035	1.238	1.135	1.099	1.091	1.025
VNL-2	1.674	1.236	1.126	1.075	1.085	1.099
VNL-3	1.147	1.245	1.131	1.105	1.065	0.977

% Cytotoxicity = (Control – OD) × 100

❖ Graph by Graphpad prism 10.2.1 :

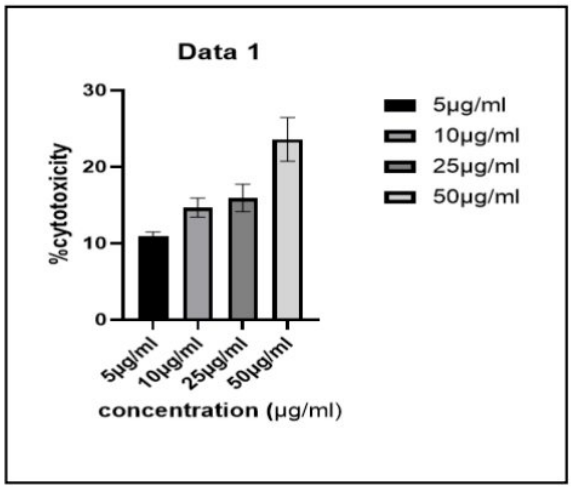

Fig 10: Cytotoxic activity of *Vitex negundo*

ANOVA table	SS	DF	MS	F (DFn, DFd)	P value
Treatment (between columns)	255.7	3	85.25	F (3, 8) = 25.70	P=0.0002
Residual (within columns)	26.53	8	3.317		
Total	282.3	11			

To measure the concentration of living cells, the MTT Assay is used. The mitochondria of the living cells contain enzymes that are dependent on NADP. Purple crystals are formed as a result of the Tetrazolium dye being reduced. At that specific concentration, the drug is less effective, as indicated by the more purple crystals. According to the aforementioned observation, purple crystal concentrations are higher in 5 µg/ml and 10 µg/ml concentrations. However, for this specific plant species, the 25 µg/ml and 50 µg/ml concentrations are significantly more effective. The P≤0.05, so this is an effective drug.

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Instrument used:

Instrument used	Comapny	Model No.
Weighing balance(gm)	Ohaus weighing India Pvt.Ltd	SdX 622/E
Centrifuge	Remi motors	R8C 3/2000
Weighing balance(mg)	Ohaus weighing India Pvt.Ltd	P/523
Microplate reader	Thermo scientific Multiskan FC	Type: 357
Evator rotary evaporator	Equitron	CB 2000V
Laminar air flow hood	ESCO class II BSC	AC2-4E8
Inverted Microscope	EVOS	XL CORE
CO_2 incubator	ESCO	CCL-170B-9
Compound Microscope	Olymeus	CX21Ifs1

Chemical used:

Chemical used	Comapny	Batch number
Methanol	Rankem	R007H22
Copper sulphate	Himedia	0000143100
Ferric chloride	Himedia	0000060095
Mercuric chloride	Pallav	BC/0055/19-2
Lead Acetate	Fisher scientific	6378 6906-1
Acetic Acid Glacial	Rankem	A004H22
Naphthol GR	Lobachemie	53997
Sulphuric Acid	Rankem	S507J22
Dimethyl Sulphoxide	Qualikems Fine Pvt. Ltd.	CL362GC01
DMEM	Himedia	0000467633

Abbreviation:

ANOVA: Analysis of variance, DMSO: Dimethyl sulfoxide, FBS: Foetal bovine serum, MI: Mitotic index, MTT: 3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyl Tetrazolium Bromide, HEK-293: Human Embryonic Kidney cell line, AICAR: aminoimidazole-4-carboxamide ribonucleotide PBS: Phosphate Buffer Saline, WHO: World Health Organization, EDTA: Ethylenediaminetetraaceticacid, VNL: *Vitex negundo* leaves, XTT: methoxynitrosulfophenyl-tetrazolium carboxianilidine,MTS:3-(4,5-dimethylthiazol-2-yl)-5-(3-carboxymethoxyphenyl)-2-(4-sulfophenyl)-2H-tetrazolium, WST: (2-(4-iodophenyl)-3-(4-nitrophenyl)-5-(2,4-disulfo-phenyl)-2H-tetrazolium, monosodium salt).

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A PROJECT REPORT

ON

PRASHANT CASTING PVT LTD.

PREPARED BY:

DEEP BHIMJIBHAI ASODARIYA

ENROLLMENT NO**. 200401005**

PROGRAM – B.COM.

SEMESTER -V

ACADEMIC YEAR: 2022 – 2023

GUIDED BY:

MR. MEHUL CHHANIYALA

SUBMITTED TO:

FACULTY OF BUSINESS & COMMERCE

DEPARTMENT OF COMMERCE

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(Established under the Gujarat Private University Act 11, 2018)

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Certificate

This is to certify that Mr./Ms. Deep bhimjibhai visodariya *with Enrollment No.* 200401005 *of* ***B.COM. SEMESTER 5,*** *has satisfactorily completed his/her Project Report Titled* Prashant Casting Pvt Ltd. *in the course of* ***Project Report and Presentation,*** *Course Code* ***18BCMCC504*** *for the term ending in the month of Sep-Oct, Academic Year 2022-2023.*

Remarks:

29/12/2022	MDC	
Date	***Faculty in Charge***	***Head***

Head of the Department,
Department of Commerce,
Faculty of Business and Commerce,
Atmiya University, Rajkot

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Phone : +91-281-2360421/22
Fax : +91-281-2388899
E-mail : admin@prashantcast.com

Factory :
Gondal Road, Near Hotel Krishna Park,
Vavdi Road, Rajkot - 360 004.

CIN U27310GJ2009PTC056501

TO WHOM IT MAY CONCERN

This is to certify that **Deep Bhimjibhai Asodariya** Student of ATMIYA UNIVERSITY RAJKOT, from department of B.COM. 5th Sem.

He has Attended Training in our organization during 17th August to 27th August 2022 and completed his project.

During the training he was found sincere & hardworking. We wish him bright future in days to come.

PRASHANT CASTECH PVT. LTD.

DIRECTOR
GOVIND B. PARSANA
DIN : 00914313

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DECLARATION

I, the undersigned MR.DEEP BHIMJIBHAI ASODARIYA the student of B.COM SEM-V of department of commerce, Atmiya University, hereby declare that this report is my own work has been carried out under guidance and supervision of **MR.MEHUL CHHANIYALA.**This work has not been previously submitted any other university for any examination.

Date: 29/12/2022

Place: Rajkot

DeepA
(Signature)

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Rajkot

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Rajkot

ACKNOWLEDGEMENT

Any Endeavour cannot lead to success unless and until a proper platform provide for the same. In the same way not be entirely dedicated to any single individual also. No work is truly original the successful competition of any task requires support in thought process or action we borrow from and rely on other the completion of the present project report has been possible due to support and co-operation of my teacher and friend. So many people have helped me to crystallize my project report.

I have anyalsed of PRASHANT CASTING PVT LTD

and preparation of this project has been done with the help of many people. I take this opportunity to express my sincere thanks to **Dr. Piyush Mehta (H.O.D.), MR. MEHUL CHHANIYALA.**And other members of our college staff who helped & guided us in preparation of this project.

I am also very grateful to my family, our seniors and other friends who also helped us in this preparation.

Date:29/12/2022

Place: Rajkot

DeepA

(DEEP ASODARIYA)

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Atmiya University
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Atmiya University
Rajkot

PREFACE

It gives me a great pleasure to write this project report at PRASHANT CASTING PVT LTD.

the project report is prepared mainly to understand and learn the various processes of industry in practical manner.

I have analyzed the PRASHANT CASTECH PVT LTD. This project report covers all those points which are necessary to know the company. From this project report we can get a row idea of the things done in the company.

I hope that this project will receive its generous support and kind arrangements.

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INDEX

No.	Particulars	Page No.
1	Industry Profile	1
2	General Information	6
3	Production Department	11
4	Human Resource Depaetment	20
5	Marketing Department	27
6	Financial Department	32
7	Future Plane	41
8	Suggestion	43
9	Conclusion	45
10	Bibliography	47

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Rajkot

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Rajkot

Industry Profile

Company Profile

Name of company : Prashant

Address of office : 1-umakant

pandit Udhyognagar,

Mavdi plot,

Rajkot-

360004

Telephone no. : (0281)2360421

Website/email id :

www.prashantcasting.com

Year of establishment : 1967

Total factory area : 30000 meters

Size of industry : small scale

industry

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Accounting year : 01/04/2010 to

31/03/2011Name of Director :

Mr.Shambhubhai Parsana Off day in week :

Wednesday

No. of workers : 400

Bankers : HDFC

BankBank of India

History and Development

LOCATION

The location of Prashant casting is an industrial area it is also known as

udhyognager.The location of Prashant casting as under.

Prasant

casting

Umakantpandi

tUdhyognagar

Mavadi plot

Rajkot-

360004

Prashant casting is locate in above address, because of it is an industrial area and thus they caneasily get labour work.

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Organization chart

Prashant casting having line types of organization chart is a graphical presentation of authorrelation. This chart is away to explain entire organization in from of a picture.

Time keeping system

"Time & tide Waite for none" time cannot be wasted as once it's lost its last forever this in mind a unit has to develop an efficient time keeping system. There are various benefits that a firm is able to avail only because of discipline in time management system. To get those benefits that affects the system of time keeping like production capacity, demand for products etc. after studding all these factor studding all these factor time schedule are adjusted.

Time keeping system is important for the businessmen and employers. This system can also be used to improve employee relation.

PRASHANT CASTING PVT. LTD. Has separate time keeping system, which are given below:

Shift : 2 Shift

Worker time : 08:30AM to 12:30PM

&01:3PM to 05:30PM

Brake time : 12:30PM to 01:30PM

Staff time : 08:30AM to12:30PM

&01:30PM to 05:30PM

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BANKER

Bank is one person or rather than institute that he kept all financial transaction, like investment, withdrawn etc. through the stsment of finance. Prashant casting pvt. Ltd. Hardly task borrowmoney from the bank.

PRASHANT CASTING PVT.LTD. Have two banks that are as under

1. HDFC Bank
2. Bank of India

MANAGING GROUP

Managing director : Mr. Shambhubhai Parsana
Financial management : Mr. Govindbhai Parsana
Quality control : Mr. Narotambhai Parsana
Marketing management : Mr. Prasantbhai Parsana
Human resource management : Mr. Nayan Patel

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Rajkot

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Rajkot

GENERAL INFORMATION INDEX

NO.	SECTION	PG.NO
1.	INTRODUCTION	7
2.	ORGANIZATION STRUCTURE	7
3.	PRODUCTION OF THE COMPANY	8
4.	RAW MATIRIYAL USED IN PROCESS	9

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General Information

PRODUCTION DEPARTMENT

Introduction

"production is an organized activity of covering raw materials into final products" every process of converting raw material into final goods is knows as production process.

It is the basic activity of all industrial unit. The step by step conversions of one form of material into another for the satisfaction of human needs.

Production is an activity through which the form utility is either created or enhances. Prashant casting are engaged in manufacturing of electric motor body and its cover the output of this factor is not consumer good but producer's goods. Production management is well defined in prashant casting. Every stage of production is well planned. There is a supervisior for every production process. Production management is very efficient.

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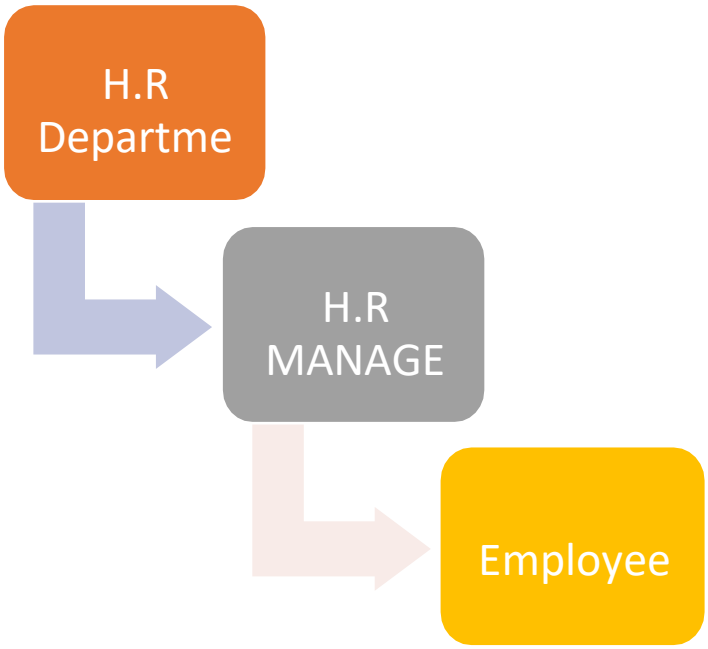
Organization structure



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Production of the company

also large. PRASHANT CASTING doing the produce thing which is made and producein the CI CASTING.

Prashant casting Pvt. Ltd. Produced following items

- Motor bod PRASHANT CASTING PVT. LTD. Is a big company so , itsproduction and marketing mix
- CNC machine tools
- Conventional machine tools
- Gear box
- Wheels and pulleys
- Casting for stator housing
- Casting for end shields

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- Bearing cover
- Fan cover
- Pump parts
- Small pump parts
- Submersible pump parts

Raw material used in process

Raw material plays a key role in the quality of the product . Without raw material, production process cannot be started. if the raw material used is of low standard, than thequality of the product will also less. As such more weight must be put on the quality of the raw material.

The total cost of production involves cost of raw materials , so it should be carefully purchased

.

PRASHANT CASTING PVT. LTD. Is manufacturing of CI CASTING and production of motorbody? So, the productions have to need below raw material and machinery:

- Oil
- Iron scrap
- Pig iron
- Coal
- Silicate
- Lime stone
- Gargi shots
- Wood
- M- seal
- Miracle thinner

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Rajkot

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Rajkot

PRODUCTION INFORMATION INDEX

NO.	SECTION	PG.NO
1.	MANUFACTURING	12
2.	SYSTEM OF MOUNDING	13
3.	FITTING	14
4.	POURIN	15
5.	ROUGH CHAPPING	16

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Manufacturing process

onProduction process can be defined as the chain or various small and big process which convertvarious inputs into desires output.

There are basic three types of production which can be easily indentify and which affect the complexity of the require control system.

- Flow production
- Unit production

PRASHANT CASTING PVT. LTD. Adopted system of flow production

System of

moundingGreen

sand system No

back system

Malaises system

Molding

Fitting

Making of casting materials

Pouring

Cleaning

Shot blasting machine

Finishing

System of mounding

There are three types of system of mounding.

- Green send system
- No back system
- Molasses system

Green sand system

In this system sand is mixturised with water.

No back system

In this system sand is mixturised with oil.

Molasses system

In this system is mixtuered with molasses.

Prashant casting Pvt. Ltd. Has adopted the no bask system.

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Moulding

There are two of core for molding.

- Side core
- Center core

For the both of the core different type of moulding process is taken because there depend on strongly needed.

Fitting

After the making of side core and center core. It taken for hardness checking.

Then center core is surrounding by the side core on the platform and thenis it clamped hardly by an iron frame and joints of the side core are iapplies with clay and at bottom side a layer is made sueeounding the side core to not leak the lava (iron liquid).

Marketing of casting material

Iron , pig iron lime stone and coal are used as a casting material. After cheaking of the material required carbon and silicon are added . in this material carbon should 3 to 3.40% and hardness have to be 8 to 200 BHS. The temperature should 1420C and above.

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To check and maintain these values the cup of the lava is taken at every two hours.

That cup having and sensor. it is kept on the director. so, all values are displayed on the LED display.

Pourin

After making lava from the casting material. it is being poured in the mould or die, for this process the temperature should above the 1420C than it is kept as it is for down the temperature.

Next day it is known out means frame is released and the side core and center core arebroken the frame .

The remaining part is the motor body from that the runner raiser and air ring.

Cleaning

The clay of the core is sticked on the body after releasing from the core . so, it is takesinto shot blasting machine.

Shot blasting machine

First the motor body is kept on the wheel then it is putted in the machine. In that the shots are fired on the motor body. The wheel is continuously rotating when the shotsare being fired.

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Finishing

After cleaning process the last process come called finishing . in this process extra unnecessary material on the motor body is kept out and surface is soomthed.

In this process there are three parts of processing as it is taken one by one they are :

- Rough chapping
- Final chapping

Rough chapping

In this process the useless part is caring out by hummer & scraper.

Grinding

This process is dividing again in two types:

- Stone grinding
- Disk grinding

Stone grinding

In this the rough surface is smoothed by the stone grinding.

Store keeping

Prashant casting Pvt. Ltd. Applied the facility of the decentralization in storage managementfor the convince of workers to handle the raw materials. It is divided in three parts.

- Storage of raw materials
- Storage of finished goods
- Storage of consumable goods

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HUMAN RESOURCE

TAGLINE IS HERE

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HUMAN RESOURCE INFORMATION INDEX

NO.	SECTION	PG.NO
1.	INTRODUCTION TO HRD DEPARTMENT	19
2.	SWOT ANALYSIS	20
3.	RECRUIMENT AND SELECTION	21
4.	PROCESS OF SELECTION	22
5.	EMPLOYES BENEFITS	23
6.	DEVLOPMENT	23

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Analysis of Selected Topic

HUMAN RESOURCE DEPARTMENT INFOMATION

Introduction

"Human resource department is concern with the obtaining & maintain of satisfaction and forces."

In PRASHANT CASTING PVT. LTD. Human resource department is done through department handal by HR manager. The Human resource department is not only maintaining is manpower but also it arranges the scope of job for the candidates.

For a currant manpower of Human resource department is look after , control them and also manage them. For people candidates it arranges activities like , interview , requirement , selection , induction etc.

SWOT ANALYSIS

S.w.o.t.analysis means the analysis

S – Strength

W – Weakness

O –Opportunity

T – Threat

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Strength

- Cost of effectiveness & large market share.
- Does not depend on other industrial for raw material.

Weakness

- Lack of professionalization in mgt.
- Less no. employs for management
- Misusing of company's policy by the customer
- Excessive government control
- Centralize discussion making
- Luck of advertisement

Opportunities

Rapidly and continues growth in the market, so company will think about expansion.

Threat

Highly competitive market against local or Indian market.

Increasing competition from private sector due to liberalization policies of

governmentThe long term financial requirement is not sufficient by the company

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Recruitment and selection

Recruitment

Recruitment is a process of to discover the sources of manpower to meet the recruitmentof the staffing schedule and to emplyoes affective measures for attracting that manpower that manpower in adequate to facilitate selection of efficient personnel.

Definition

“recruitment is process of searching for prospective employees and stimulating them toapply for jobs.”

Sources of recruitment

There are main two sources of recruitment

Internal

- Promotion
- Transfer
- The ex-employees
- The relative of employees
- Other

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External

- Application
- School / college
- Labor union
- Contractor
- Advertisement

Selection

"Selection means select the candidate who has right qualification , right ability andsuitable for job , post and place in to comes the requirement application. "

Process of selection

PRASHANT CASTING PVT. LTD.Follows process adopted for selection right candidates.

- Reception of application
- Application blank
- Employment test
- Interview
- Reference check
- Medical check
- Final interview

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Training and development

Training

Every organization needs to have well trained and experienced people to perform theactivity that have to be done. If the current potential job occupant can meet this requirement is not important . Training a sequence of programmed behaviors.

In PRASHANT CASTING PVT. LTD., training programs are arranged to improve the efficiency of workers. In this unit on job training is giving to its employees. Duration of training dependsupon the post and ability of workers learning.

Development

Development is all those activities such as panning , staffing , directing , co – ordination etc. should be change and select accounting to requiredof business , as business develop to increase executive or manager particular for future management assignment.

The scope of training and development progress should elderly be defined. The plan should elderly be defined. The plan should be define the implementation of plan.it should be related to needs or requirement and objectives at the organization . The managementfor training and development program implementation.

Here, in PRASHANT PVT. LTD. Manager tries to develop their and all of organization's management. Different methods are applying for that.

Employees Benefits

"Employees and workers and main assets of an organization"

PRASHANT CASTING PVT. LTD. Many facilities to motivate the employee. They provide following facilities to the employee.

- Medical facilities
- Safety equipment
- Provident fund
- House loan

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Rajkot

MARKETING INFORMATION INDEX

NO.	SECTION	PG.NO.
1.	INTRODUCTION TO MARKETING DEPARTMENT	26
2.	CHANNEL OF DISTRIBUTION	27
3.	TRANSPORTATION	28
4.	COMMETITORS	28

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Findings

MARKETING DEPARTMENT

Introduction

“Marketing is process.’’

Marketing is nothing but try to people make aware our product. Marketing plays critical role insuccess business.

Marketing is a social managerial process by which individual & groups obtain what they needwhat through offering & exchanging product of value with others.

The process of management is commonly understood now as the set of task know as analysis,planning, implemenatation and control of programs for achieving organizational goals.

Market segmentation

The process of market segmentation can be carried out on the basic of geographical area, age,sex,religion, lifestyle, income, personality etc.

PRASHANT CASTING PVT. LTD. Arranges market segmentation to considering requirement. Theyalways consider customer’s choice because market segmentation is depands upon customers order.

Market segmentation in “PRASHANT CASTING PVT. LTD.” Is done on the of geographical area.

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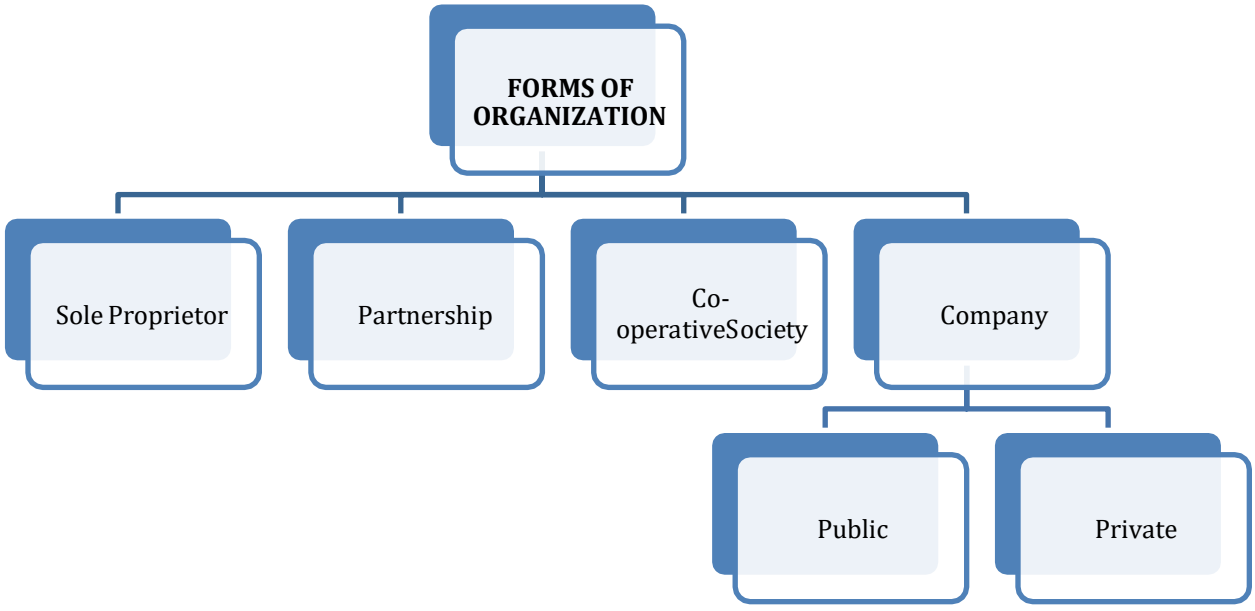
Channel of distribution

Marketing channel decisions affect all the other decision of the marketing.

Duponthepe of number, type and function of intermediaries type of distribution channel are canbe made. Distribution channel useful for transfer of goods. Various factors influencing chaise of distribution channel area:



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Transportation

Transportation means to send the goods or service from one place to another place through typeof transport service for business purpose.

In PRASHANT CASTING PVT. LTD. The casting is transported in national market by truckand train and if the transportation is international market than they use ships and airplane.

Competitors

In the market have many competitors sales same product but many products have very quality at competitive rate good market value. Competitors is facing several competitors from some part countrywhatever is done by the competitors. Still the company's product remains as the market leader only because the quality assurance reliability and trust on which the firm always street. Some of computable competitors are as under.

- Shining co. Pvt. Ltd. (Bangalore)
- Marvelous co. Pvt. Ltd. (Nasik)
- Jay cast Pvt. Ltd.
- Satyam casting Pvt. Ltd.

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Rajkot

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Rajkot

FINANCE DEPARTMENT INDEX

NO.	SECTION	PG.NO
1.	INTRODUCTION	31
2.	FINANCYAL PLANNING	32
3.	MANAGEMENT OF WORKING CAPITAL	33
4.	SOURCE OF FINANCE	34

Registrar
Atmiya University
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FINANCE DEPARTMENT

Introduction

Financeis considered as life-blood of a business. All the function of management like personnel, production and marketing require finance for their implementation. All business activities start and with finance. This is the management of money. Therefore, management of finance is crucialfor the better business performance. Financial management concerns with planning, raising and utilizing funds effectively.

“Finances an area of financial decision making harmony individual motives & enterprise goal.”

Financial function is task of producing funds needed by the enterprise in terms that are most favorable to its objective; finance is concerned with everything that place in the content of business.

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Financial planning

There are two type of financial planning:

1. Long term financial planning
2. Short term financial planning

In PRASHANT CASTING PVT. LTD. Large amount of capital is required for various purposes. They have to task decision regarding utilization money in respect of transaction such as for the purpose of purchasing raw martial, ready-mades part and to earn money by selling various kinds of product.

- Objective of the company
- Nature, size of the company
- Amount of risk method
- Status of industrial unit
- Alternative source of finance
- Capital structure
- Attitude of management

Management of working capital

"Working capital management has crucial role for both producing and selling product. A firmmust ensure adequate working capital to meet routine express management of receivable, management of inventory and profit management."

Working capital = current assets = current liabilities

- Working capital mgt. is concerned with the mgt. of the current assets. It is animportant part offinancial mgt. as short term survival prerequisite to long term

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Sources of finance

The PRASHANT CASTING PVT, LTD. Has different of sources are available finance.

Internal sourcesExternal sources

Owner capital	Share
Plunging back of profit	Debenture
Public deposit	Loan

Financial institution

- PRASHANT CASTING PVT. LTD. Uses the owner capital. They are hardly taken loan or use of external sources like and other sources as it is never requirePRASHANT CASTING PVT. LTD. Doing all process of his business by own capital.

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PRASHANT CASTING PVT LTD.

Balance Sheet

From 01/04/2018 To 31/03/2019

Liability Particulars		Asset Particulars	
Capital Account		**Fixed Assets**	
6,90,709.45	SAMBHUBHAI PARSANA	40,469.00	AIRCONDITIONER A/C.
13,08,508.37	GOVINDBHAI PARSANA	1,787.30	ELECTRIC FAN A/C
19,99,217.82		52,77,236.00	MACHINERY A/C.
		53,19,492.30	
Loans (Liability)			
50,00,638.50	BOB MACHI.LOAN A/C-03610600010876	**Deposits (Asset)**	
		50,000.00	NATHVANI KAMLESHBHAI
50,00,638.50		**50,000.00**	
Sundry Creditors		**Duties & Taxes**	
29,181.00	A-VISION PRINT	85,744.42	Central Tax A/c. (I/P)
95,956.00	ARPIT ENTERPRISE	9,03,310.00	Integrated Tax A/c. (I/P)
12,130.00	DEEP TRADERS	85,744.42	State/UT Tax A/c. (I/P)
17,016.00	JET INDUSTRIES	**10,74,798.84**	
56,000.00	PAL AGENCIES		
6,303.00	SHREE INDU AGENCIES	**Sundry Debtors**	
2,867.00	SRINIVAS PAPERS	8,019.00	JAY OFFSET
30,961.00	VIJAY SALES AGENCY	30,458.00	JENISHA PACKAGING
29,384.00	ZENITH RUBBER PVT.LTD.	35,034.00	JP DESIGN POINT
2,79,798.00		10,080.00	R K ENTERPRISE
		20,423.00	RAVI PACKAGING
		41,720.00	SHREE RAM PACKAGING
		2,016.00	UNIQUE PACKAGING
		1,47,750.00	
		Bank Accounts	
		25,258.58	HDFC BANK A/C-50200034065102
		25,258.59	
		Cash-in-hand	
		4,76,754.59	Cash Account
		4,76,754.59	
		Stock-in-hand	
		1,85,600.00	Stock In Hand
		1,85,600.00	
72,79,654.32		**72,79,654.32**	

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PRASHANT CASTING PVT LTD

Balance Sheet

From 01/04/2019 To 31/03/2020

Liability Particulars		Asset Particulars	
Capital Account		**Fixed Assets**	
15,70,856.49	SANBHUBHAI PARSANA	50,309.01	A.C A/C.
		34,399.00	AIRCONDITIONER A/C.
4,04,613.78	GOVINDBHAI PARSANA	4,220.43	ELECTRIC FAN A/C
2,70,856.49	KEYURBHAI PRAFULBHAI CHANGANI	44,85,651.00	MACHINERY A/C.
		3,533.83	PRINTER A/C.
22,46,326.76		**45,78,113.27**	
Loans (Liability)		**Deposits (Asset)**	
43,35,535.84	BOB MACHI.LOAN A/C-03610600010876	50,000.00	NATHVANI KAMLESHBHAI
43,35,535.84		**50,000.00**	
		Duties & Taxes	
Sundry Creditors		1,35,987.79	Central Tax A/c. (I/P)
8,254.00	A-VISION PRINT	7,30,952.18	Integrated Tax A/c. (I/P)
1,038.00	ACTIVE PRE-PRESS	1,35,987.79	State/UT Tax A/c. (I/P)
79,045.00	ARPIT ENTERPRISE	**10,02,927.76**	
50,062.00	DEEP TRADERS		
25,030.00	JAY ENTERPRISE	**Provisions**	
17,016.00	JET INDUSTRIES	2,666.00	TDS FOR THE YEAR-2019-20
56,000.00	PAL AGENCIES	**2,666.00**	
4,726.00	PARAGON PAPER CORPORATION		
18,172.00	PARAS GRAPHIC	**Sundry Debtors**	
21,518.00	RADHE LAMINATION	52,750.00	ALCRONA ICON CORPORATION
4,482.00	SATYAM CORPORATION	8,977.00	ANANAT BOX FACTORY UDYOGNAGAR
1,23,159.00	SHREE INDU AGENCIES	5,824.00	DHARA ART
2,820.00	SRINIVAS PAPERS PVT.LTD.	44,155.00	JALARAM OFFSET
33,267.00	T.R.C EXPORTS (P) LTD.	18,742.00	JENISHA PACKAGING
42,646.00	ZENITH RUBBER PVT.LTD.	1,49,779.00	JP DESIGN & PACKAGING
4,87,235.00		4,032.00	KAILASH DHARA PACKAGING
		18,970.00	OM BHAGVATI LAMINATION (METODA)
		5,343.00	R K ENTERPRISE
		25,861.00	RAVI PACKAGING
		2,016.00	ROYAL INDUSTRIES
		23,419.00	SHAAN PACHAGING
		13,664.00	SHREE RAM PACKAGING
		11,222.00	UNIQUE PACKAGING
		4,927.00	V K STEEL BALL
		13,278.00	VIRAT PRINTER
		4,02,959.00	
		Bank Accounts (Banks)	
		20,834.35	HDFC BANK A/C-50200034065102
		20,834.35	
		Cash-in-hand	
		6,90,747.22	Cash Account
		6,90,747.22	

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PRASHANT CASTING PVT LTD

Balance Sheet

From 01/04/2019 To 31/03/2020

Liability Particulars		Asset Particulars	
		Stock-in-hand	
		3,20,850.00	Stock In Hand
		3,20,850.00	
70,69,097.60		**70,69,097.60**	

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PRASHANT CASTING PVT LTD.

Balance Sheet

From 01/04/2020 To 31/03/2021

Liability Particulars		Asset Particulars	
Capital Account		**Fixed Assets**	
17,35,981.97	SHAMBHUBHAI PARASANA	72,002.00	AIRCONDITIONER A/C.
		39,283.00	CCTV CAMERA EXP.
5,12,030.76	GOVINDBHAI PARASANA	27,696.00	COMPUTER A/C.
3,81,981.97	KEYURBHAI PRAFULBHAI CHANGANI	3,587.00	ELECTRIC FAN A/C
		32,34,138.00	MACHINERY A/C.
26,29,994.70		20,381.00	MOBILE INSTUMENT EXP.
		33,97,087.00	
Loans (Liability)			
10,07,253.00	BOB A/C-0361030000536	**Deposits (Asset)**	
8,70,000.00	BOB LOAN A/C-03610600011272	10,07,253.00	BOB FD A/C-03610300046324
		50,000.00	NATHVANI KAMLESHBHAI
27,68,191.24	BOB MACHI.LOAN A/C-03610600010876	**10,57,253.00**	
46,45,444.24		**Duties & Taxes**	
		2,36,517.21	Central Tax A/c. (I/P)
Sundry Creditors		2,53,126.14	Integrated Tax A/c. (I/P)
6,230.00	A-VISION GRAPHICS PROCESS	2,36,517.21	State/UT Tax A/c. (I/P)
25,801.00	A-VISION PRINT	**7,26,160.56**	
19,150.00	BIG FLY ENTERPRISE		
50,112.00	CONTACT ELECTROTECH PVT. LTD	**Provisions**	
		2,666.00	TDS FOR THE YEAR-2019-20
19,071.46	DEEP TRADERS	2,209.00	TDS FOR THE YEAR-2020-21
32,889.46	PARAS GRAPHIC	**4,875.00**	
1,32,312.97	SHREE INDU AGENCIES		
31,462.00	SURDHAN PRINT	**Sundry Debtors**	
14,048.00	VIJAY SALES AGENCY	1,12,000.00	AKSHAR CONTRUCTION
3,31,076.89		27,750.00	ALCRONA ICON CORPORATION
		11,255.00	ANANAT BOX FACTORY UDYOGNAGAR
		1,05,000.00	BALAJI WASTE PAPER SUPPLER
		54,440.00	DHARA ART
		2,124.00	INSTA PRINT PACK PRIVATE LIMITED
		47,200.00	J B INDUSTRIES
		9,251.00	JALARAM OFFSET
		2,006.00	JENISHA PACKAGING
		56,915.00	JP DESIGN & PACKAGING
		10,443.00	KAILASH DHARA PACKAGING
		62,304.00	MAYUR PRINTING
		5,244.00	OM BHAGVATI LAMINATION (METODA)
		20,593.00	PARTH GRAPHICS
		2,79,989.00	RADHE LAMINATION
		1,18,000.00	RAM ENTERPRISE
		10,266.00	RAVI BOX
		33,239.00	RAVI PACKAGING
		9,676.00	ROYAL INDUSTRIES
		17,758.00	SHAAN PACHAGING
		1,13,254.00	SHREE RAM PACKAGING
		19,462.00	SHYAM PACKAGING & OFFSET

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PRASHANT CASTING PVT LTD

Balance Sheet

From 01/04/2020 To 31/03/2021

Liability Particulars		Asset Particulars	
		19,854.00	VIRAT PRINTER
		14,31,023.00	
			Bank Accounts (Banks)
		19,172.05	BANK OF BARODA A/C-03610200000900
		19,172.05	
			Cash-in-hand
		7,66,309.22	Cash Account
		7,66,309.22	
			Stock-in-hand
		2,04,636.00	Stock In Hand
		2,04,636.00	
76,06,515.83		**76,06,515.83**	

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FUTURE PLAN

PRASHANT CASTING PVT. LTD. Is to increase capital investment, increases product range,develop high quality product, to increase profit, to increase customer base.

Here, they are planning to put pollution control machine & automation other plans are as follows:

- Expansion of many branch like, PRASHANT FEREX, PRASHANT CASTECH
- Minimizing rejection development machinery.
- To increase production.
- To increase the productivity.Export the product to more & more.

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Suggestions

I would like to suggest the following point to the partners of prashant casting:

- They should handle their raw-materials properly.
- They should emphasize more on the research and development for better qualitypredication.
- The export market should be extended to various countries.
- They export market should be extended to various countries.
- They should givenopportunities to qualified employees to use their knowledge and skill.

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Conclusion

* Today, in this completive are due to the industrial policy of Indian government of liberalization, privatelization and globalization, industrial have got a wider scope for expanding their business aroundthe leasing in production casting product.

* The financial position of the firm is very strong and can get finance easily if required. They have smooth relation with customer and workers. The firm is very efficient and capable ofcontribution themaximum development of India

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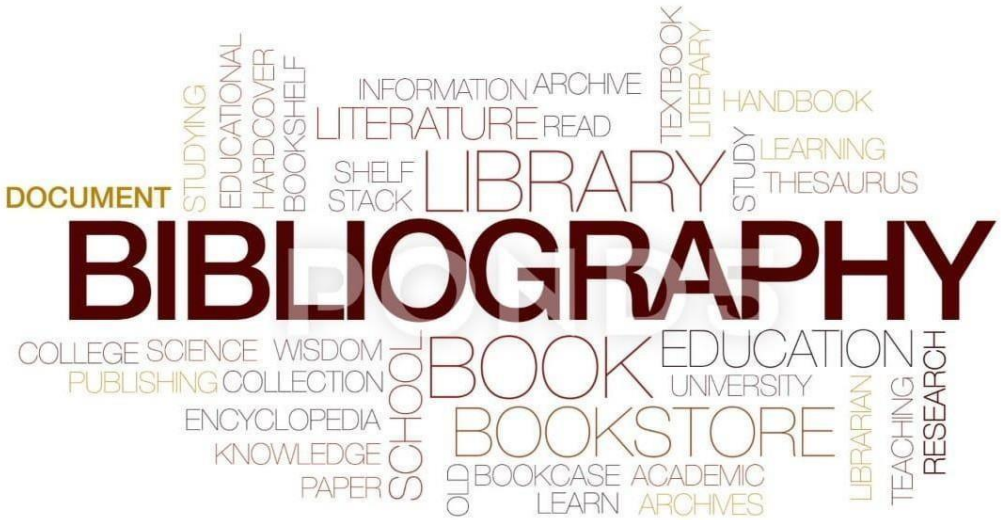

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I have completed this project report from the following:

- Company literatures and brochures.
- By company website.

Company website

www.prashantcasting.co.in

Nameauthor

1. Business organization & mgt. M.C. Shukla
2. Principal & practice of mgt. B.S. Shah

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Yogidham Gurukul, Kalawad Road, Rajkot - 360005, Gujarat (INDIA)

Project Report

On

"ONLINE GROCERY SHOPPING"

Under subject of

MAJOR PROJECT

B.Tech, Semester – VIII

(Department of Information Technology)

Submitted by:

1.	Het Suhagiya	190004040
2.	Naitik Shah	190004036
3.	Yashrajsinh Zala	190004048

Hiren Bhatt

(Faculty Guide)

Prof. Darshan Jani

(Head of the Department)

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Atmiya University
Rajkot

Academic Year

(2022-23)

CANDIDATE'S DECLARATION

We hereby declare that the work presented in this project entitled "**Online Grocery Shopping Application"** submitted towards completion of project in 8th **Semester** of B. Tech. (Information Technology) is an authentic record of our original work carried out under the guidance of "**Prof. Hiren Bhatt".**

We have not submitted the matter embodied in this project for the award of any other degree.

Semester: 8th

Place: Atmiya University, Rajkot

Signature:

Het Suhagiya(190004040)

Naitik Shah(190004036)

Yashrajsinh Zala(190004048)

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Yogidham Gurukul, Kalawad Road, Rajkot - 360005, Gujarat (INDIA)

CERTIFICATE

Date: 5/04/2023

This is to certify that the "**Online Grocery Shopping Application**" has been carried out by **Naitik Shah** under my guidance in fulfillment of the subject Major Project in Information Technology (8th Semester) of Atmiya University, Rajkot during the academic year 2022-23.

Prof. Hiren Bhatt

(Project Guide)

Prof. Darshan Jani

Head of Department
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Yogidham Gurukul, Kalawad Road, Rajkot - 360005, Gujarat (INDIA)

CERTIFICATE

Date:5/04/2023

This is to certify that the "**Online Grocery Shopping Application**" has been carried out by **Het Suhagiya** under my guidance in fulfillment of the subject Major Project in Information Technology (8th Semester) of Atmiya University, Rajkot during the academic year 2022-23.

Prof. Hiren Bhatt

(Project Guide)

Prof. Darshan Jani

(Head of the Department)

Head of Department
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CERTIFICATE

Date:5/04/2023

This is to certify that the "**Online Grocery Shopping Application**" has been carried out by **Yashrajsinh Zala** under my guidance in fulfillment of the subject Major Project in Information Technology (8th Semester) of Atmiya University, Rajkot during the academic year 2022-23.

Prof. Hiren Bhatt

(Project Guide)

Prof. Darshan Jani

Head of Department
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ACKNOWLEDGEMENT

We have taken many efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. We would like to extend our sincere thanks to all of them.

We are highly indebted to **Prof. Hiren Bhatt** for their guidance and constant supervision as well as for providing necessary information regarding the Major Project titled **"Online Grocery Shopping Application".** We would like to express our gratitude towards staff members of Information Technology Department, Atmiya University for their kind co-operation and encouragement which helped us in completion of this project.

We even thank and appreciate to our colleague in developing the project and people who have willingly helped us out with their abilities.

Naitik Shah (190004036)
Het Suhagiya (190004040)
Yashrajsinh Zala (190004048)

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ABSTRACT

The “Online Grocery Shopping System” has been developed to override the problems prevailing in the practicing manual system. This software is supported to eliminate and in some cases reduce the hardships faced by this existing system. Moreover, this system is designed for the particular need of the company to carry out operations in a smooth and effective manner. It also provides error message while entering invalid data. No formal knowledge is needed to use this application. There is no confinement for placing and receiving orders, since the order can be placed online. The delivery of the placed order is received at your doorstep. Database includes Customers who can order any grocery item from their nearby grocery stores on the basis of their current location; from different food categories and staff will process the orders and deliver the requested order, and asking the customers for the reviews or feedbacks.

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INDEX

Sr. No.	TITLES			Page No.
	Acknowledgement			**1**
	Abstract			**2**
	List of Figures			**9**
	List of Tables			**10**
1.	**Introduction**			**11**
	1.1	Purpose		11
	1.2	Scope		11
	1.3	Technology and tool		12
2.	**Project Management**			**13**
	2.1	Project Planning		13
	2.2	Project Scheduling		13
	2.3	Risk Management		13
		2.3.1	Risk Identification	14
		2.3.2	Risk Analysis	15
3.	**System Requirements Study**			**17**
	3.1	Hardware and Software Requirements		17
		3.1.1	Server side hardware requirement	17
		3.1.2	Software requirement	17
		3.1.3	Client Side requirement	17
	3.2	Constraints		18
		3.2.1	Hardware Limitation	18
		3.2.2	Reliability requirements	18
4.	**System Analysis**			**19**
	4.1	Study of Current System		19
	4.2	Problem and Weaknesses of Current System		19
	4.3	Requirements of New System		20
		4.3.1	User Requirements	20
		4.3.2	System Requirements	20
	4.4	Feasibility Study		21

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	4.5	Selection Of Hardware and Software and Justification		21
5	**System Design**			**22**
	5.1	Input /output interface		24
	5.2	Interface Design		24
		5.2.1	Use Case Diagram	25
		5.2.2	Data Flow Diagram	26
6	**Code Implementation**			**28**
	6.1	Implementation Environment		28
	6.2	Program/Module Specification		28
	6.3	Coding Standards		28
7	**Testing**			**29**
	7.1	Testing Strategy		29
	7.2	Testing Method		29
		7.2.1	Unit Testing	29
		7.2.2	Integration Testing	29
		7.2.3	Validation Testing	29
8	**Limitations and Future Enhancement**			**30**
	8.1	Limitations		30
	8.2	Future Enhancement		30
9	**Conclusion**			**31**
10	**References**			32

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LIST OF FIGURES

Figure No.	Table Title	Page No.
5.1.1	Login / Registration Activity	22
5.1.2	Main Activity	23
5.1.3	Order Activity	24
5.2.1	Use case Diagram	25
5.2.2.1	Context Level DFD	26
5.2.2.2	First Level DFD	27

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LIST OF TABLES

Table No.	Table Title	Page No.
3.1.1.1	Server side Hardware Requirements	17
3.1.2.1	Software Requirements	17
3.1.3.1	Client side Requirements	17

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CHAPTER – 1

INTRODUCTION

1.1 Purpose

The purpose of the Online Grocery Shopping System is to automate the existing manual system by the help of computerized equipments and full-fledged computer software, fulfilling their requirements, so that their valuable data/information can be stored for a longer period with easy accessing and manipulation of the same. The required software and hardware are easily available and easy to work with. The main objective is to learn and implement a real-time application on database. It manages all the information about Grocery, Address, Product. Purpose of making the project is to build an application program to reduce the manual work. It tracks all the the details about the orders, products, etc.

1.2 Scope

It may help collecting perfect management in details. In a very short time, the collection will be obvious, simple and sensible. It will help a person to know the management of passed year perfectly and vividly. It also helps in current all works relative to Online Grocery Ordering System. It will be also reduced the cost of collecting the management & collection procedure will go on smoothly.

Our project aims at Business process automation, i.e. we have tried to computerize various processes of Online Grocery Ordering System.

- In computer system the person has to fill the various forms & number of copies of the forms can be easily generated at a time.
- In computer system, it is not necessary to create the manifest but we can directly print it, which saves our time.
- To assist the staff in capturing the effort spent on their respective working areas.
- To utilize resources in an efficient manner by increasing their productivity through automation.
- The system generates types of information that can be used for various purposes.
- It satisfy the user requirement

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- Be easy to understand by the user and operator
- Be easy to operate
- Have a good user interface
- Be expandable
- Delivered on schedule within the budget.

1.3 Technology and tools:

1.3.1 Flutter

This application This application is built on Flutter technology. Flutter offers several advantages because it is a Google product. The following is a quick overview of flutter. The app development process is revolutionized by Flutter. You can design, test, and publish stunning mobile, web, desktop, and embedded apps by writing onetime code. Google built Flutter as an open-source project. It's used to make hybrid apps for Android, iOS, Linux, macOS, Windows, Google Fuchsia, and the web from a single codebase.

You can develop and iterate quickly using Hot Reload. You'll observe changes very immediately after updating the code, with no loss of state. Maintain every pixel to create unique, responsive designs that look and feel great on every device.

Every component in flutter is referred to as a widget. It is entirely widget based. Stateless or stateful widgets are available. There are several states in a stateful widget, not just one. They have the ability to modify their state in response to user interest. A Stateless widget, on the other hand, is a static widget that is utilized for static data or functionality. It is devoid of any state. We need to utilize it in some circumstances because we work with static data.

Flutter is an open-source project, anybody may use and contribute to it at any level. Flutter code is written in Dart, which has many cryptos and encrypts libraries that employ various cryptographic hashing and encryption techniques.

1.3.2 Android

Android is a multitasking mobile operating system that runs on smartphones, tablets, readers, televisions, and even domestic robots. Android is a very adaptive and engaging system, and a basic acquaintance takes less than an hour. Because there are so many essential programs accessible, any customer may easily configure OS settings. You can modify everything past recognition: if you don't like the look, symbols, or ringtone, simply go to the Google Play Store, download a significant program, and quickly customize everything to your desire.

1.3.3 Dart

Dart is a client-oriented programming language that enables rapid app development across all platforms. Its primary goal is to create one of the most productive languages on a variety of platforms. Both the server and the user will benefit from it. The Dart SDK includes the Dart VM compiler as well as the dart2js tool, which generates the JavaScript version of a Dart Script so that it may be executed on sites that don't support it. It is a very similar object-oriented programming language to C++.

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Dart is a popular programming language for creating single-page websites and online apps Dart is designed to provide logic and, as a result, a beautiful user interface. For mobile, desktop, and backend apps, compile specialized machine code. Alternatively, for web use, compile to JavaScript.

Backend Technology:

1.3.4 Firebase

Firebase is a Google program that allows developers to create apps for a variety of platforms, including iOS, Android, and web-based apps. Firebase is a quick tool for developing things that would take a long time in a traditional database system, such as bespoke APIs. Firebase has built-in APIs that allow us to construct applications quickly. One of the nicest features of Firebase is that it gives us tools for tracking business reports and experimenting with different goods.

The Firebase database is a real-time database that allows clients to immediately access data. Even if you are not connected to the internet, you can still use your program with all of your prior data sets. Firebase allows users to use data in a secure and secured manner.

Software used:

1.3.5 Android Studio

It's a Google-created integrated development environment (IDE). The goal of Android is to speed up progress and make it easier for users to create high-quality apps for Android devices. Commonly used operating frameworks, such as Mac and Windows, allow variations of this IDE. It also provides a development kit and plugins for developers. cross-platform application support (IDE).

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2.PROJECT MANAGEMENT

2.1 Project Planning:

Project Planning is concerned with identifying and measuring the activities, milestones and deliverables produced by the project. Project planning is undertaken and completed sometimes even before any development activity starts. Project planning consists of following essential activities:

- Scheduling manpower and other resources needed to develop the system.
- Staff organization and staffing plans.
- Risk identification, analysis, and accurate planning.
- Estimating some of the basic attributes of the project like cost, duration and efforts. The effectiveness of the subsequent planning activities is based on the accuracy of these estimations.
- Miscellaneous plans like quality assurance plan, configuration management plan, etc.

Project management involves planning, monitoring and control of the people, process, and the events that occurs as the software evolves from a preliminary concept to an operational implementation. Cost estimation is a relative activity that is concerned with the resources required to accomplish the project plan.

2.2 Project Scheduling:

The scheduling is the peak of a planning activity, a primary component of software project management. When combined with estimation methods and risk analysis, scheduling establishes a roadmap for project management. The characteristics of the project are used to adapt an appropriate task set for doing work.

2.3 Risk Management:

Risk management consists of a series of steps that help a software development team to understood and manage uncertain problems that may arise during the course of software development and can plague a software project.

Risks are the dangerous conditions or potential problems for the system which may damage the system functionalities to very high level which would not be acceptable at any cost. So in order to make our system stable and give its 100% performance we must have identify those risks, analyze their occurrences and effects on our system and must prevent them to occur.

2.3.1 Risk Identification:

Risk identification is a first systematic attempt to specify risks to project plan, Scheduling resources, project development. It may be carried out as a team process using brainstorming approach

Technology risk:

Technical risks concern implementation, potential design, Interfacing, testing, and maintenance problems

- Database Corruptness
- Garbage Collection

People Risks:

These risks are concerns with the team and its members who are taking part in developing the system.

- Leaking an important data
- Failure of the administration
- Lack of knowledge ,
- Lack of clear product vision.
- Technical staff conflict
- Poor communication between people

Tools Risks:

These are more concerned with tools used to develop the system

- Tools containing virus.

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General Risks:

General Risks are the risks, which are concerned with the mentality and resources.

- Lack of resources can cause great harm to efficiency and timely productivity.
- Rapidly changing requirements.
- Changes in requirements can cause a great harm to implementation, designing and schedule of developing the system.
- Insufficient planning and task identification.

2.3.2 Risk Analysis

"Risk analysis = risk assessment + risk management + risk communication." Risk analysis is employed in its broadest sense to include:

Risk assessment:

Involves identifying sources of potential harm, assessing the likelihood that harm will occur and the consequences if harm does occur.

For this project It might be :- • System Crash.

Risk management:

Evaluates which risks identified in the risk assessment process require management and selects and implements the plans or actions that are required to ensure that those risks are controlled.

Precautions taken to make risks minimal are as under:-

- Periodical backups are taken to avoid major loss in case of system crash.

Risk communication:

Involves an interactive dialogue between stakeholders and risk assessors and risk managers which actively informs the other processes.

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Steps taken for risk communication is as under:-

- Probability of certain risks is negotiated with client.
- All the possible risks are listed out during communication and project is developed taking care of that risks.

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3. SYSTEM REQUIREMENTS STUDY

3.1 Hardware and Software Requirement

This shows minimum requirements to carry on to run this system efficiently.

3.1.1 Hardware Requirements

Server side Hardware Requirement:

Devices	Description
Processor	Intel Core Duo 2.0 GHz or more
RAM	512 MB or more
Hard Disk	10 GB or more

Table 3.1.1.1 Server side Hardware Requirement

3.1.2 Software Requirements

For which	Software
Operating System	Windows 7/8/10, Linux
Front End	Flutter
Back End	Flutter,Firebase
Coding language	Dart

Table 3.1.2.1 Software Requirement

3.1.3 Client side Requirements

For which	Requirement
Android	Greater than 4.1

Table 3.1.3.1 Client side Requirement

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3.2 Constraints

3.2.1 Hardware Limitations

The major hardware limitations faced by the system are as follows:

If the appropriate hardware is not there like processor, RAM, hard disks

-The problem in processing requests of client

-If appropriate storage is not there our whole database will crash due to less storage because our main requirement is large storage.

3.2.2 Reliability Requirements

Since many users can access the server simultaneously, load on the server becomes very high. Hence, the server should be of enough high configurations. There should be high back up storage and management of huge data for overall ideas, videos , images, multiple countries, multiple user profile.

The Reliability requirements are the validations used to protect the system against one or more incorrect activities. Without proper validation of the system, the failure possibilities of it grow higher so it is must to understand the proper validation of the system and must implement them. All the required validator controls spend very good role to keep the system secure from any unauthorized or incorrect information. In all these validation actions if system found one or more entries violating validation rules then user will be warned by proper error messages and the details or the record is not going to be saved until corrections are made to them.

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4. SYSTEM ANALYSIS

4.1 Study Current System

Implementation is the stage where the theoretical design is turned into a working system. The most crucial stage in achieving a new successful system and in giving confidence on the new system for the users that it will work efficiently and effectively.

The system can be implemented only after thorough testing is done and if it is found to work according to the specification.

It involves careful planning, investigation of the current system and its constraints on implementation, design of methods to achieve the change over and an evaluation of change over methods a part from planning. Two major tasks of preparing the implementation are education and training of the users and testing of the system.

The more complex the system being implemented, the more involved will be the systems analysis and design effort required just for implementation.

The implementation phase comprises of several activities. The required hardware and software acquisition is carried out. The system may require some software to be developed. For this, programs are written and tested. The user then changes over to his new fully tested system and the old system is discontinued.

4.2 Problem and weakness of current system:

In the existing system the exams are done only manually but in proposed system we have to computerize the exams using this application.

- Lack of security of data.
- More man power.
- Time consuming.
- Consumes large volume of pare work.
- Needs manual calculations.
- No direct control higher officials

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4.3 Requirements of New System

4.3.1 User Requirements:

The user requirement for this system is to make the system fast, flexible, less prone to error, reduce expenses and save the time.

4.3.2 System Requirements:

The Software Requirements Specification is produced at the culmination of the analysis task. The function and performance allocated to software as part of system engineering are refine by establishing a complete information description, a detailed functional and behavioral description, an indication of performance requirements and design constraints, appropriate validation criteria, and other data pertinent to requirements.

The proposed system has the following requirements:

- System needs store information about new entry of Grocery.
- System needs to help the internal staff to keep information of Customer and find them as per various queries.
- System need to maintain quantity record.
- System need to keep the record of Order.
- System need to update and delete the record.
- System also needs a search area.
- It also needs a security system to prevent data.

4.4 Feasibility Study:

After doing the project Online Grocery Ordering System, study and analyzing all the existing or required functionalities of the system, the next task is to do the feasibility study for the project. All projects are feasible - given unlimited resources and infinite time.

Feasibility study includes consideration of all the possible ways to provide a solution to the given problem. The proposed solution should satisfy all the user requirements and should be flexible enough so that future changes can be easily done based on the future upcoming requirements.

A. Economical Feasibility

This is a very important aspect to be considered while developing a project. We decided the technology based on minimum possible cost factor. All hardware and software cost has to be borne by the organization. Overall we have estimated that the benefits the organization is going to receive from the proposed system will surely overcome the initial costs and the later on running cost for system.

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B. Technical Feasibility

This included the study of function, performance and constraints that may affect the ability to achieve an acceptable system. For this feasibility study, we studied complete functionality to be provided in the system, as described in the System Requirement Specification (SRS), and checked if everything was possible using different type of frontend and backend platforms

.

C. Operational Feasibility

No doubt the proposed system is fully GUI based that is very user friendly and all inputs to be taken all self-explanatory even to a layman. Besides, a proper training has been conducted to let know the essence of the system to the users so that they feel comfortable with new system. As far our study is concerned the clients are comfortable and happy as the system has cut down their loads and doing.

4.5 Selection of Hardware and Software and Justification

The configuration of the existing systems is:

Processor : Pentium III, 500 MHz (or above)

Memory : 128 MB (or above) Secondary

Storage : 20 GB (or above)

For Software there are following alternatives:

Operating System : Window 9/8/10, 2000, XP, NT

Development tools : Flutter, Dart language, Firebase

for database (JSON format)

Documentation tool : MS-Word

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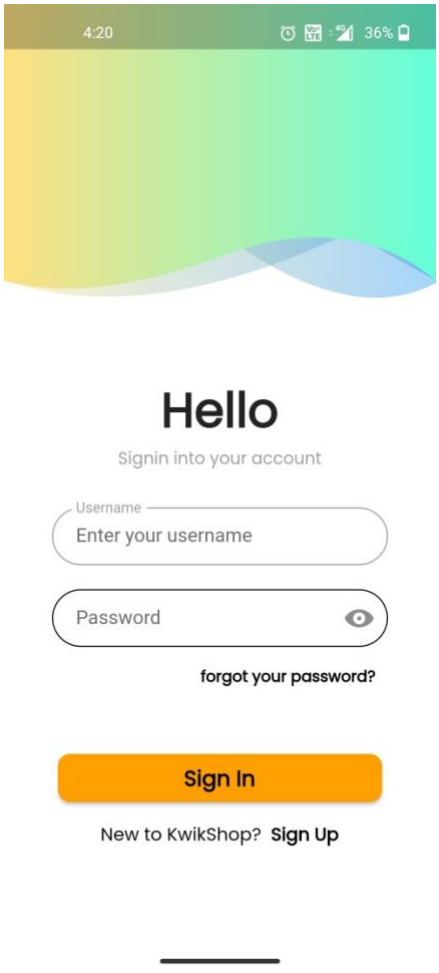
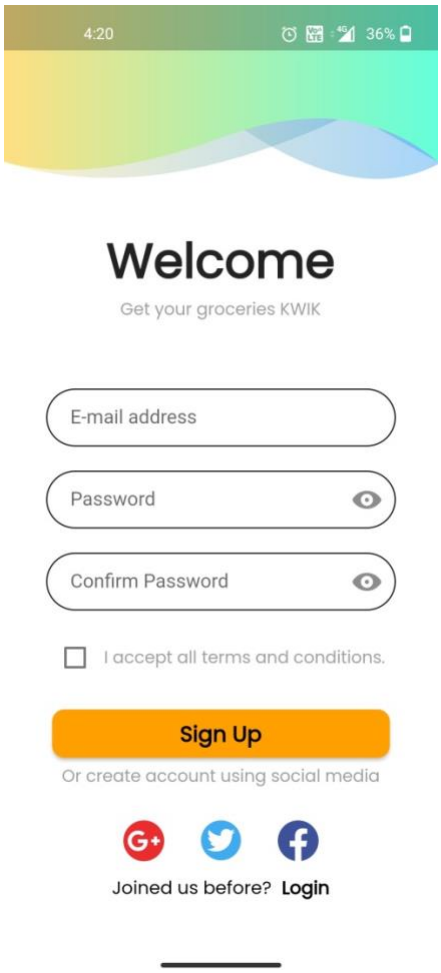
5. System Design

5.1 Input /output interface

5.1.1 Registration / Login activity



Login Page



Registration Page

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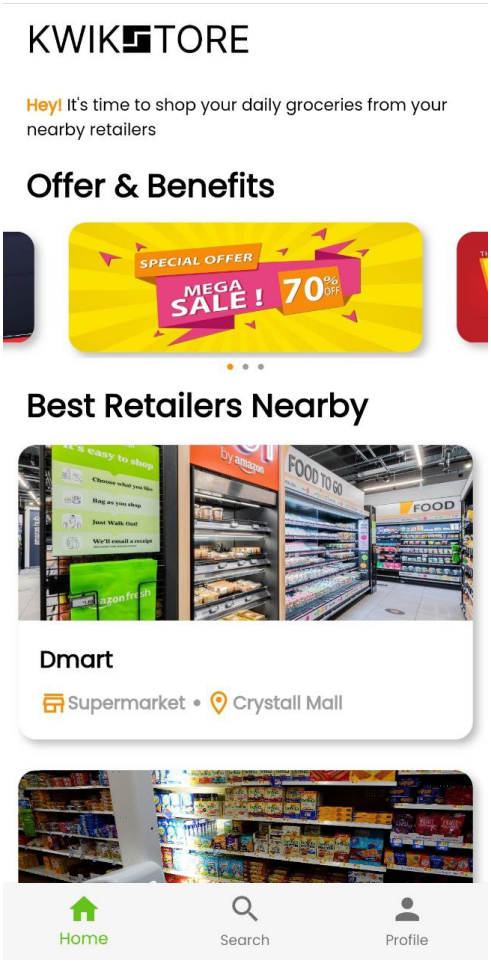
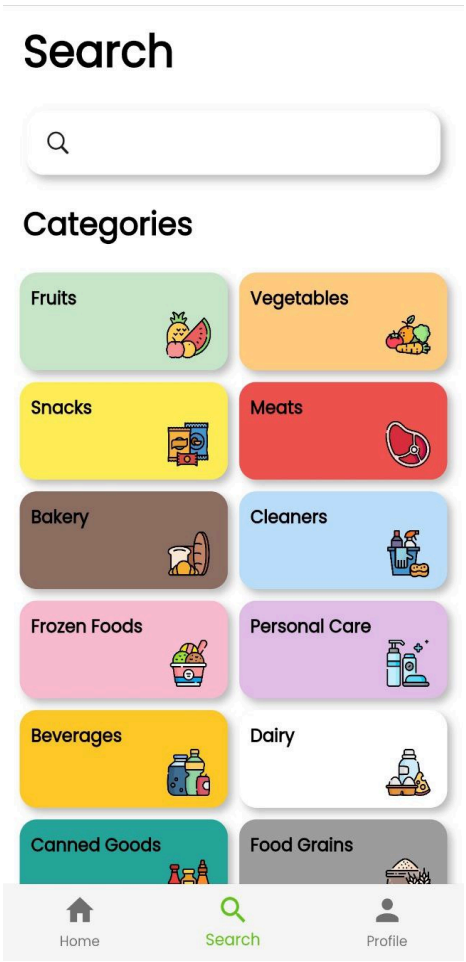
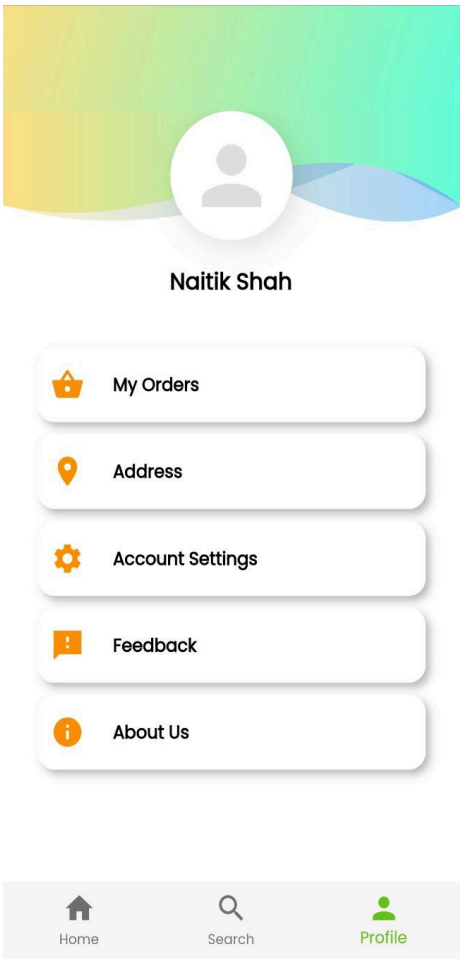
5.1.2 Main activity







Home Page **Search Page** **Profile Page**

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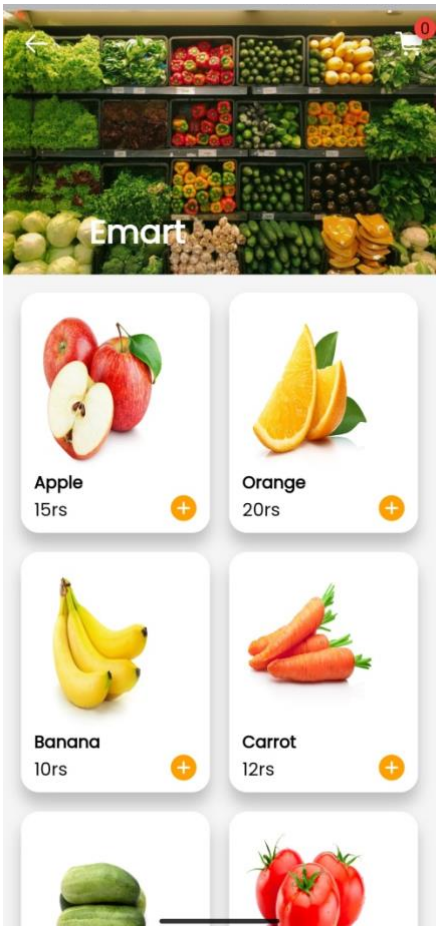
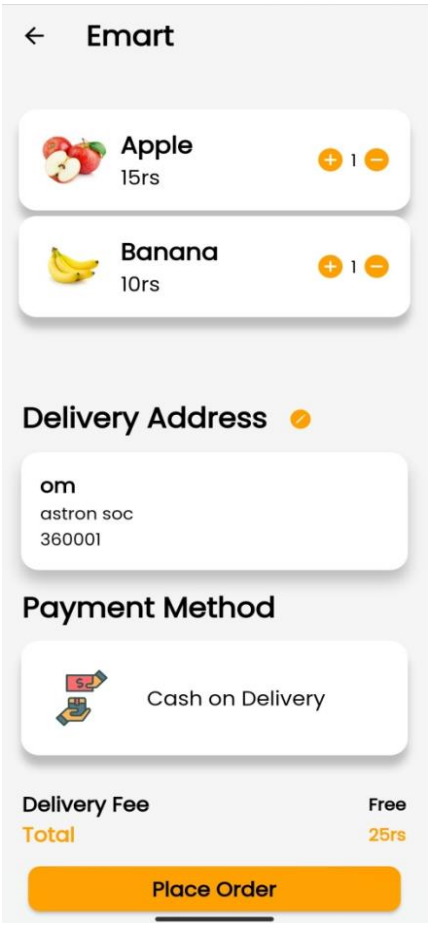
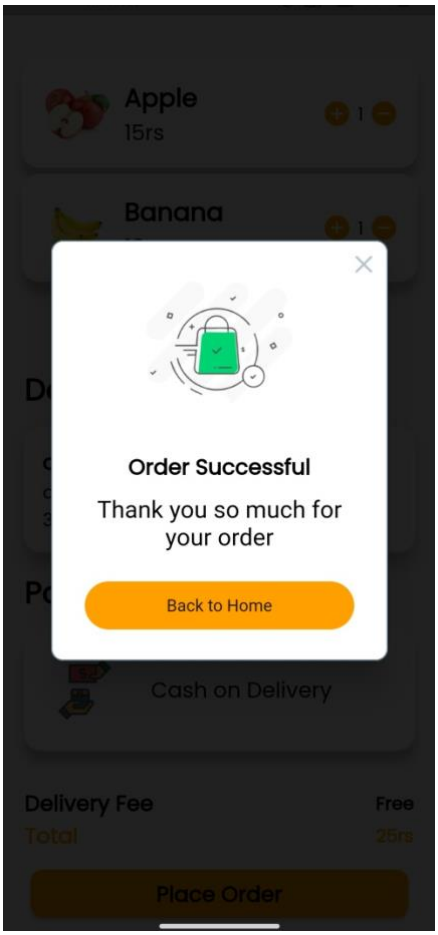
5.1.3 Order activity







Add Item **Cart** **Order Confirmation**

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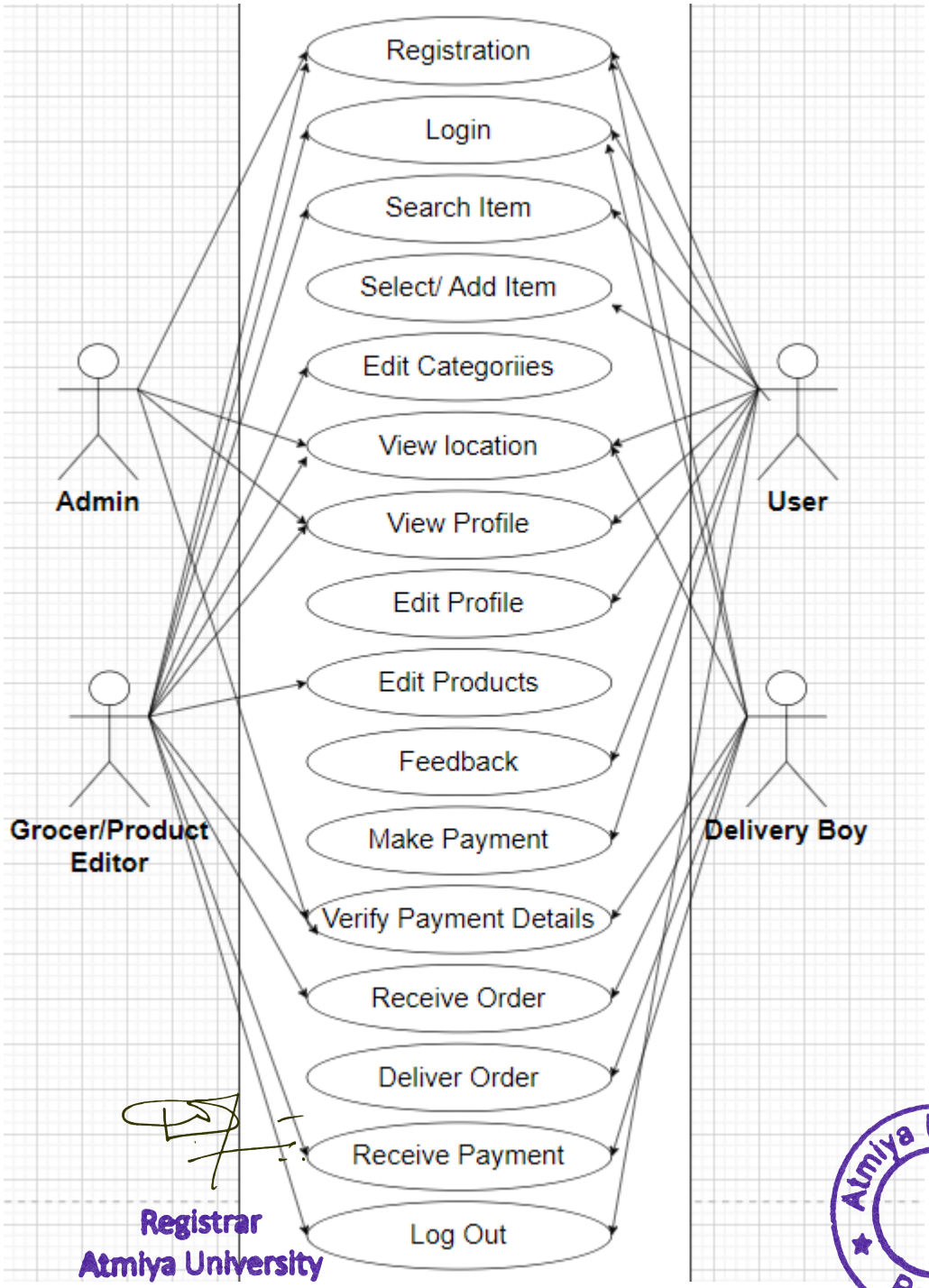
5.2 Interface Design

5.2.1 Use case diagram



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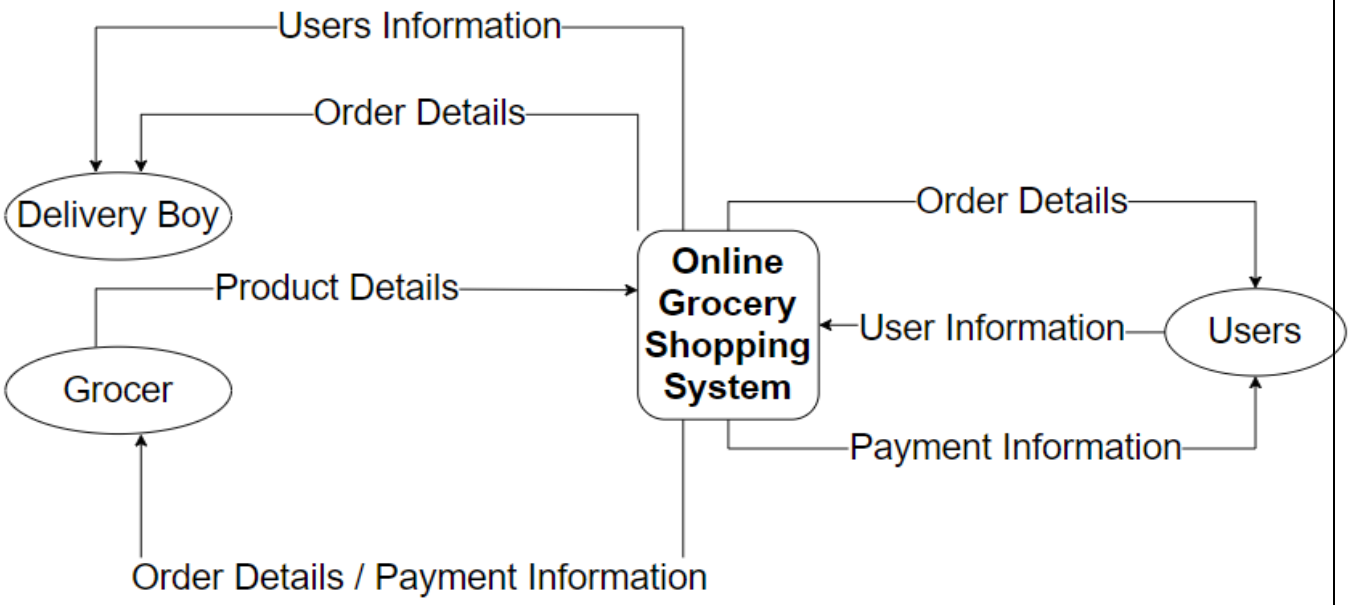
5.2.2 Dataflow diagram

5.2.2.1 DFD level 0



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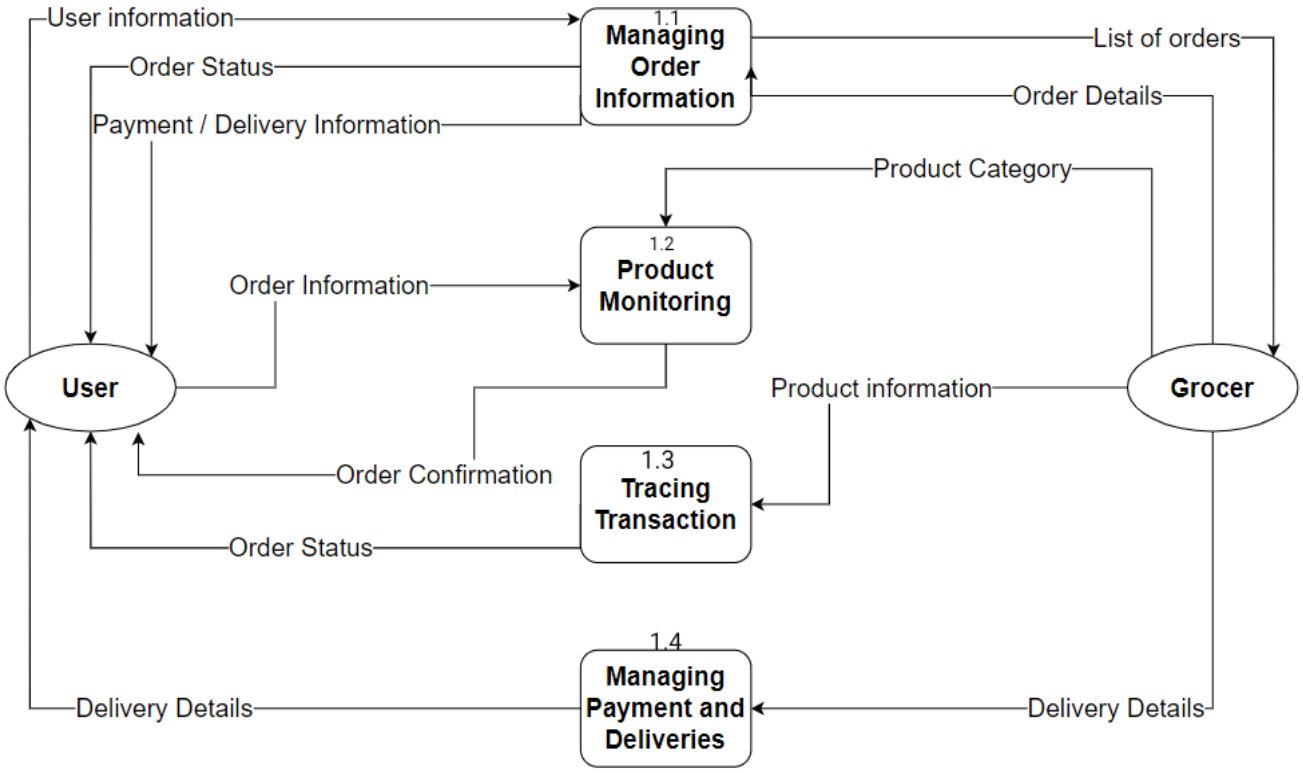
5.2.2.2 DFD level 1



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6. Code Implementation

6.1 Implementation Environment

Challenges identified for successful design and implementation of this project are dominated by:

- Complexity, reliability/availability, transparent data access. The project was a result of a group consensus. The team was having two members. The team was guided by project manager. The team structure depends on the management style of the organization, the no. of people in the team, their skill levels and the problem difficulty.

6.2 Program/Module Specification

- System GUI must be as simple and user friendly as anyone can use it. At front side we implemented User registration and login page.
- A Session is maintained throughout the system when a particular user enters their names into the system.

6.3 Coding Standards

- Normally, good software development organization requires their programmers to maintain some well-defined and standard style of coding called coding standard.

6.3.1 Comment Standards:

- The comment should describe what is happening, how it is being done, what parameters mean, which global are used and which are modified, and any registration or bugs.

The standards I have followed are:

- Comment may also be used to explain individual sections or lines of codes to easily get access and easily review or manage the classes or properties for the pages.
- Inline comments should be made with the //. Comment style and should be indented at the same level as the code described.
- For multiple line comments we write between /* ..... */.

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7. Testing

7.1 Testing Strategy

A strategy for software testing integrates software test case design method into a well-planned series of steps that result in the successful construction of the software. The strategy provides the roadmap that describes the steps to be conducted as a part of testing, then these steps are planned and then undertaken, and how much effort, time and resource will be required.

7.2 Testing Method

7.2.1 Unit Testing

The unit testing is meant for testing smallest unit of software. There are two approaches namely bottom-up and top-down. In bottom up approach the last module is tested and then moving towards the first module while top down approach reverses the action. In present work we opt for the first one. The bottom up approach for the current project is carried out as shown in.

7.2.2 Validation Testing

After the integration testing software is completely assembled as a package, interfacing error have been uncovered and corrected, and then validation testing may begin. Validation can be defined in many ways but a simple definition is what a validation succeeds when software functions in a manner that can be reasonably accepted by the user.

7.2.3 Integration Testing

The integration testing is meant to test all the modules simultaneously because it is possible that all the modules may function correctly when tested individually. But they may not work altogether and may lead to unexpected outcome.

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8. Limitations and Future Enhancement

8.1 Limitations:

Although I have put my best efforts to make the software flexible, easy to operate but limitations cannot be ruled out even by me. Though the software presents a broad range of options to its users some intricate options could not be covered into it; partly because of logistic and partly due to lack of sophistication. Paucity of time was also major constraint, thus it was not possible to make the software foolproof and dynamic. Lack of time also compelled me to ignore some part such as storing old result of the candidate etc.
In the current project we have not worked on online payment methods.

8.2 Future Enhancement:

There is always a scope for enhancements in any developed system, especially when our nature of the project is iterative waterfall which allows us to rethink on the method of development to adopt changes in the project. Below mentioned are some of the changes possible in the future to increase the adaptability, and efficiency of the system.

- More attractive GUI (Graphical user interface).
- Communication options like chat.
- Online payment options.

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9. Conclusion

Our project is only a humble venture to satisfy the needs to manage our project work. Several user friendly coding is also adopted. This package shall prove to be a powerful package with satisfying all the requirements. The objective of software planning is to provide a frame work that enables the manager to make reasonable estimates made within a limited time frame at the beginning of the software project and should be updated regularly as the project progresses.

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10. Reference

We used Google for the reference.
We learnt the whole flutter course from the Udemy courses.
Images source: Google
We also watched many YouTube tutorials.

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"Analysis and Optimization of C-Type Frame Structure of 110 Ton Hydraulic Power Press"

A Thesis Submitted to Atmiya University

For the partial fulfilment of the requirement for the degree of

Master of Technology

In

Mechanical Engineering- CAD/CAM

By

Mr. Kelvin J. Umaretiya

Enrolment No. 210045003

Under supervision of

Mr. Shivang S. Jani

Faculty of Engineering & Technology

Department of Mechanical Engineering

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[June 2023]

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CERTIFICATE

It is certified that the work contained in the dissertation thesis entitled **"Analysis and Optimization of C-type Frame Structure of 110 ton Hydraulic Power Press"** submitted by **Mr. Kelvin J. Umaretiya (210045003)**, studying at Mechanical Engineering Department, Faculty of Engineering & Technology, for the award of M.Tech. (CAD/CAM) is absolutely based on his own work carried out under my supervision and this thesis has not been submitted elsewhere for any degree.

Date: 13/07/2023

Place: Rajkot.

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To,

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Kalawad Road,
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Subject : Permission for conducting research

Dear Mr. Kelvin J. Umaretiya

SEW pleased to inform you that we give you permission in respect of your research request of studying the MECHANICAL POWER PRESS of Atmya University.

Your initiative is appreciable and we are ready to support research in SEW.

We wish you all the best in your research.

Thanking you,

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COMPLIANCE REPORT

It is certified that the work contained in this dissertation thesis entitled "**Analysis and Optimization of C-type Frame Structure of 110 ton Hydraulic Power Press**" submitted by **Mr. Kelvin J. Umaretiya (210045003)** studying at Mechanical Engineering Department, Faculty of Engineering & Technology for partial fulfillment of M.Tech. (CAD/CAM) degree to be awarded by Atmiya University. He has complied the comments of the Dissertation Progress Review-I, Mid Semester Dissertation as well as Dissertation Progress Review-II with my satisfaction.

Date: 13/07/2023

Place: Rajkot

Mr. Kelvin J. Umaretiya
(210045003)

Mr. Shivang S. Jani
Assistant Professor
Mechanical Engineering Department
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PAPER PUBLICATION CERTIFICATE

This is to certify that research work embodied in this dissertation titled **"Analysis and Optimization of C-type Frame Structure of 110 ton Hydraulic Power Press"** was carried out by **Mr. Kelvin J. Umaretiya (210045003)** at **Faculty of Engineering & Technology, Rajkot** for partial fulfillment of Master of Technology degree to be awarded by Atmiya University has published review article **"The Analysis and Optimization of the 110-ton Frame Structure of a Hydraulic Press"** for publication in the **"International Journal of Production Engineering Volume 08 Issue 02 Year 2022."**

Date: 13/07/2023

Place: Rajkot

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Date: 14/07/2023

Place: Rajkot

External Examiners Sign and Name:

1) R. L. Patel

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We certify that, to the best of our knowledge, the current thesis does not infringe upon anyone's copyright nor violate any proprietary rights and that any ideas, techniques, quotations or any other material from the work of other people included in our thesis, published or otherwise, are fully acknowledged in accordance with the standard referencing practices. Furthermore, to the extent that we have included copyrighted material that surpasses the boundary of fair dealing within the meaning of the Indian Copyright (Amendment) Act 2012, we certify that we have obtained a written permission from the copyright owner(s) to include such material(s) in the current thesis and have included copies of such copyright clearances to our appendix.

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Signature of Guide:

Name of Guide: Mr. Shivang S. Jani

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This dissertation work would not have been possible without the kind support of many people. I take this opportunity to acknowledge those who has been great sense of support and inspiration thought the dissertation work successful. There are lots of people who inspired me and helped, in completion of my dissertation work successfully.

I am very grateful to **Mr. Shivang S. Jani & Mr. Hardik N. Chauhan,** Assistant Professor at Department of Mechanical Engineering for all their diligence, guidance, encouragement and help throughout the period of dissertation, which have enabled me to complete the work in time. I also thank them for the time that they spared for me, from their extreme busy schedule. Their insight and creative ideas are always the inspiration for me during the dissertation work.

I would like to thanks **Mr. Manojkumar V. Sheladiya,** Head of Mechanical Engineering Department and **Dr. G. D. Acharya,** Professor Emeritus for their guidance, encouragement and support during dissertation work. I would also like to thank my industrial guide **Mr. Darshanbhai Tratiya.**

I am thankful to all faculty members and friends at **Atmiya University, Rajkot** for providing valuable suggestions and constant help during my work.

Above all, I am forever thankful to my mother and family members for their valuable time and encouragement.

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TABLE OF CONTENT

Sr. No.	Title	Page No.
	Certificate	**I**
	Industry Certificate	**II**
	Compliance Report	**III**
	Paper Publication Certificate	**IV**
	Thesis Approval Certificate	**V**
	Declaration of Originality	**VI**
	Acknowledgement	**VII**
	Table of Contents	**VIII**
	List of Figures	**XI**
	List of Tables	**XIII**
	List of Nomenclature	**XIV**
	Abstract	**XV**
Chapter - 1	**Introduction**	**1-11**
1.1	Introduction to power press	1
1.2	Types of power press	1
1.2.1	Types of power press based on their power sources	1
1.2.2	Types of power press based on frame design	4
1.2.3	Types of power press based on frame position	6
1.3	Components of power press	7
1.4	Applications of power press	8
1.5	Operations of power press	9
1.6	C-frame or gap frame power press machine	10
Chapter - 2	**Literature Review**	**12-19**
2.1	Introduction	12
2.2	Literature review	12
2.3	Summary of literature review	18
2.4	Literature mapping	18

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Rajkot

Chapter - 3	**Problem Definition**	**20-23**
3.1	Introduction to company	20
3.2	Part details of press machine	20
3.3	Problem occurred in press machine	22
3.4	Objectives	23
Chapter - 4	**Modelling and Analysis of Existing Frame of Power Press**	**24-31**
4.1	Modelling of existing frame of power press	24
4.1.1	Modelling parts of existing frame structure of power press	24
4.1.2	Assembly of existing frame structure of power press	26
4.2	Analytical calculation	27
4.3	Analysis in simulation software	30
Chapter - 5	**Optimization of C-type Frame Structure of Power Press**	**32-47**
5.1	Introduction	32
5.2	Design of press for different plate thickness	32
5.3	Calculation for a 32 mm Plate	32
5.4	Calculation for a 28 mm Plate	34
5.5	Calculation for a 25 mm Plate	36
5.6	Calculation for a 22 mm Plate	38
5.7	Finite element methods	40
5.8	Model of frame of power press machine	42
5.9	Numerical simulations	42
5.9.1	Meshing	42
5.9.2	Applying boundary conditions	44
5.9.3	Effect of plate thickness on deformation	47
5.9.4	Effect of plate thickness on Von Mises stress	49
5.10	Optimization	50
Chapter – 6	**Conclusion and Future Scope**	**53**
6.1	Conclusion	53
6.2	Future scope	53

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References **54**

Appendix A: Review card **59**

Appendix B: Compliance Report **65**

Appendix C: Paper Publication Certificate **66**

Appendix D: Standards **67**

Appendix E: Plagiarism **73**

Registrar
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LIST OF FIGURES

Figure No.	Figure Name	Page No.
1.1	Mechanical power press	2
1.2	Hydraulic power press	2
1.3	Pneumatic power press	3
1.4	C-frame power press	4
1.5	H-frame power press	5
1.6	Straight sided power press	5
3.1	Schematic diagram of power press-i	20
3.2	Schematic diagram of power press-ii	22
3.3	Position where the crack is generated	23
4.1	Modelling of parts of existing power press frame structure	25
4.2	Assembly of existing frame structure of power press	26
4.3	Meshing of existing frame structure	30
4.4	Apply boundary condition to existing frame structure	30
4.5	Effect of Von Mises stress on frame structure	31
4.6	Effect of deformation on frame structure	31
5.1	Assembly of frame of power press	42
5.2	Meshing of 32 mm thickness plate	43
5.3	Meshing of 28 mm thickness plate	43
5.4	Meshing of 25 mm thickness plate	44
5.5	Meshing of 22 mm thickness plate	44
5.6	Boundary condition of 32 mm thickness plate	45
5.7	Boundary condition of 28 mm thickness plate	45
5.8	Boundary condition of 25 mm thickness plate	46
5.9	Boundary condition of 22 mm thickness plate	46
5.10	Deformation of 32 mm thickness plate	47
5.11	Deformation of 28 mm thickness plate	47
5.12	Deformation of 25 mm thickness plate	48
5.13	Deformation of 22 mm thickness plate	48
5.14	Von Mises stress of 32 mm thickness plate	49

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

5.15	Von Mises stress of 28 mm thickness plate	49
5.16	Von Mises stress of 25 mm thickness plate	50
5.17	Von Mises stress of 22 mm thickness plate	50

Registrar
Atmiya University
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Atmiya University
Rajkot

LIST OF TABLES

Table No.	Table Name	Page No.
4.1	Specification of material ST42W	27
4.2	Chemical composition of material ST42W	27
4.3	Deformation and Von Mises stress of existing frame of power press	31
5.1	Specification of material ST42W	32
5.2	Chemical composition of material ST42W	32
5.3	Effect of plate thickness on deformation	51
5.4	Effect of plate thickness on Von Mises stress	51

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LIST OF NOMENCLATURE

Symbols	Description	Unit
$\bar{Y}$	Centre of Gravity	mm
e	Eccentricity	mm
P	Force	N
M_b	Bending Moment	N mm
I	Moment of Inertia	mm^4
σ_b	Bending Stress	N/mm^2
σ_t	Tensile Stress	N/mm^2
σ_{max}	Maximum Allowable Stress	N/mm^2
R	Radius of Gyration	mm
δ	Deflection of Frame	mm

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"Analysis and Optimization of C-Type Frame Structure of 110 Ton Hydraulic Power Press"

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ABSTRACT

Metal forming is one of the manufacturing processes which are almost chip less. Machines and press tools are mostly used to carry out such operations.

These procedures involve bending metal workpieces to their designed shapes and sizes by applying pressure or force. Press machines are always operating with impact loads. Structure of power press is constantly under tensile stress as a result of the continuous impact load. Continuous stress is applied to press machines, and as a result, structural problems are regularly encountered. With the use of the FEM Tool, load situation experienced by frame determines thickness of the plate.

The objective of this dissertation work is to analyse and optimization of C-frame of hydraulic power press at Singhal Engineering Works (SEW). SolidWorks software is used to design the frame. Analytical and computer-based simulations using the ANSYS software are used to evaluate design parameters. The design modification and analysis of the frame structure within the allowed parameters, including the stresses and deformation of the frame, are the subjects of this dissertation.

Key Words: C-frame, Power press, FEM etc.

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CHAPTER – 1

Introduction

1.1 Introduction to power press[47]

A power press is a machine tool used in various industries for shaping, forming, and processing materials through the operation of force. It's designed to exert controlled and exact pressure on a workpiece to achieve specific manufacturing operations, like as cutting, bending, stamping, punching, or shaping.

Power presses are generally equipped with a ram, which moves vertically or horizontally to apply force to the workpiece. The force is generated by various means, like as mechanical, hydraulic, pneumatic, or electric systems, depending on the type of power press.

These machines are utilized in a wide range of industries, involving automotive, aerospace, material fabrication, electronics, appliance manufacturing, and more. Power presses are required for mass product, as they can perform repetitive jobs fast and precisely, upgrading efficiency and productivity.

Power presses come in different configurations and sizes, offering various force capacities and capabilities. The choice of a power press depends on the specific operation conditions, similar as the material being processed, the desired operation, accuracy requirements, and work volume.

Safety is of ultimate significance when working with power presses due to their high force capabilities. Proper training, adherence to safety guidelines, and the use of self-protective measures, like as guards and safety bias, are key to ensure operator security.

In summary, a power press is a machine tool that applies force to shape, form, or process materials for various manufacturing operations. It plays a vital part in many industries, contributing to effective output and the creation of a wide range of products.

1.2 Types of power press [54]

1.2.1 Types of power presses based on their power sources

Power presses can be categorized based on the power source used to generate force.

1.2.1.1 Mechanical power press:

Mechanical power presses use mechanical energy from a motor and a flywheel to generate force. The flywheel stores rotational energy, which is then converted into linear motion through a crankshaft mechanism. Mechanical power presses are

known for their high speed and accuracy. They are commonly used in applications such as stamping, punching, and forming.

Figure 1.1 Mechanical power press [48]

1.2.1.2 Hydraulic power press:

Hydraulic power presses utilize hydraulic systems to generate force. They rely on hydraulic cylinders powered by hydraulic fluid to provide force for the ram. Hydraulic power presses offer high force capabilities, precise control, and versatility. They are commonly used in metal forming, deep drawing, bending, and assembly applications.

Figure 1.2 Hydraulic power press [49]

1.2.1.3 Pneumatic power press:

Pneumatic power presses use compressed air as the power source. They employ pneumatic cylinders to create the pressing force. Pneumatic power presses are often smaller and lighter compared to hydraulic or mechanical presses. They are suitable for lighter-duty applications, including small part stamping, riveting, and assembly tasks.

Figure 1.3 Pneumatic power press [50]

1.2.1.4 Electric power press:

Electric power presses are powered by electricity and use electric motors to generate force. These presses offer precise control, energy efficiency, and quieter operation compared to other types of power presses. Electric power presses are often used in applications requiring high precision, such as electronics manufacturing, medical device production, and small-scale operations.

1.2.1.5 Servo power press:

Servo power presses use servo motors as the power source. Servo systems offer precise control over force, speed, and position. These presses can be programmed for various operations, including forming, stamping, and precise part positioning. Servo power presses are commonly used in industries that require high accuracy and repeatability.

Each type of power press has its own advantages and is suitable for specific applications based on factors such as force requirements, precision needs, operational preferences, and

energy efficiency considerations. The choice of power press depends on the specific requirements of the manufacturing process.

1.2.2 Types of power press machines based on frame design

Power press machines can be classified based on the design of their frames. Here are some common types of power press machines based on frame design:

1.2.2.1 C-frame power press:

C-frame power presses, also known as gap frame presses, have a C-shaped frame structure. They feature an open front and sides, allowing for easy access to the work area. C-frame presses are versatile and commonly used for stamping, punching, forming, and bending operations. They are widely used in various industries due to their compact design and ease of use.

Figure 1.4 C-frame power press [51]

1.2.2.2 H-frame power press:

H-frame power presses have an H-shaped frame structure. The frame consists of two vertical columns connected by a horizontal beam at the top. H-frame presses offer high rigidity and stability, making them suitable for heavy-duty applications that require precise and powerful force. They are commonly used in operations such as deep drawing, forming, and heavy metal fabrication.

Figure 1.5 H-frame power press [52]

1.2.2.3 Straight-side power press:

Straight-side power presses have a straight-sided frame structure. The frame consists of two vertical columns and a rigid crosshead at the top. Straight-side presses provide excellent stability and resistance to deflection. They are known for their high precision and uniform force distribution, making them ideal for applications requiring high accuracy, such as fine blanking, precision stamping, and high-speed production.

Figure 1.6 Straight sided power press [53]

1.2.2.4 Four-column power press:

Four-column power presses, also known as column presses or portal presses, have a frame structure supported by four vertical columns. This design provides excellent stability, rigidity, and load-bearing capacity. Four-column presses are commonly used for heavy-duty operations such as deep drawing, die spotting, and forming large and complex components.

These are some of the main types of power press machines based on the design of their frames. The choice of the appropriate type depends on factors such as the intended application, required force capacity, precision needs, available workspace, and specific design preferences. Each type has its advantages and is suited for specific tasks and industries.

1.2.3 Types of power presses based on the frame position

Power press machines can also be classified based on the position of their frames. Here are some types of power presses based on the frame position:

1.2.3.1 Vertical power press:

Vertical power presses have a vertically oriented frame, with the ram moving in a vertical direction. These presses are commonly used for applications such as blanking, piercing, and bending, where the force needs to be applied vertically. Vertical power presses are suitable for operations that require downward force and are often used in industries like automotive, aerospace, and sheet metal fabrication.

1.2.3.2 Inclined power press:

Inclined power presses have an inclined or angled frame, with the ram moving at an angle to the horizontal plane. These presses are designed to apply force in a specific direction, often used for tasks like shearing, trimming, or forming components at an angle. Inclined power presses are useful when the workpiece needs to be processed at a non-vertical angle or when there are ergonomic considerations for the operator.

1.2.3.3 Horizontal power press:

Horizontal power presses have a horizontally oriented frame, with the ram moving in a horizontal direction. These presses are commonly used for operations such as bending, straightening, and extruding. Horizontal power presses are suitable for applications that require a horizontal force application, such as bending long workpieces or forming components in a horizontal plane.

The classification of power presses based on the position of the frame reflects the orientation and direction of the force application. Each type has its advantages and is suitable for specific applications where force needs to be applied in a particular direction or at a specific angle. The choice of the appropriate type depends on the specific requirements of the manufacturing process and the desired orientation of force application.

1.3 Components of power press [54]

Power press machines consist of various components that work together to perform the desired operations. Here are some key components commonly found in power presses:

Frame: The frame is the main structure of the power press, providing rigidity and support. It houses and supports other components such as the ram, bed, and guiding systems. The frame must be sturdy and rigid to withstand the forces and vibrations generated during operation.

Ram: The ram, also known as the slide or plunger, is the moving part of the power press. It delivers the force to the workpiece for shaping, forming, or cutting. The ram is driven by a power source, such as a motor or hydraulic system, and moves vertically, horizontally, or at an angle depending on the type of power press.

Bed: The bed is the stationary surface on which the workpiece is placed during the operation. It provides support and stability for the workpiece. The bed may have T-slots or other fixtures for securing the workpiece in position.

Clutch and Brake: Power presses are equipped with a clutch and brake system to control the motion and stopping of the ram. The clutch engages and disengages the power transmission from the motor to the ram, allowing the operator to start and stop the machine. The brake system is responsible for quickly stopping the ram movement when needed, ensuring safe and precise operation.

Drive Mechanism: The drive mechanism transfers power from the motor to the ram, providing the necessary force for the operation. Depending on the type of power press, the drive mechanism can be mechanical, hydraulic, pneumatic, or electric.

Control System: Power presses feature a control system to regulate the machine's operation. The control system may include buttons, switches, and levers for starting, stopping, and controlling the speed and stroke length of the ram. Some advanced power presses may also have programmable control systems for automation and precise operation.

Guiding System: The guiding system ensures smooth and accurate movement of the ram. It consists of guides, bushings, and other components that minimize play and maintain alignment between the ram and the frame. Proper guiding is crucial for precise and repeatable operation.

Safety Features: Power presses are equipped with various safety features to protect operators and prevent accidents. These may include safety guards, light curtains, emergency stop buttons, two-hand controls, and overload protection devices. Safety measures should be in place and followed to ensure safe operation of the power press.

These are some of the key components found in power press machines. The specific configuration and features may vary depending on the type, size, and manufacturer of the power press.

1.4 Applications of power press [54]

Power press machines find applications in a wide range of industries and manufacturing processes. Here are some common applications of power presses:

Automotive Industry: Power presses are extensively used in the automotive industry for various operations such as stamping car body panels, forming metal components, punching holes, and creating intricate shapes. Power presses play a crucial role in the mass production of automotive parts.

Appliances and Electronics Manufacturing: Power presses are used in the manufacturing of household appliances and electronics. They are utilized for operations like forming metal casings, punching holes for switches and connectors, and creating precise shapes for components used in appliances and electronic devices.

Metal Fabrication: Power presses are widely employed in metal fabrication processes. They are used for cutting, blanking, shearing, bending, and forming metal sheets, plates, and profiles. Power presses enable the efficient production of various metal components used in industries such as construction, HVAC, and furniture manufacturing.

Packaging Industry: Power presses are utilized in the packaging industry for operations like cutting, creasing, and embossing packaging materials. They help in producing custom-designed packaging boxes, cartons, and labels.

Aerospace Industry: Power presses play a crucial role in the aerospace industry for operations such as forming and trimming sheet metal components used in aircraft structures, panels, and interior fittings. They are also used for manufacturing precision parts used in engines, landing gear, and other aircraft systems.

Furniture Manufacturing: Power presses are employed in the furniture industry for bending, forming, and cutting metal and wood components. They are used to create furniture frames, brackets, and other structural elements.

Electrical and Electronics Industry: Power presses are used in the production of electrical and electronic components. They are employed for operations such as punching, forming, and blanking metal parts used in switches, connectors, and circuit boards.

Construction Industry: Power presses find applications in the construction industry for operations such as punching holes, shearing metal plates, and forming structural components. They are used in the fabrication of building components, scaffolding, and metal structures.

Medical Device Manufacturing: Power presses are utilized in the production of medical devices and equipment. They are employed for operations such as stamping, forming, and cutting components used in medical instruments, implants, and diagnostic devices.

General Manufacturing: Power presses are widely used in various other industries for a range of manufacturing operations. These include operations such as piercing, coining, embossing, assembly, and riveting, which are applicable to multiple sectors.

These are just a few examples of the diverse applications of power press machines. The versatility and adaptability of power presses make them essential tools in numerous manufacturing processes across different industries.

1.5 Operations of power press [41]

Power press machines are versatile tools used in various industrial applications for performing different operations. Here are some common operations that can be carried out using power presses:

Stamping: Power presses are widely used for stamping operations, where a shaped die is used to cut or form materials. Stamping is used in industries such as automotive, appliances, and electronics for manufacturing components like sheet metal parts, brackets, and connectors.

Punching: Power presses are capable of punching holes in materials using specialized punch and die sets. This operation is commonly used in industries like metal fabrication, signage manufacturing, and construction for creating holes in sheets, plates, and other materials.

Forming: Power presses can be used for forming operations, such as bending, deep drawing, and shaping materials. These operations are crucial in industries like automotive, aerospace, and furniture manufacturing for producing complex and customized components.

Blanking: Blanking is the process of cutting out a flat shape from a sheet or strip of material. Power presses equipped with blanking dies can efficiently produce large quantities of blanks used in industries like packaging, automotive, and consumer goods manufacturing.

Coining: Coining is a precision forming operation that produces high-quality finishes and tight tolerances. Power presses can be used for coining operations, such as creating embossed designs, logos, or patterns on materials.

Riveting: Power presses equipped with riveting attachments can perform riveting operations. Riveting joins two or more materials together using rivets or fasteners. This operation is commonly used in industries like automotive, aerospace, and construction.

Assembly: Power presses can be used for assembly operations, where multiple components are joined together using fasteners or other methods. Power presses equipped with automation systems are capable of high-speed and accurate assembly tasks.

Shearing: Power presses can be used for shearing operations, where materials are cut or trimmed using a shear blade. Shearing is commonly used in industries like metal fabrication and manufacturing for cutting sheets, plates, and other materials.

Bending: Power presses can perform bending operations, where materials are bent to a desired angle or shape. This operation is used in industries like HVAC, furniture manufacturing, and metalworking.

Extrusion: Power presses can be used for extrusion operations, where materials are forced through a die to create profiles, tubes, or other complex shapes. Extrusion is commonly used in industries like aluminium extrusion, plastic extrusion, and rubber manufacturing.

These are just a few examples of the operations that can be carried out using power presses. The specific operations performed depend on the type of power press, tooling, and the requirements of the manufacturing process.

1.6 C-frame or gap frame power press machine [55]

C-frame power press machines, also known as gap frame power press machines, are a type of power press commonly used in manufacturing industries. They are named "C-frame" or "gap frame" due to the distinctive C-shaped frame design which provides an

open space or gap in the front of the machine. Here is an introduction to C-frame or gap frame power press machines:

Design: C-frame power presses have a robust and compact design. The frame structure resembles the shape of the letter "C," with the open side facing the front. This design allows easy access to the work area, making it suitable for various applications.

Gap Frame: The term "gap frame" refers to the gap or opening in the front of the press machine. This gap provides flexibility for accommodating larger workpieces or tooling setups that require extra clearance. The size of the gap can vary depending on the specific machine model.

Construction: C-frame power press machines are typically constructed using heavy-duty cast iron or welded steel frames. The frame provides stability, rigidity, and vibration damping, ensuring precise and reliable operations.

Versatility: C-frame power presses are known for their versatility and adaptability. The open front design allows for easy loading and unloading of workpieces, making it suitable for applications requiring frequent material changes. The gap frame also facilitates the use of specialized tooling setups, allowing for complex and diverse operations.

Applications: C-frame power presses find applications in a wide range of industries, including automotive, appliance manufacturing, electronics, and general metalworking. They are commonly used for tasks such as blanking, piercing, forming, embossing, and shallow drawing of metal sheets or other materials.

Safety Features: Like any power press machine, C-frame power presses require proper safety measures. They should be equipped with guards to prevent access to moving parts, emergency stop buttons, and two-hand controls to ensure operator safety. Adequate training and regular maintenance are crucial for safe and efficient operation.

In summary, C-frame or gap frame power press machines are versatile machines used in various industries for shaping and forming metal sheets. Their distinctive C-shaped frame design with an open front gap provides flexibility, accessibility, and the ability to accommodate larger workpieces or specialized tooling setups. With their robust construction and precise operation, C-frame power presses are essential tools for many manufacturing processes.

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CHAPTER – 2

Literature Review

2.1 Introduction

This chapter talks about the review of literature on the press machine. In this chapter of literature review main focus is on the failure occur in the frame of C-type press machine and crack initiation in the corner of the frame. There is vast amount of literature available for press frame, but in present capture mainly focused on the frame of power press machine.

2.2 Literature review

Rangraj S More et al. [1] have optimized by FEA implementation is used for analysis and optimization of a 200-tonne "C" type press frame. They used the perfectly homogeneous and isotropic material ST32 (structural steel) for the frame. For design optimization, they use the ANSYS software tool. a lighter design with reduced material cost by removing the top material of the frame and making it hollow, and by cutting the corner of the frame. It is shown that the weight of the press frame is reduced from 17366 kg to 15420 kg, which means a 12.62% weight reduction with a maximum deformation of 0.633 mm, which is acceptable, and a stress induced of 102 MPa. which is less than yield stress of 250 MPa when consideration factor of safety 2.45.

B. Parthiban et al. [2] used CATIA software for modelling, and for analysing stress and strain distribution simulation software ANSYS was used. In this paper press, a capacity of 60 tonnes of mild steel is used. After design and analysis results, the cylinder's fillet radius is reduced from 25 mm to 15 mm, and the thickness of some frame plates is reduced. so that its weight is also reduced to 90 kg.

Rajdipsinh G. Vaghela et al. [3] have suggested topology optimization do with the intention of reducing thickness. The results of the simulation and analytical work indicate that the stress values are well within the permitted ranges. According to the results of the optimization analysis, the current thickness may be lowered by up to 20% without sacrificing functionality.

Umesh S Badakundri et al. [4] have analysed the reduction of cost by reducing material in the press frame. Material is reduced through the use of various thicknesses of plates. First, they calculate stress, and they get stress of four tie rods, a lower plate, an upper head, two tie rods, and the frame, respectively: 38.30, 114, 19.62, 75, and 2.35 N/mm^2. Also, using ANSYS analysis software, they find out stresses of 38.31, 123.875, 23.25, 83.93, and 2.69 N/mm^2.

Stress values obtained by theoretical to values obtained by software within 15% of error. The thickness is reduced from 5.4 to 4 mm.

D. Ravi [5] studied to look into the finite element modelling of a 10-tonne capacity "C" frame power press and analyse the press under static conditions. The structure is under a maximum stress of 56.68 N/mm^2 and a maximum deflection of 1.533 mm in the existing design. The structure is subjected to a maximum stress of 56.42 N/mm^2 and a maximum deflection of 1.647 mm in the suggested design. Static analysis shows that the design is secure. The frame and bed thickness are reduced in this design. There is a weight reduction as a result. There has been a 13.5% weight reduction. Finally, researchers draw the conclusion that this design is the better one.

Ameet B. Hatapakki et al. [6] optimise the thickness of the side plates of the C frame and maintain the top frame deflection of 50 microns. The software analysis is done by ANSYS. They are assuming a factor of safety of 3, the deformation of the top frame of the model is found to be 49.26 microns, which is less than the desired limit, and the percentage of net component weight is reduced to 12%. Hence, design optimization as well as cost optimization are obtained.

Sumit Suresh Patil et al. [7] do work using the computer-aided design (CAD) programme NX-CAD, a 20-ton hydraulic press is built and tested using components obtained locally. The hydraulic actuator and clamping mechanism in this machinery have dimensions of 200*80*200 mm and 100*60*200 mm, respectively, and the actuator's stroke length is taken into account to be 200 mm (working pressure of 200 bar). Now the pipe is being squeezed and flared to a diameter and thickness of 100*02 mm at a check load of 10 kN. The authors also came to the conclusion that the horizontal machine is superior to the vertical machine.

N. Venkatesh et al. [8] suggested to redesign the Hydraulic Roller Press existing frame assembly. Two upper frame members and two lower frame members, both consisting of steel with a maximum thickness of 260 mm, make up the majority of this frame assembly. These thicker plates are not available for purchase as regular thick plates. This research revealed that the existing design's safety factor is maintained at 3.5, despite the required being just 2.5. With the same boundary conditions, Stress Analysis and Simulation Software (ANSYS-11) has been used to model and analyse alternative hollow cross sections with standard plate thickness.

Jagadish Mahakal et al. [9] said that a deep-drawing press is developed using the standard process, and the components of the closed-type press are designed for 200 kN or 200 tons.

CATIA V5 is used to simulate the designed press. For the analysis, the model is exported into ANSYS Workbench. First, maximum deflection of press and stress are determined for the specified dimension and the load. They reduce the deflection from 0.11975 mm to 0.10361 mm by comparing the results of the old bottom plate with the redesigned final bottom plate, and this value is within the allowable range. Von-Miss stresses decrease from 37.021 MPa to 30.668 MPa, and they also don't go beyond the allowable limit, making our bottom plate safe for use.

H. N. Chauhan et al. [10] have suggested that simulation software is an effective tool for predicting the thickness of plate needed for a given load. Since that machine only requires a 25mm thickness of plate, it will be useful to keep the plate thickness within the limit. A change in thickness can result in a size that uses 29% less raw materials.

Asim M. Kamate et al. [11] have studied a model and analysis of an existing 20-ton hydraulic press. They show analysis results where the maximum shear stress is 166.15 MPa and the total deformation is 1.901 mm. After that, the total design of the press is changed by using standard components such as C channels and I section channels, which reduces the cost of manufacturing. After the modification of the press design, analysis results show that the maximum shear stress is 298.14 MPa and the total deformation is 2.0642 mm. By calculating cost reduction, they show the cost reduction of hydraulic presses is 53.48 percent.

Dr. Mohammad Israr et al. [12] design a power press according to the 33 kN of cutting force required to cut the desired material. They are using the press to cut an aluminium sheet that is up to 0.5 mm thick and not more than 20 mm wide.

Muni Prabaharan et al. [13] shown 26.36% weight reduction and 26.26% cost reduction for the scrap baling press, and also 24.54% weight reduction and 24.54% cost reduction for the hydraulic press. They are fabricated 5-ton hydraulic presses that use topology optimization, too. For topology optimization, they are used to create models in ProE software and analyse stress distribution in ANSYS Workbench software.

Ankit H Parmar et al. [14] suggested the reduction of overall mass of the hydraulic press while maintaining sufficient lateral stiffness is the objective of structure optimization. For hydraulic presses, a method of structural optimization is suggested in order to decrease mass while maintaining acceptable rigidity. In order to they examine the relation between stiffness, mass, and design factors, CREO builds a common batch file and ANSYS does the study. Authors can lower the weight from 2263 kg to 1303 kg by comparing the results of the new final bottom

plate with the old bottom plate. The deflection rises from 0.055 to 0.22 mm, yet it stays within acceptable limits. It has no impact.

Malachy Sumaila et al. [15] study design, manufacturing, and calibration of a 30-ton hydraulic press is completed. The machine is put under a load of 10 kN, which is supply by two parallel compression springs. After that, the springs are axially compressed to a length of 100 mm. Two hours are given for this configuration to stand before leaks were checked. The lower platen does not deviate from its initial position, ruling out system leakage.

Benjamin Ufuoma Oreko et al. [16] have suggested design and analysis of a 10-ton, H-frame hydraulic press with an integrated force measurement device in this study. For the H-frame, Mild steel is also ductile and soft, making it simple to produce for structural uses. IS 2062 (AISI 1020) is chosen for the entire frame. The upper portion of the frame experiences the most stress, which can reach up to 46.82 MN/mm^2 in compression. The designed 10 tonne maximum compressive force may efficiently press various materials like ABS plastics and wood but is insufficient for materials like mild steel and aluminium.

Nawale Sagar et al. [17] have studied maximum load, the distance the load resistance has to travel (piston stroke, 300 mm), the system pressure, the cylinder area (piston diameter, 150 mm), and the volume flow rate of the working fluid are key parameters of design. The frame, the hydraulic circuit, and the cylinder and piston arrangement are main structural elements of press. Two compression springs with constant spring rates of 9 N/mm each were placed parallel between the upper and lower platens of the machine to test its performance under a load of 10 kN, and the results were satisfactory.

G. J. Pol et al. [18] have analysed system is under a maximum stress of 39.007 MPa and a minimum stress of 0 MPa after applying a force of 981 KN. The optimised machine weighs 165 kg, compared to the current C-frame weight of 530 kg. And Authors managed a 363-kilogram weight loss. To raise C-frame strength, surface treatment may be applied. Build a pressure base and bed; optimization can be achieved by changing the shape or physical properties of the foundation or bed.

Deepak Annasaheb More et al. [19] studied the welded construction of a hydraulic press machine with a nominal operational load of 200 kN has been the subject of theoretical and analytical research. The findings acquired by the analytical software and those theoretically expected have been compared to design of the press structure objective. Weight reduction occurs as a result of employing standard portions when creating press frames.

Mohammed Iqbal Khatib et al. [20] have suggested the materials used to build the machine came from the town. The majority of the machine parts were fabricated using mild steel. A variety of press operations were carried out using the designed hydraulic press equipment. The machine operated without issue because there was no distortion, deformation, weld failure, or leaks, and the hydraulic pump, ram, and pump mechanism all operated well under a range of loads. The dimensions of hydraulic press machine are length 800 mm, breadth 600 mm, and material thickness.

Miss. Snehal Ambekar et al. [21] have analysed existing system of sponsored investment is heavier. The optimized system is lighter in weight and a solution to the disadvantages of the existing system. Optimization is achieved on load-bearing components of systems such as the C-frame. Design calculations, analysis models and experimental results of the existing system and the optimized system are compared on a load basis. The weight of the existing C-frame is 530 kg and the weight of the optimized system is 165 kg. They achieved a weight reduction of 363 kg. 68% material was saved in an optimized system compared to the existing system, which saves further cast parts of the system.

Rucha. S. Khisti et al. [22] are examined the hydraulic, and the C frame is designed in accordance with the specifications by using the reverse engineering method. Using Unigraphics software, the C frame was modelled. Software called Solid Thinking is used to analyse the assembly press. By removing the excess material from the areas where the stresses were not present, the design was optimised without sacrificing quality. Used material is EN24 and C40. The outcome of the analysis programme is within the acceptable range.

Nikhil Mahajan et al. [23] have suggested after researching the uses of various materials, mild steel with 0.3 to 0.4% carbon and 0.3 to 0.6% manganese is chosen for the machine frame or body. Typical designation of this material is C 35. As the system is hydraulic, a relief valve will open and the flow of oil will be diverted to a reservoir for higher than prescribed pressures, hence 2.5 is used here as the factor of safety.

Satish B. Mariyappagoudar et al. [24] have analysed at 10 Ton, the machine frame with plate experiences a maximum stress of 251Mpa and a maximum deformation of 2.5mm. The highest stress created is about equal to the yield stress of mild steel (250Mpa). The safety factor is 0.99. Without a plate, the machine frame is subjected to a maximum stress of 641.3Mpa. With this load, the maximum deformation is 3.3mm. The safety factor is 0.409. The design frame can sustain the maximum stress up to 3 Ton without a plate, according to the results. If the hydraulic

frame loads more than 3 tonnes, it will break since the factor of safety is below 2. Before optimization, the overall cost of the hydraulic press was Rs. 4925. After optimization, the cost of the hydraulic press frame was Rs. 1672. Cost reduction percentage of 66.058%.

Akshay Vaishnav et al. [25] suggested with incremental iteration, the design is changed by the sizing optimization method. The FEA results for 250 mm of rib height are obtained. Maximum von Mises stress of the design is lower than the material's ultimate tensile stress, making it safe. These findings show that, for Iteration 1, a rib height of 350 mm can be used to obtain the desired deformation. The weight is 571.87 kg, and the maximum von Mises stress at this height is 520.29 MPa. For Iteration-2, 450 mm of rib height, a maximum von Mises stress of 484.43 MPa, and a weight of 678.31 kg can be used to accomplish the desired deformation. For iteration 3, adding 250 mm of rib height, 400 kg of weight, and the maximum von-Mises stress of 393.57 MPa will result in the desired deformation. They analysed design-3 is recommended for manufacture. Compared to other designs, it weighs considerably less, saving on material costs. It also complies with all the design requirements. By using the casting procedure, it can be produced.

Abhijeet S Khandekar [26] have studied the Metal Forming Heavy Duty Hydraulic Press conventional design calculation and 3D modelling have been defined in this study. Stress calculated using traditional design methods is equal to 150 kg/cm^2. Finite element approach will also be employed to calculate the optimization's design.

Karkhane Himanshu Namdev et al. [27] have suggested because it is ductile and soft, mild steel (IS2062) was chosen for the frame because it is simple to weld and process. By merely lowering the frame thickness by 2mm When the volume was reduced by 5 x 108 mm^3, the mass was likewise decreased, going from 1937.8 kg to 1892.4 kg. Mass loss is calculated as 1937.8 - 1892.4 = 45.4 kg.

S. Raja Shekar et al. [28] have studied to optimize the plate thickness used in the manufacture of the frame, topology optimization has been done. Topology improvement based on stress and deflection has resulted in a significant weight decrease. The corresponding Von Mises stresses and deflections obtained for the final design are well within the material yield limitations. Maximum equivalent stress, measuring 162.08 MPa, was observed at the frame structure's corner, while the top plate's maximum deflection was determined to be 1.161 mm.

Bhushan V. Gadekar et al. [29] have analysed the highest stress that the machine can withstand is 66.95 N/mm^2, which is less than the maximum stress that the material can tolerate. Further

material reduction results in unsafe and higher deformations and stresses that are not acceptable for the machine. In this project, machine is used for punching and bending operations in the sheet metal industries, where the press deformation is essential to maintaining the close tolerance between punches and dies. The maximum deformation measured, as shown by the research, is 0.0042 m, which is suitable for such an operation. After optimization, the machine weighed 63 kg in total.

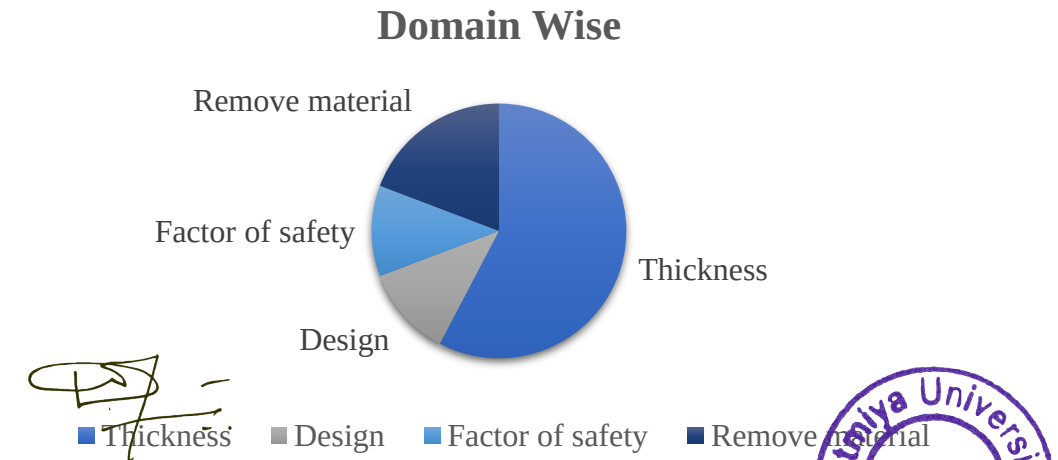
Dr. Mohammad Israr et al. [30] determine the cutting force needed to cut the chosen material before developing the power press. The press has been created to cut aluminium sheets up to 0.5 mm thick and no wider than 20 mm. To be safe, they use a punch length of 55 mm. They use the pinion shaft diameter, which is 22 mm, as the safety diameter. They use a 24 mm gear shaft diameter for safety reasons.

2.3 Summary of literature review

Based on a review of published information on design and analysis of mechanical press frame structures and supporting experimental data, the following conclusions can be drawn:

- Mechanical press failure most of the sharp corner of press frame and crack initiate at junction of two plates.
- FEA Analysis is best solution method for stress analysis and shape optimization of frame structure. FEA analysis gives accurate result.
- Optimization by reducing thickness of plates so decreasing material cost and weight.

2.4 Literature mapping



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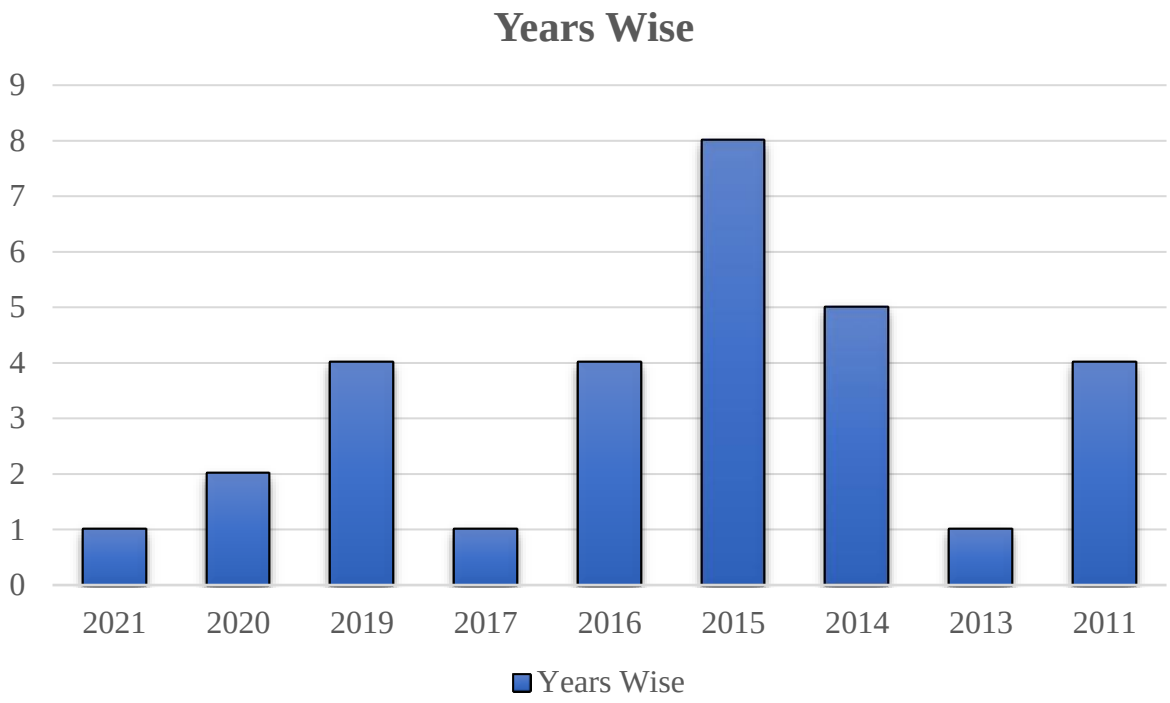

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CHAPTER – 3

Problem Definition

3.1 Introduction to company

The I.S.Chawla Group of Companies is a group of engineering companies that provides capital equipment to a wide range of industries, including those that build pre-fabricated structures, fabricate sheet metal, manufacture pumps and valves, make white body goods, build ships, work on pipe lines, and make lighting poles, among others..[45]

The Hero Group, Tata, Mahindra, Toyota, Hyundai, Maruti, Honda are among the many of the automobile manufacturers that frequently utilize power presses, making Singhal Power Presses Pvt. Ltd. (SEW Presses) the nation's top producer of these machines. Its power presses have a 600T capacity. [45]

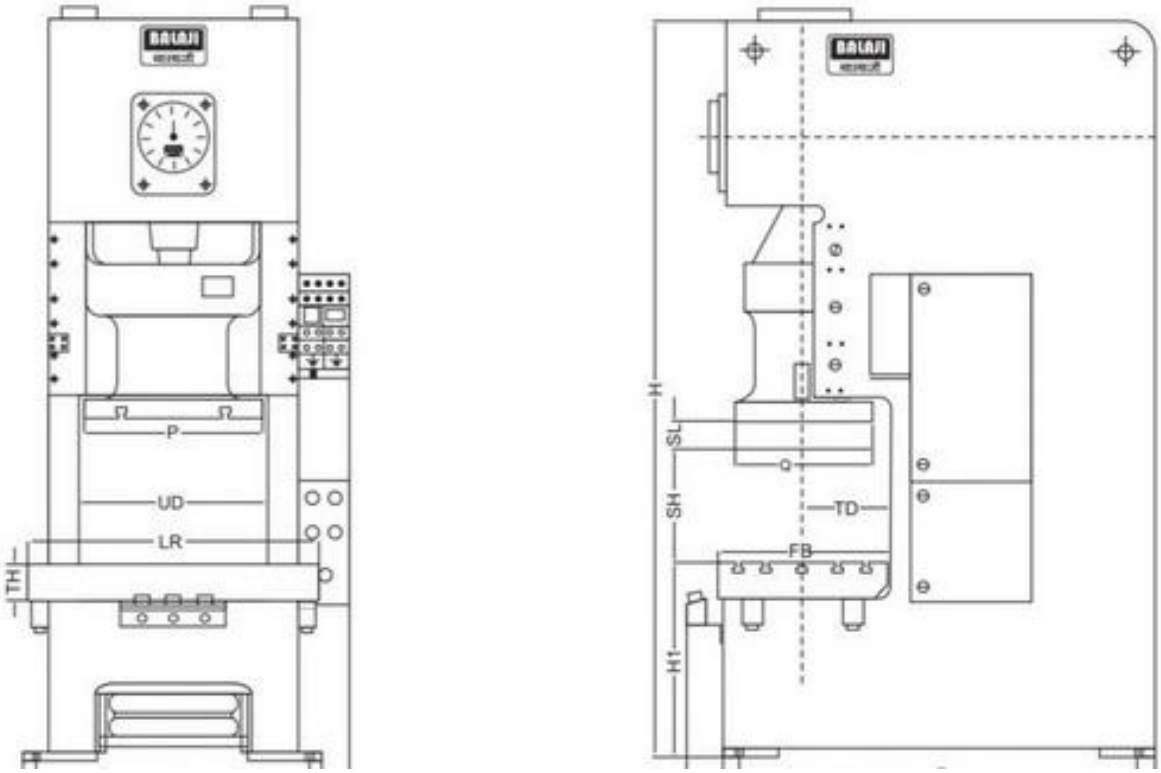


Figure 3.1 Schematic diagram of power press-i [46]

3.2 Part details of press machine

Different press types contain almost identical major component types. These components are explained below.[41]

- **Base**

One of the components of a press is the base, which is an all-machine tool. It serves as the press's primary supporting component for the work piece housing dies and various control systems. The largest work item that can be processed on a press is limited by the size of the table. For some unique presses, the base has a mechanism that allows the frame to be tilted in any desired inclined position.

- **Frame**

Frame constitutes main body of the press located at one edge of its base. It houses the ram support as well as the driving and control mechanisms. Some presses feature a frame in the shape of a column.

- **Ram**

This is the primary component of the press that operates when processing a work item. Ram executes set stroke length and power to and from within its guide routes. According to the needs, the stroke length and power imparted can be changed. Ram has a punch at the bottom to process the work item.

- **Driving Mechanism**

The driving mechanisms employed in various types of presses include eccentric and crankshaft mechanisms in mechanical presses, cylinder and piston arrangements in hydraulic presses, etc. By transmitting power from the motor to the ram, these devices are employed to drive the ram.

- **Controlling Mechanisms**

In order to operate a press under precisely controlled circumstances, controlling mechanisms are employed. Normally two parameters are adjusted by controlling mechanisms length of stroke of ram and power of stroke. With the aid of the clutch included with driving mechanisms when needed, power transfer can be disengaged. In the majority of presses, the driving and controlling mechanisms are integrated. Today's presses are compute-controlled, with a microprocessor acting as the controlling factor. These presses offer automated control that is dependable and accurate.

- **Brakes**

Any movable system needs brakes immediately. Two types of brakes are typically employed: the standard brake, which may swiftly put the driven shaft to rest after disengaging it from the flywheel. Another option is emergency brakes,

which may be attached to any machine as a foot brake. These brakes have a power off option in addition to regular, more difficult braking to instantly stop all motion.

- **Bolster Plate**

It is a strong plate fastened to the press's base or bed. To support the work piece, it is used to closely secure the die assembly. The phrase "die assembly" is used in place of "die" since the die used in press operating may contain multiple parts.

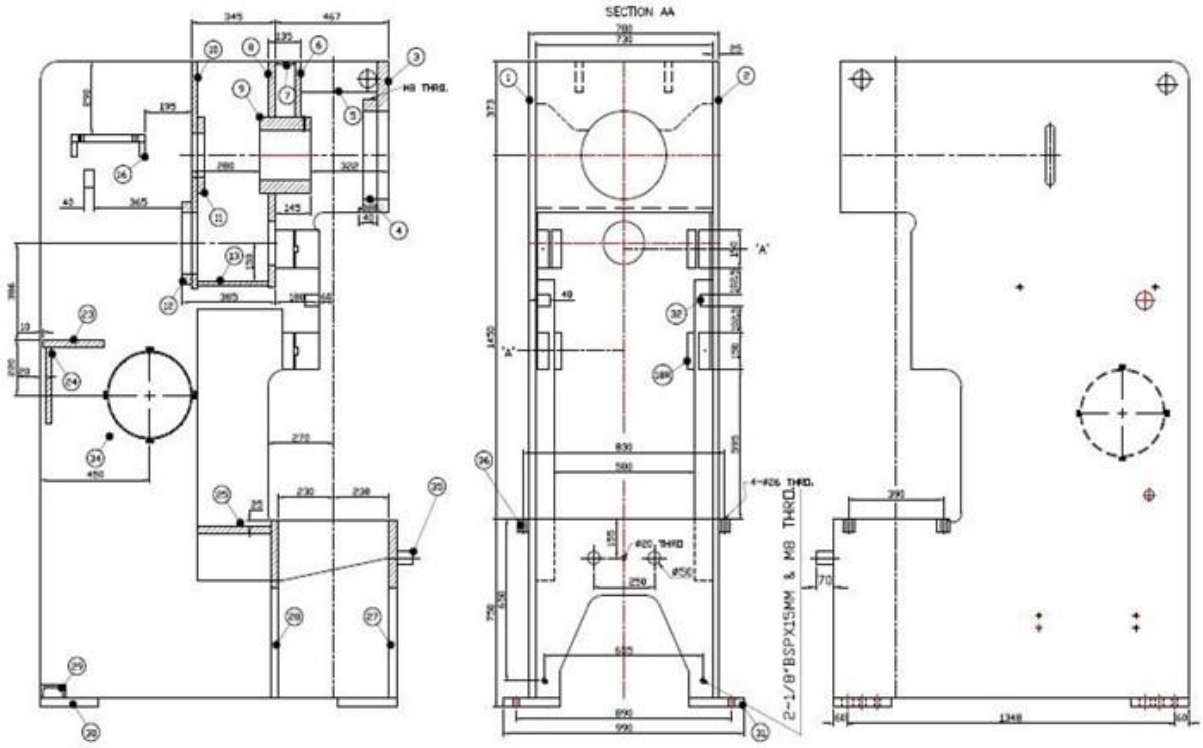


Figure 3.2 Schematic diagram of power press-ii [41]

3.3 Problem occurred in press machine

Since there is a frame failure issue with the press machine, such a heavy component shouldn't fail under the right working load conditions. The frame of the press machine constantly receives tensile stress as a result of the impact load. Continuous stress is applied to press machines, and as a result, structural problems are regularly encountered. Understanding the causes of structural failure in press machines can help. the frame's distribution of stress to identify the point of crack beginning in the frame structure, use a finite element analysis (FEM) tool. Identifying where the crack initially originated allows one to strengthen that particular section.

The inadequate side plate is what caused this issue. Use 36mm thick plate to reduce this

type of defect company without taking any technical considerations. Therefore, it is desirable to specify the appropriate plate thickness and to construct the press design according to the appropriate design consideration.

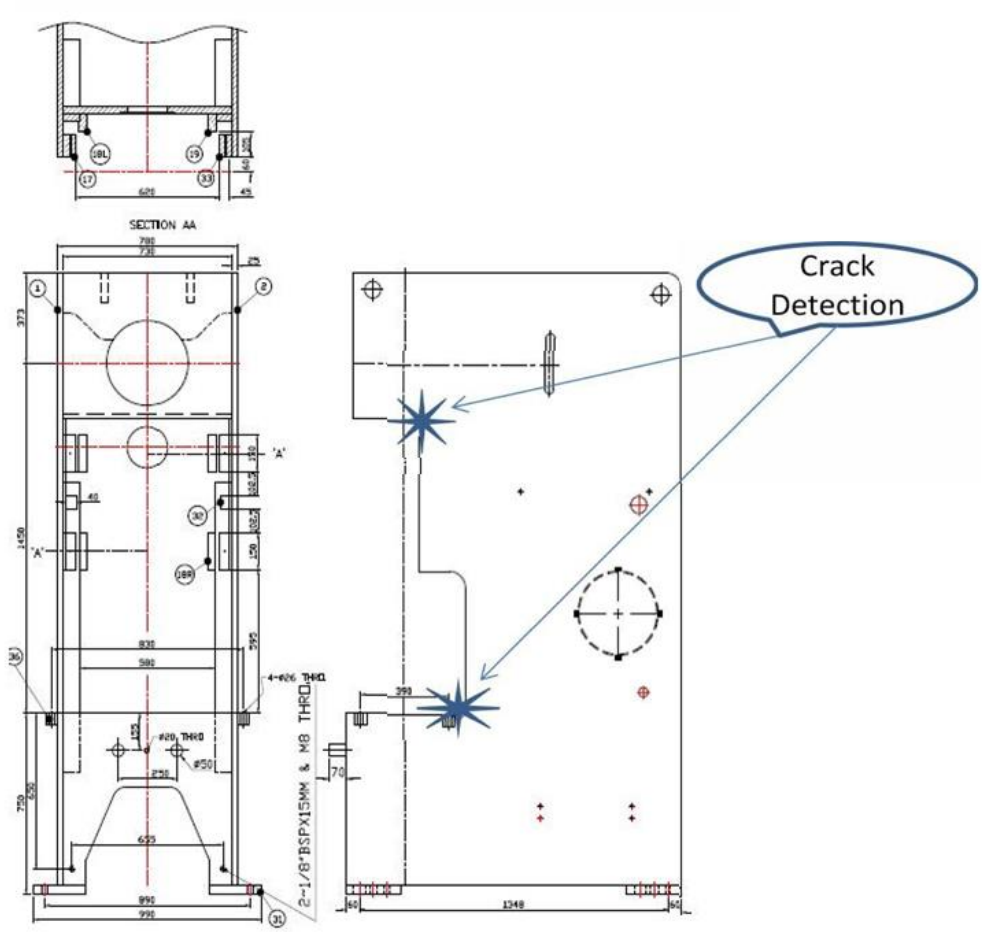


Figure 3.3 Position where the crack is generated [41]

3.4 Objectives

- To analytically determine the deformation of existing frame structure of power press.
- To identify the design parameter responsible for failure of power press frame structure.
- To modify the design parameter of frame structure to permissible range of deformation and calculation effect of loading condition on frame structure.
- To compare analytical results of frame structure deformation and stress results obtain by simulation with different plate thickness.
- To specify the optimum value of plate thickness to make design of press as per the standard design consideration with cost and material reduction.

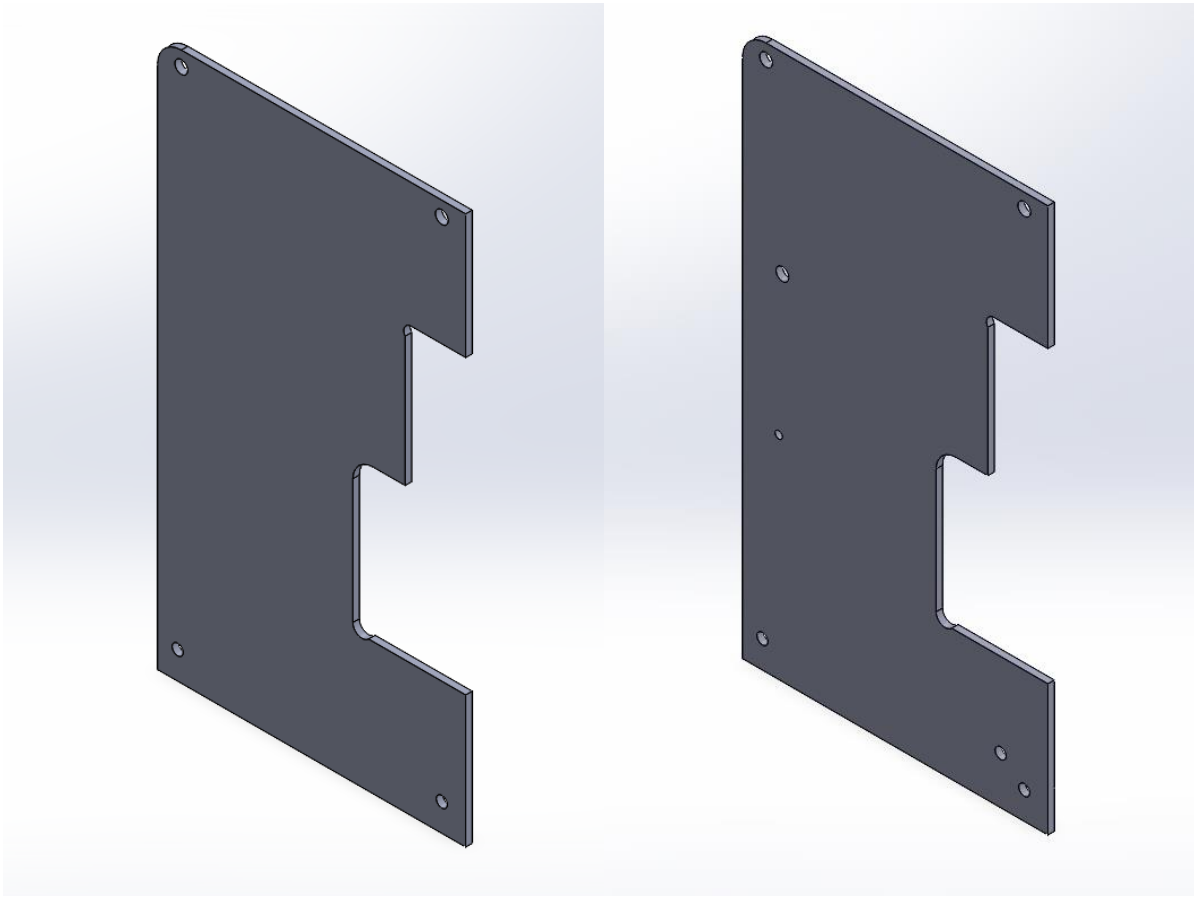
CHAPTER – 4

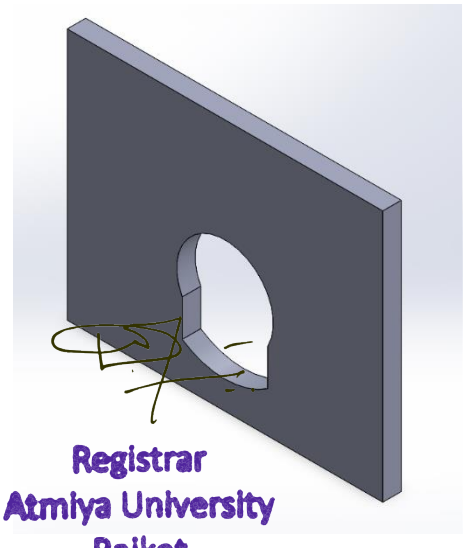
Modelling and Analysis of Existing Frame of Power Press

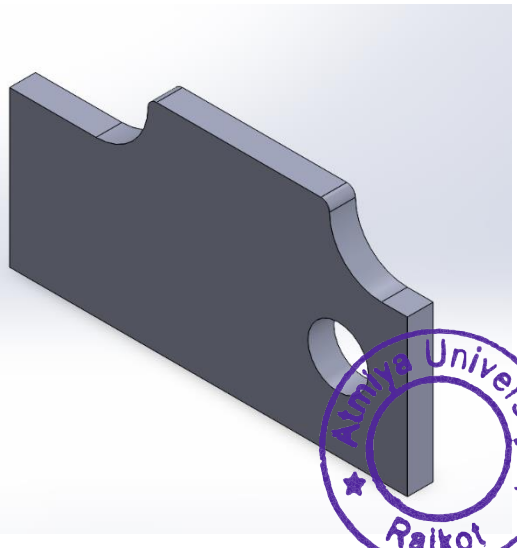
4.1 Modelling of existing frame of power press

4.1.1 Modelling parts of existing frame structure of power press

A 3D model of different plates which is used to make frame structure of power press are created using Solid works software as shown in figure below.







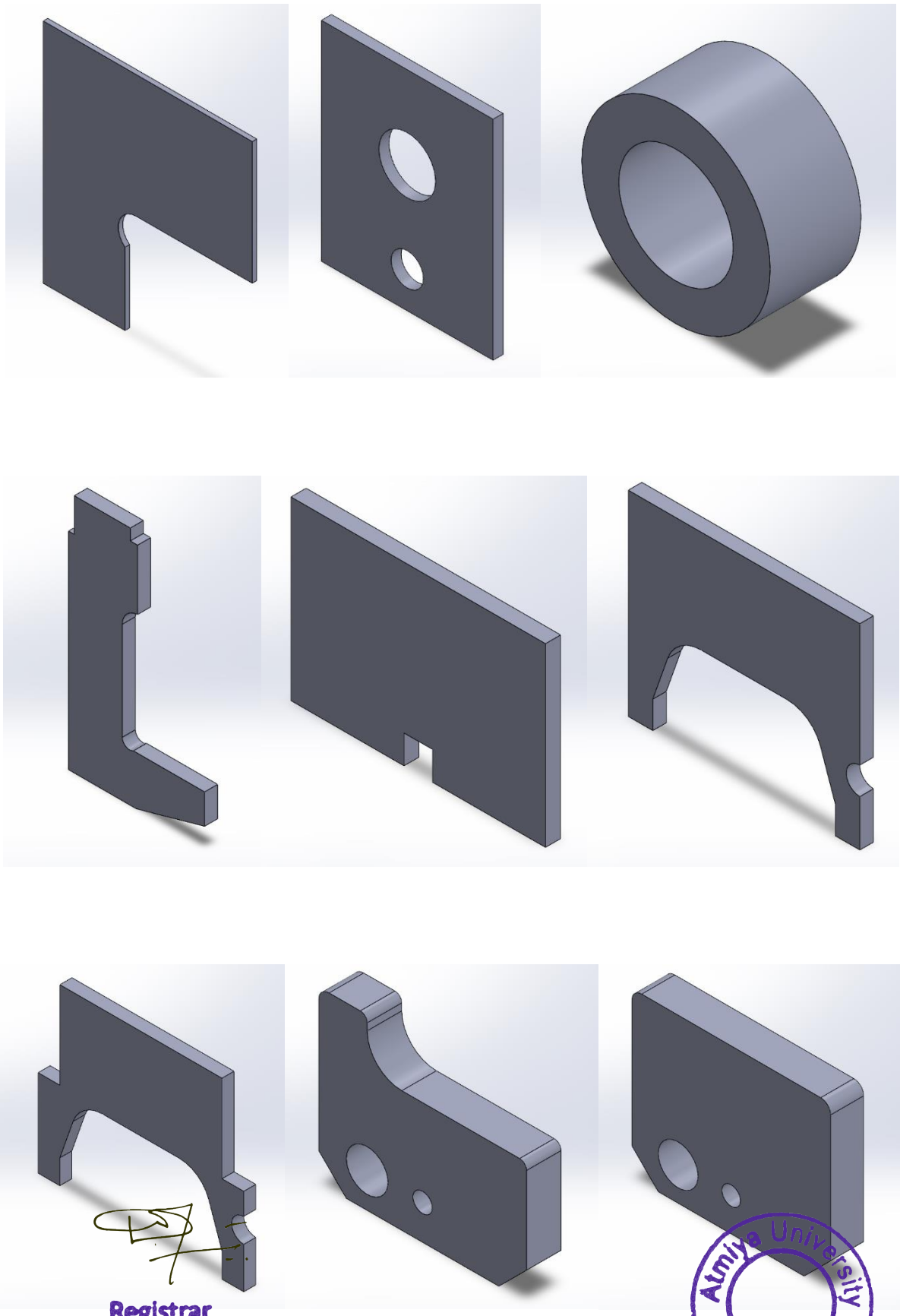


Figure 4.1 Modelling of parts of existing power press frame structure

4.1.2 Assembly of existing frame structure of power press

Assembly of frame structure of power press is shown below.

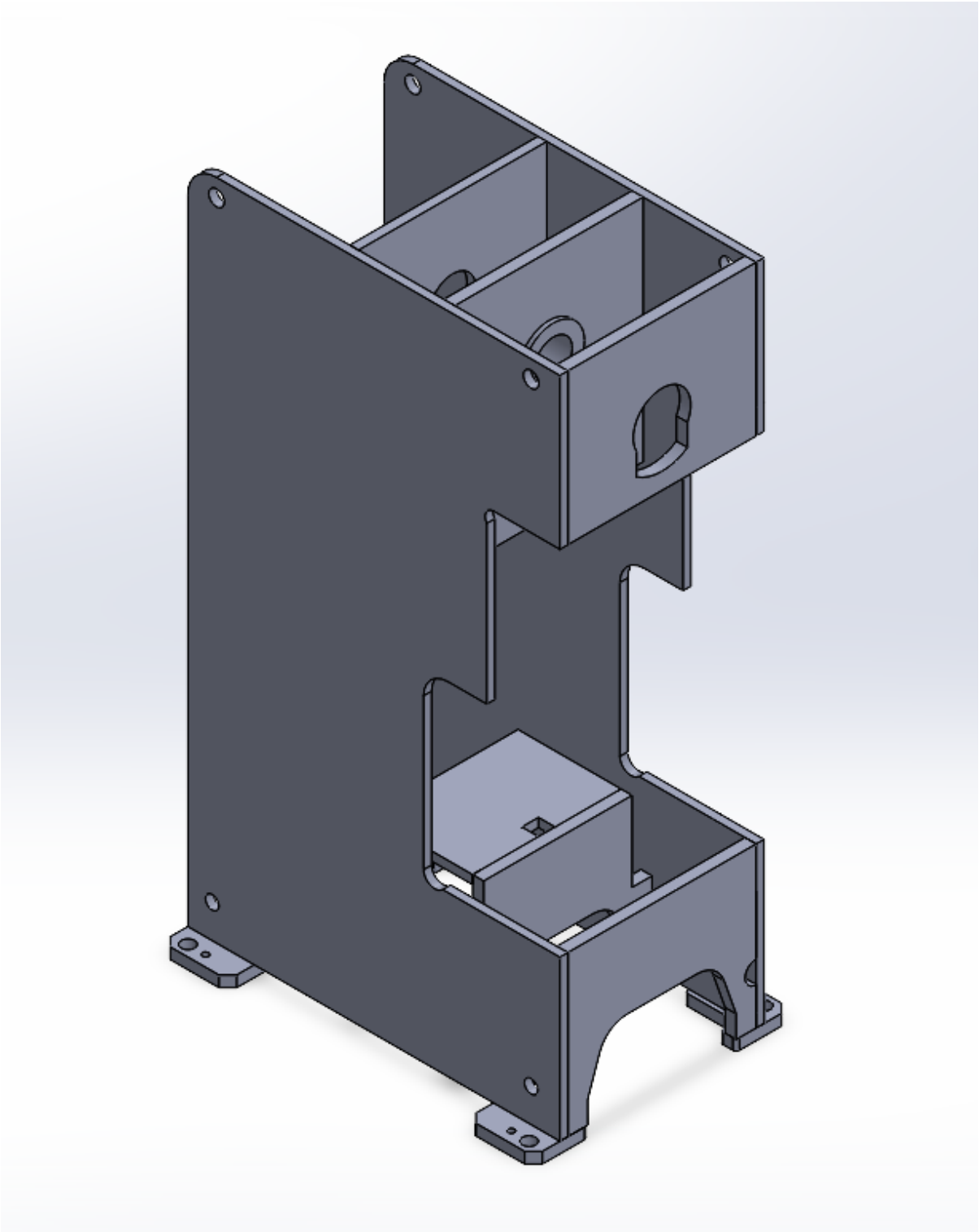


Figure 4.2 Assembly of existing frame structure of power press

4.2 Analytical calculation

"ST42W" from the "WESTERMANN TABLE" is the material used by the company, "SINGHAL POWER PRESS PVT. LTD." for the metal trade.[40]

Table 4.1 Specification of material ST42W

Mechanical Properties	Units
Designation	ST42W
Tensile Strength	420 to 540 MPa
Yield Strength for Thickness 20-40 mm	240 MPa
Elongation % Min	23
Density	7860 kg/m^3
Young's Modulus	2.1 x 10^5 N/mm^2
Factor of Safety	2

Table 4.2 Chemical composition of material ST42W

C % Max	S % Max	P % Max
0.20	0.055	0.055

As a section is symmetrical, one side of the frame has been considered for the analysis

Centre of Gravity:

$$\bar{Y} = \frac{a_1 x_1 + a_2 x_2 + \cdots}{a_1 + a_2 + \cdots}$$

$$\bar{Y} = \frac{(1680*36)(840)+(1350*36)(675)+(1065*36)(532.5)+(1680*36)(840)}{(1680*36)+(1350*36)+(1065*36)+(1680*36)}$$

$$\bar{Y} = \frac{4300762.5}{5775}$$

$$\bar{Y} = 744.72\ mm$$

A = 1680 – 615 + 355

A = 1420

Eccentricity

e = A - $\bar{Y}$

e = 1420 – 744.72

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e = 675.28 mm

1 Ton = 9806.65 N

110 Ton = 1078731.5 N

P = $\frac{1078731.5}{2} = 539365.75\ N$

Avg. A = $\frac{5775*36}{4} = 51975\ mm^2$

Bending Moment

$M_b = P * e$

$M_b = 539.36 * 103 * 675.28$

$M_b = 364.22 * 10^6\ Nmm$

Moment of Inertia

$I = \sum a_i * (y_i - \bar{Y})^2$

$I = (1680 * 36)(840 - 744.72)^2 + (1350 * 36)(675 - 744.72)^2 + (1065 * 36)(532.5 - 744.72)^2 + (1680 * 36)(840 - 744.72)^2$

$I = 3061.08 * 10^6\ mm^4$

Fareast distance

$Y = 1680 - \bar{Y} = 935.28\ mm$

Bending Stress

$\sigma_b = \frac{M * y}{I} = \frac{364.22 * 10^6 * 935.28}{3061.08 * 10^6}$

$\sigma_b = 111.28\ N/mm^2$

Tensile Stress

$\sigma_t = \frac{P}{A} = \frac{539365.75}{51975}$

$\sigma_t = 10.38\ N/mm^2$

Maximum Stress

$\sigma_{max} = \sigma_b + \sigma_t$

$\sigma_{max} = 111.28 + 10.38$

$\sigma_{max} = 121.66\ N/mm^2$

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$\sigma_{max} \leq 270\ N/mm^2$ as per Westermann table

Checking for deformation:

$$\delta = \frac{H(e+L)}{R}$$

Now,

$$\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$$

$$R = \frac{E * I}{M}$$

$$R = \frac{2.1 * 10^6 * 3061.08 * 10^6}{364.22 * 10^6}$$

$$R = 17.65 * 10^6 mm$$

Here,

$E = 2.1 * 10^6\ N/mm^2$

$I = 3061.08 * 10^6 mm^4$

$M = 364.22 * 10^6 Nmm$

$R = 17.65 * 10^6 mm$

$H = 825 + 770$

$L = 615 - 355$

$$\delta = \frac{1595 * (675.28 + 260)}{17.65 * 10^6}$$

$\delta = 0.0845 mm$

$\delta \leq 0.13$ mm as per ISO standard

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4.3 Analysis in simulation software

- Meshing of existing frame structure of 36 mm plate thickness.

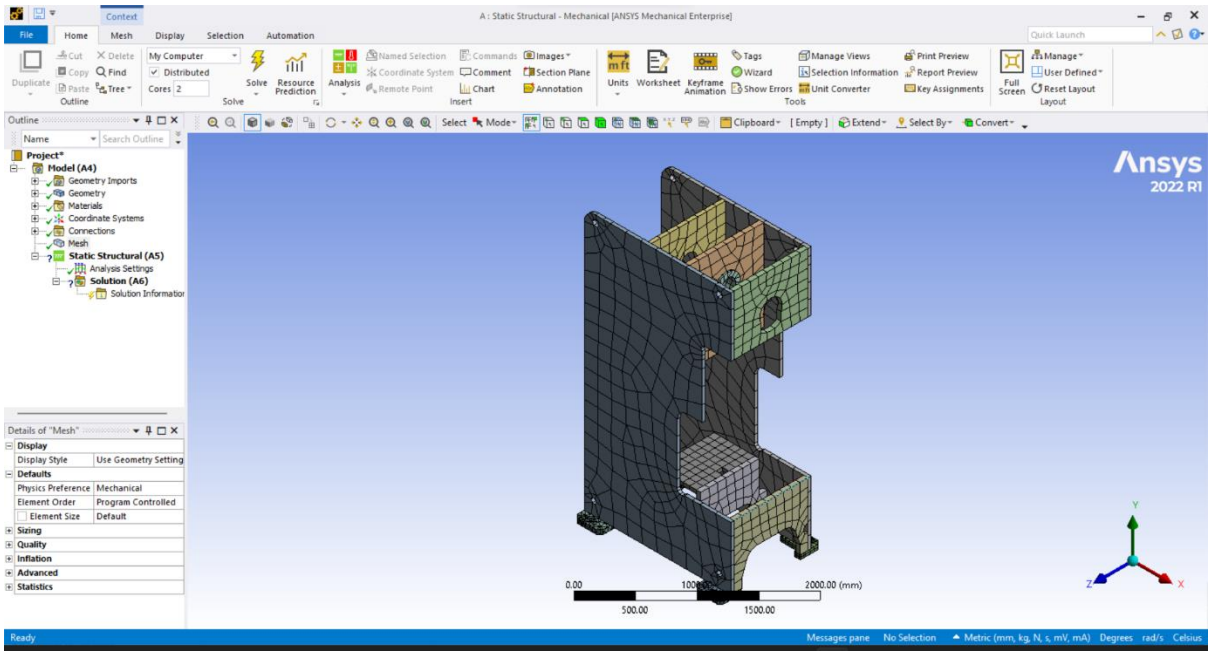

Figure 4.3 Meshing of existing frame structure

- Apply boundary condition to existing frame structure of 36 mm plate thickness.

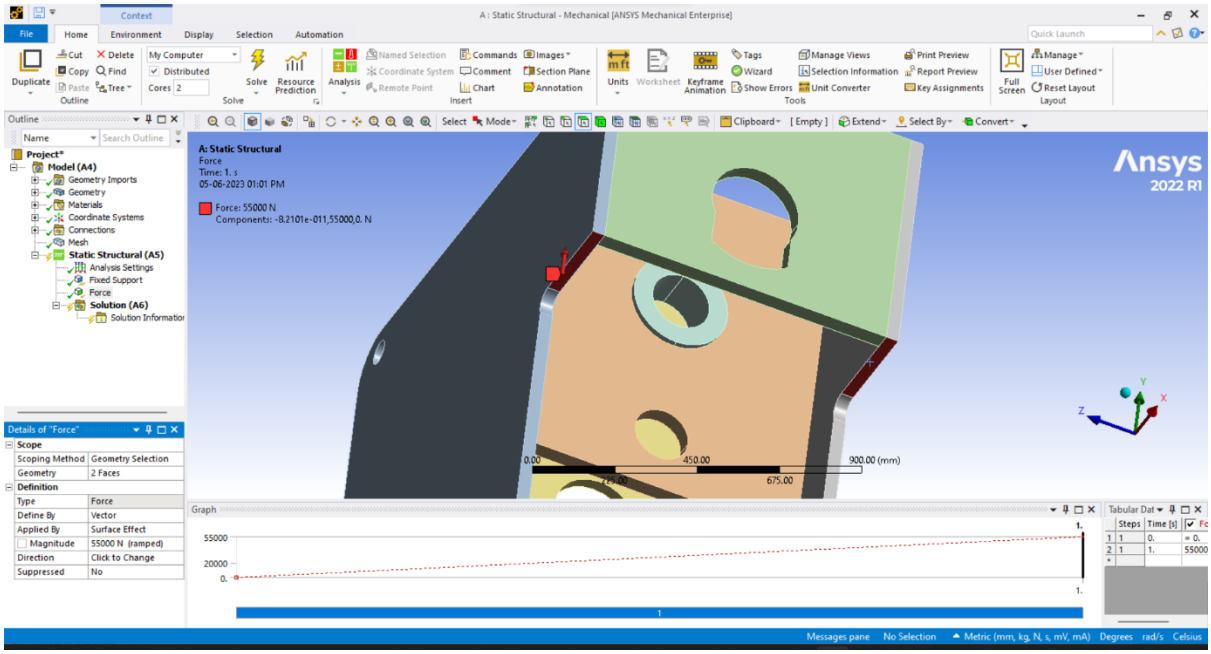

Figure 4.4 Apply boundary condition to existing frame structure

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- Effect of Von Mises stress on 36 mm plate thickness of frame structure of press is 120.25 MPa.

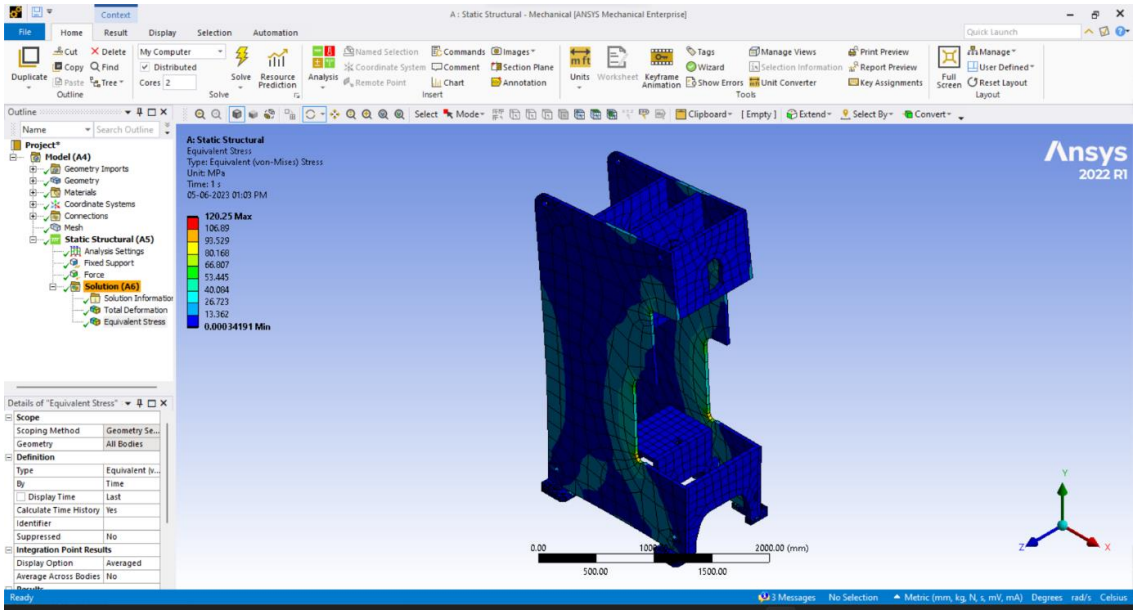

Figure 4.5 Effect of Von Mises stress on frame structure

- Effect of deformation on 36 mm plate thickness of press frame structure is 0.083 mm.

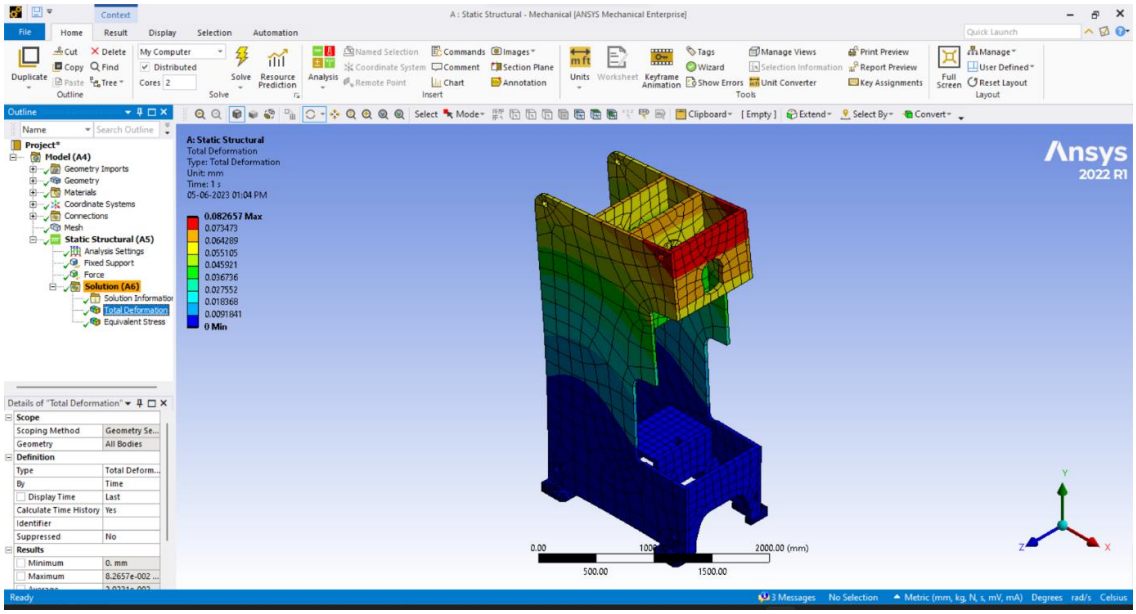

Figure 4.6 Effect of deformation on frame structure

Table 4.3 Deformation and Von Mises stress of existing frame of power press

Plate Thickness	Analytical	Simulation	Difference
36 mm	Deformation		
	0.0845 mm	0.083 mm	2.18 %
	Von Mises Stress		
	121.66 MPa	120.25 MPa	1.15 %

CHAPTER – 5

Optimization of C-Type Frame Structure of Power Press

5.1 Introduction

This chapter discusses the precise design of frame plates for various plate thicknesses in order to determine the ideal dimensions for plates that will not fail during use and can withstand loads of 110 tons for the duration of their useful lifespans.

5.2 Design of press for different plate thickness

"ST42W" from the "WESTERMANN TABLE" is the material used by the company, "SINGHAL POWER PRESS PVT. LTD." for the metal trade.[40]

Table 5.1 Specification of material ST42W

Mechanical Properties	Units
Designation	ST42W
Tensile Strength	420 to 540 MPa
Yield Strength for Thickness 20-40 mm	240 MPa
Elongation % Min	23
Density	7860 kg/m^3
Young's Modulus	2.1 x 10^5 N/mm^2
Factor of Safety	2

Table 5.2 Chemical composition of material ST42W

C % Max	S % Max	P % Max
0.20	0.055	0.055

5.3 Calculation for a 32 mm plate

Centre of Gravity:

$$\bar{Y} = \frac{a_1 x_1 + a_2 x_2 + \cdots}{a_1 + a_2 + \cdots}$$

$$\bar{Y} = \frac{(1680*32)(840)+(1350*32)(675)+(1065*32)(532.5)+(1680*32)(840)}{(1680*32)+(1350*32)+(1065*32)+(1680*32)}$$

$$\bar{Y} = \frac{43007\text{62.5}}{5775}$$

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$\bar{Y} = 744.72\ mm$

A = 1680 – 615 + 355

A = 1420

Eccentricity

e = A - $\bar{Y}$

e = 1420 – 744.72

e = 675.28 mm

1 Ton = 9806.65 N

110 Ton = 1078731.5 N

P = $\frac{1078731.5}{2} = 539365.75\ N$

Avg. A = $\frac{5775*32}{4} = 46200\ mm^2$

Bending Moment

$M_b = P * e$

$M_b = 539.36 * 103 * 675.28$

$M_b = 364.22 * 10^6\ Nmm$

Moment of Inertia

$I = \sum a_i * (y_i - \bar{Y})^2$

$I = (1680 * 32)(840 - 744.72)^2 + (1350 * 32)(675 - 744.72)^2 + (1065 * 32)(532.5 - 744.72)^2 + (1680 * 32)(840 - 744.72)^2$

$I = 2720.95 * 10^6\ mm^4$

Fareast distance

$Y = 1680 - \bar{Y} = 935.28\ mm$

Bending Stress

$\sigma_b = \frac{M * y}{I} = \frac{364.22 * 10^6 * 935.28}{2720.95 * 10^6}$

$\sigma_b = 125.19\ N/mm^2$

Tensile Stress

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$$\sigma_t = \frac{P}{A} = \frac{539365.75}{46200}$$

$$\sigma_t = 11.67\ N/mm^2$$

Maximum Stress

$$\sigma_{max} = \sigma_b + \sigma_t$$

$$\sigma_{max} = 125.19 + 11.67$$

$$\sigma_{max} = 136.86\ N/mm^2$$

$\sigma_{max} \leq 270\ N/mm^2$ as per Westermann table

Checking for deformation:

$$\delta = \frac{H(e+L)}{R}$$

Now,

$$\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$$

$$R = \frac{E * I}{M}$$

$$R = \frac{2.1 * 10^6 * 2720.95 * 10^6}{364.22 * 10^6}$$

$$R = 15.69 * 10^6 mm$$

$$\delta = \frac{1595 * (675.28 + 260)}{15.69 * 10^6}$$

$$\delta = 0.095\ mm$$

$\delta \leq 0.13$ mm as per ISO standard

5.4 Calculation for a 28 mm plate

Centre of Gravity:

$$\bar{Y} = \frac{a_1 x_1 + a_2 x_2 + \cdots}{a_1 + a_2 + \cdots}$$

$$\bar{Y} = \frac{(1680*28)(840)+(1350*28)(675)+(1065*28)(532.5)+(1680*28)(840)}{(1680*28)+(1350*28)+(1065*28)+(1680*28)}$$

$$\bar{Y} = \frac{4300762.5}{5775}$$

$$\bar{Y} = 744.72\ mm$$

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A = 1680 – 615 + 355

A = 1420

Eccentricity

e = A - $\bar{Y}$

e = 1420 – 744.72

e = 675.28 mm

1 Ton = 9806.65 N

110 Ton = 1078731.5 N

P = $\frac{1078731.5}{2} = 539365.75\ N$

Avg. A = $\frac{5775*28}{4} = 40425\ mm^2$

Bending Moment

$M_b = P * e$

$M_b = 539.36 * 103 * 675.28$

$M_b = 364.22 * 10^6\ Nmm$

Moment of Inertia

$$I = \sum a_i * (y_i - \bar{Y})^2$$

$$I = (1680 * 28)(840 - 744.72)^2 + (1350 * 28)(675 - 744.72)^2 + (1065 * 287)(532.5 - 744.72)^2 + (1680 * 28)(840 - 744.72)^2$$

$I = 2380.84 * 10^6\ mm^4$

Fareast distance

$Y = 1680 - \bar{Y} = 935.28\ mm$

Bending Stress

$$\sigma_b = \frac{M * y}{I} = \frac{364.22 * 10^6 * 935.28}{2380.84 * 10^6}$$

$\sigma_b = 143.08\ N/mm^2$

Tensile Stress

$\sigma_t = \frac{P}{A} = \frac{539365.75}{40425}$

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$\sigma_t = 13.34\, N/mm^2$

Maximum Stress

$\sigma_{max} = \sigma_b + \sigma_t$

$\sigma_{max} = 143.08 + 13.34$

$\sigma_{max} = 156.42\ N/mm^2$

$\sigma_{max} \leq 270\ N/mm^2$ as per Westermann table

Checking for deformation:

$$\delta = \frac{H(e+L)}{R}$$

Now,

$$\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$$

$$R = \frac{E * I}{M}$$

$$R = \frac{2.1 * 10^6 * 2380.84 * 10^6}{364.22 * 10^6}$$

$R = 13.73 * 10^6 mm$

$$\delta = \frac{1595 * (675.28 + 260)}{13.73 * 10^6}$$

$\delta = 0.108\, mm$

$\delta \leq 0.13$ mm as per ISO standard

5.5 Design for a 25 mm plate

Centre of Gravity:

$$\bar{Y} = \frac{a_1 x_1 + a_2 x_2 + \cdots}{a_1 + a_2 + \cdots}$$

$$\bar{Y} = \frac{(1680*25)(840)+(1350*25)(675)+(1065*25)(532.5)+(1680*25)(840)}{(1680*25)+(1350*25)+(1065*25)+(1680*25)}$$

$$\bar{Y} = \frac{4300762.5}{5775}$$

$\bar{Y} = 744.72\, mm$

A = 1680 – 615 + 355

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A = 1420

Eccentricity

e = A - $\bar{Y}$

e = 1420 – 744.72

e = 675.28 mm

1 Ton = 9806.65 N

110 Ton = 1078731.5 N

P = $\frac{1078731.5}{2} = 539365.75\ N$

Avg. A = $\frac{5775*25}{4} = 36093.75\ mm^2$

Bending Moment

$M_b = P * e$

$M_b = 539.36 * 103 * 675.28$

$M_b = 364.22 * 10^6\ Nmm$

Moment of Inertia

$$I = \sum a_i * (y_i - \bar{Y})^2$$

$$I = (1680 * 25)(840 - 744.72)^2 + (1350 * 25)(675 - 744.72)^2 + (1065 * 25)(532.5 - 744.72)^2 + (1680 * 25)(840 - 744.72)^2$$

$I = 2125.75 * 10^6\ mm^4$

Fareast distance

$Y = 1680 - \bar{Y} = 935.28\ mm$

Bending Stress

$$\sigma_b = \frac{M * y}{I} = \frac{364.22 * 10^6 * 935.28}{2125.75 * 10^6}$$

$\sigma_b = 160.25\ N/mm^2$

Tensile Stress

$\sigma_t = \frac{P}{A} = \frac{539365.75}{36093.75}$

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$\sigma_t = 14.94\, N/mm^2$

Maximum Stress

$\sigma_{max} = \sigma_b + \sigma_t$

$\sigma_{max} = 160.25 + 14.94$

$\sigma_{max} = 175.19\ N/mm^2$

$\sigma_{max} \leq 270\ N/mm^2$ as per Westermann table

Checking for deformation:

$$\delta = \frac{H(e+L)}{R}$$

Now,

$$\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$$

$$R = \frac{E * I}{M}$$

$$R = \frac{2.1 * 10^6 * 2125.75 * 10^6}{364.22 * 10^6}$$

$$R = 12.26 * 10^6 mm$$

$$\delta = \frac{1595 * (675.28 + 260)}{12.26 * 10^6}$$

$\delta = 0.122\ mm$

$\delta \leq 0.13$ mm as per ISO standard

5.6 Design for a 22 mm plate

Centre of Gravity:

$$\bar{Y} = \frac{a_1 x_1 + a_2 x_2 + \cdots}{a_1 + a_2 + \cdots}$$

$$\bar{Y} = \frac{(1680*22)(840)+(1350*22)(675)+(1065*22)(532.5)+(1680*22)(840)}{(1680*22)+(1350*22)+(1065*22)+(1680*22)}$$

$$\bar{Y} = \frac{4300762.5}{5775}$$

$\bar{Y} = 744.72\ mm$

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A = 1680 – 615 + 355

A = 1420

Eccentricity

e = A - $\bar{Y}$

e = 1420 – 744.72

e = 675.28 mm

1 Ton = 9806.65 N

110 Ton = 1078731.5 N

P = $\frac{1078731.5}{2} = 539365.75\ N$

Avg. A = $\frac{5775*22}{4} = 31762.5\ mm^2$

Bending Moment

$M_b = P * e$

$M_b = 539.36 * 103 * 675.28$

$M_b = 364.22 * 10^6\ Nmm$

Moment of Inertia

$$I = \sum a_i * (y_i - \bar{Y})^2$$

$I = (1680 * 22)(840 - 744.72)^2 + (1350 * 22)(675 - 744.72)^2 + (1065 * 22)(532.5 - 744.72)^2 + (1680 * 22)(840 - 744.72)^2$

$I = 1870.66 * 10^6\ mm^4$

Fareast distance

$Y = 1680 - \bar{Y} = 935.28\ mm$

Bending Stress

$$\sigma_b = \frac{M * y}{I} = \frac{364.22 * 10^6 * 935.28}{1870.66 * 10^6}$$

$\sigma_b = 182.10\ N/mm^2$

Tensile Stress

$$\sigma_t = \frac{P}{A} \quad \frac{539365.75}{31762.5}$$

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$\sigma_t = 16.98\, N/mm^2$

Maximum Stress

$\sigma_{max} = \sigma_b + \sigma_t$

$\sigma_{max} = 182.10 + 16.98$

$\sigma_{max} = 199.08\ N/mm^2$

$\sigma_{max} \leq 270\ N/mm^2$ as per Westermann table

Checking for deformation:

$$\delta = \frac{H(e+L)}{R}$$

Now,

$$\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$$

$$R = \frac{E * I}{M}$$

$$R = \frac{2.1 * 10^6 * 1870.66 * 10^6}{364.22 * 10^6}$$

$R = 15.69 * 10^6 mm$

$$\delta = \frac{1595 * (675.28 + 260)}{10.78 * 10^6}$$

$\delta = 0.130\ mm$

$\delta \leq 0.13$ mm as per ISO standard

5.7 Finite element methods

Performing a finite element analysis (FEA) of a frame in a power press involves several steps. Here is a general outline of the process:

Geometry and mesh generation: Using computer-aided design (CAD) software, create a 3D model of the geometry of the frame. Make sure the model properly represents the actual structure. Next, create a mesh by dividing the frame into finite elements. Primarily in areas of interest and possible stress concentrations, the geometry should be perfectly captured by the mesh.

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Material properties: Use the frame elements the required material properties. Young's modulus (also known as elastic modulus), Poisson's ratio, and, if necessary, yield strength or additional important mechanical properties, are some examples of these characteristics. Based on the actual material used to construct the power press frame, these values should be utilised.

Boundary conditions: Define the boundary conditions for the analysis. To be able to simulate where the frame is fixed or connected to the ground or other components, provide the limitations or fixed supports. Consider about the power press frame supports, connections, and any other structural constraints that could be present.

Loading conditions: Define the loading conditions that the power press frame will be subjected to. This may include the weight of individual components of the press and any load or forces applied to the frame from outside. Take into consideration scenarios for static and dynamic loading.

Finite element analysis: Perform the FEA using a suitable software package. Apply the defined boundary conditions and loading conditions to the model. Solve the equations to obtain the displacements, stresses, strains, and other relevant quantities within the frame.

Results interpretation: Analyse and interpret the results obtained from the FEA. Evaluate the stresses and deformations to assess the structural behaviour of the power press frame. Identify any areas of concern, such as high stress concentrations, excessive displacements, or potential failure points.

Validation and refinement: Compare the FEA results with available experimental data or analytical solutions to validate the model's accuracy. If discrepancies exist, refine the model, mesh, or analysis settings to improve the accuracy of the results.

Documentation and reporting: Document the FEA process, including model details, analysis settings, and obtained results. Prepare a comprehensive report summarizing the analysis, key findings, and recommendations.

It is essential to note that performing an accurate FEA requires expertise in structural analysis, understanding of the power press frame's behaviour, and familiarity with the chosen FEA software. Seeking guidance from experienced structural engineers and considering relevant design codes and standards specific to power presses is highly recommended.

5.8 Model of frame of power press machine

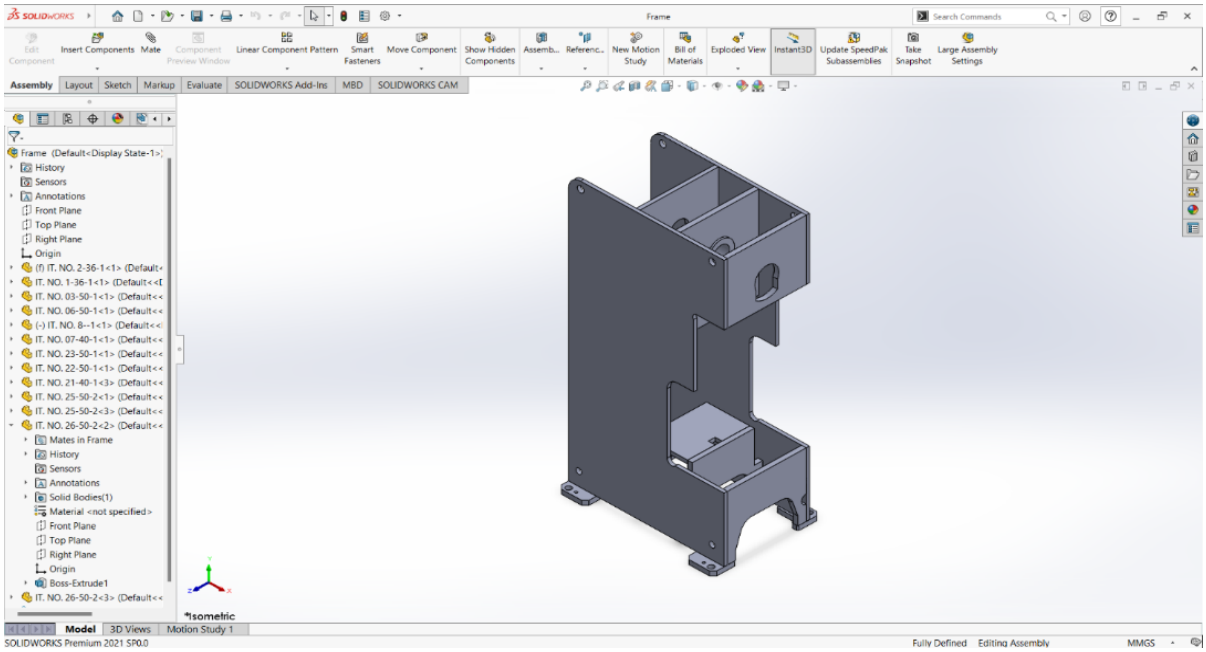

Figure 5.1 Assembly of frame of power press

The details of about the mechanical power press frame modelling are covered in this chapter. Press machines are briefly mentioned in an earlier chapter. After that, modelling and processing are shown. Parts breakdown for the press machine and an overall view of the press frame. This chapter provides in-depth understanding of the frame's construction and the location of the failure.

5.9 Numerical simulations

5.9.1 Meshing

The method of dividing out a complex geometry into a discrete set of smaller, connected elements is known as meshing for finite element analysis (FEA). These individual components come together to form a mesh that is used to approximate the behaviour of the structure or system being studied. The geometry is discretized by the mesh, allowing the governing equations within each element to be solved numerically.

In FEA, the mesh provides the fundamental elements for solving partial differential equations that characterize the behaviour of the system. The intricate challenge is simplified into a number of connected sub-problems by breaking the geometry into smaller components. Following the solution of the governing equations for each component, the outcomes are integrated to produce an approximation of the whole system.

- Meshing of 32 mm thickness plate of power press frame structure.

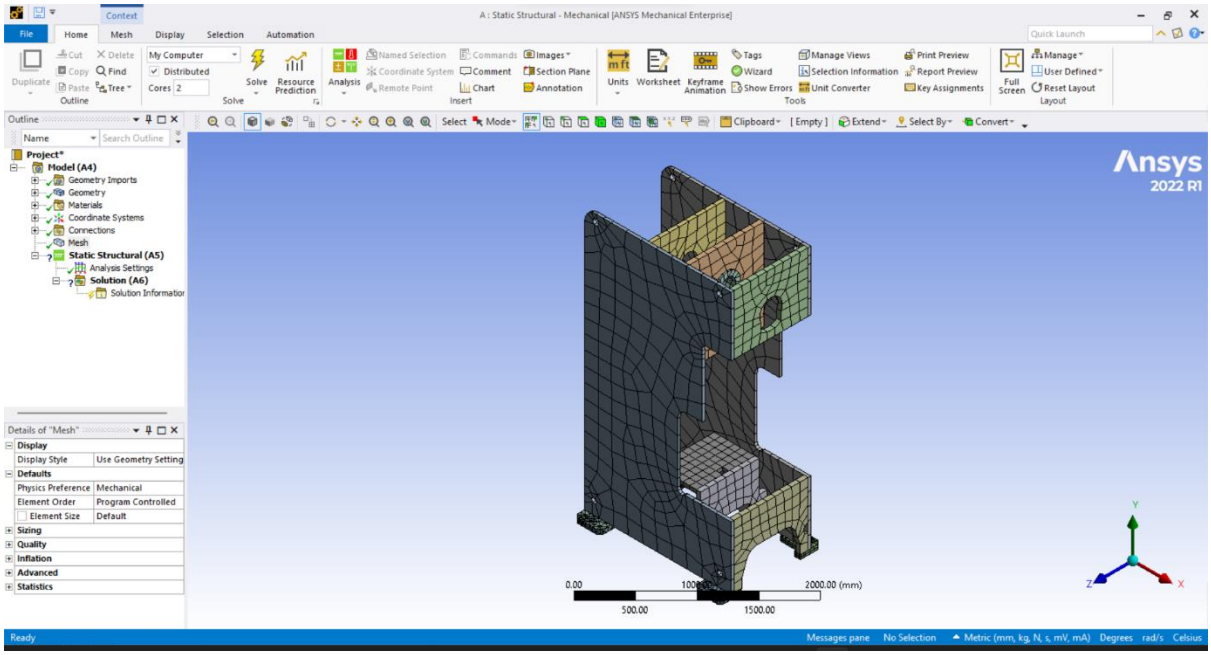

Figure 5.2 Meshing of 32 mm thickness plate

- Meshing of 28 mm thickness plate of power press frame structure.

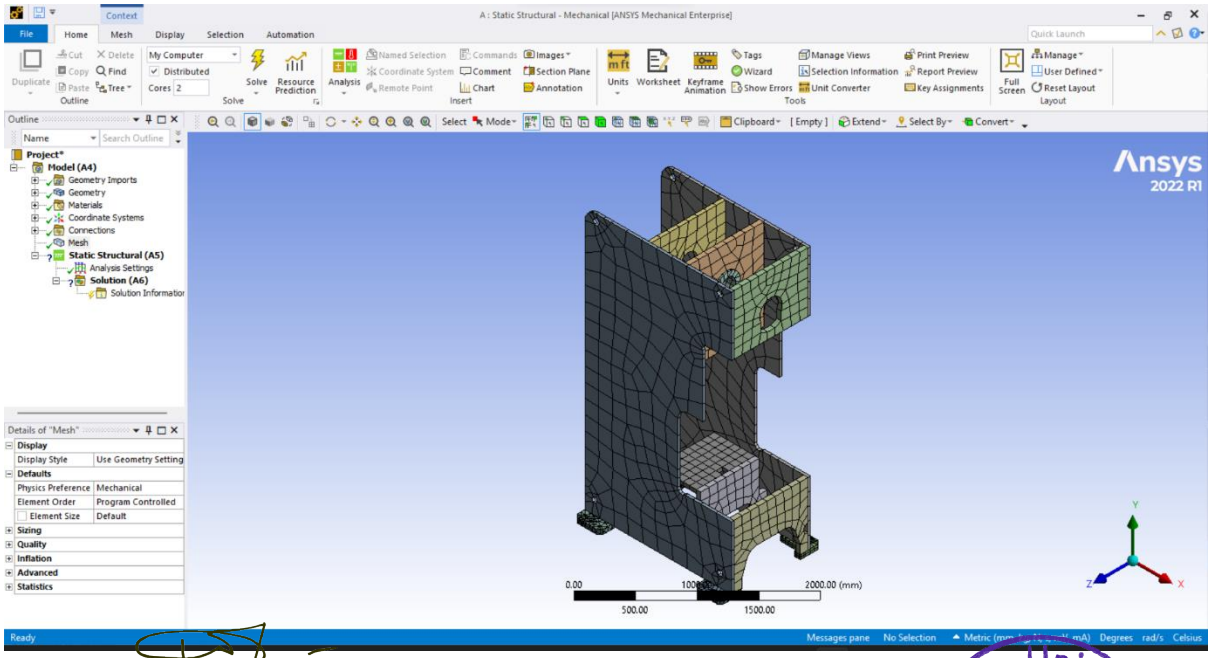

Figure 5.3 Meshing of 28 mm thickness plate

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- Meshing of 25 mm thickness plate of power press frame structure.

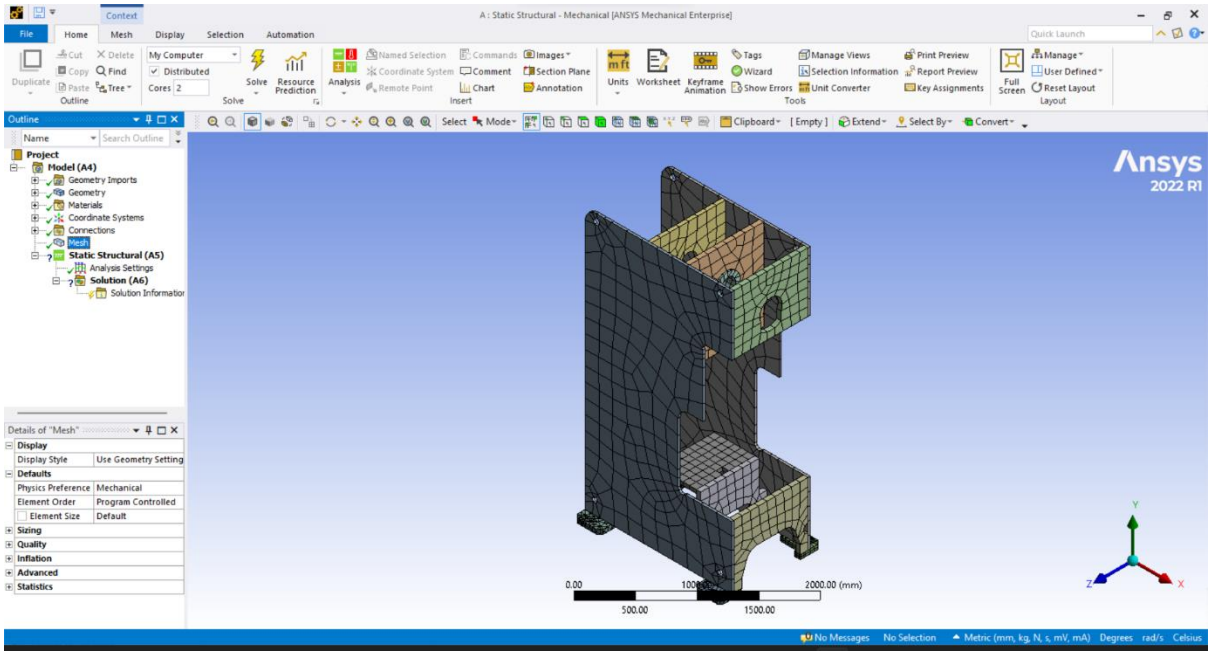

Figure 5.4 Meshing of 25 mm thickness plate

- Meshing of 22 mm thickness plate of power press frame structure.

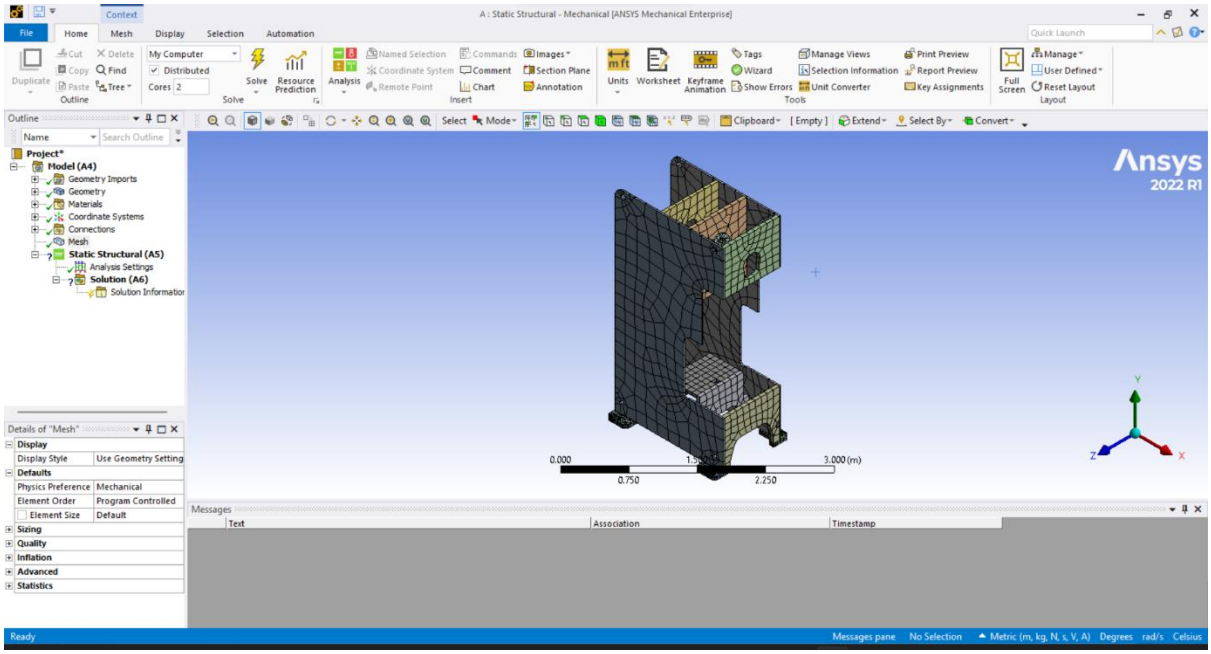

Figure 5.5 Meshing of 22 mm thickness plate

5.9.2 Appling boundary conditions

Identify the loads and boundaries on the structure. This involves establishing any boundary conditions that are relevant to the issue, such as fixed displacements, applied forces, thermal conditions, or other boundary requirements.

- Boundary condition of 32 mm thickness plate of power press frame structure.

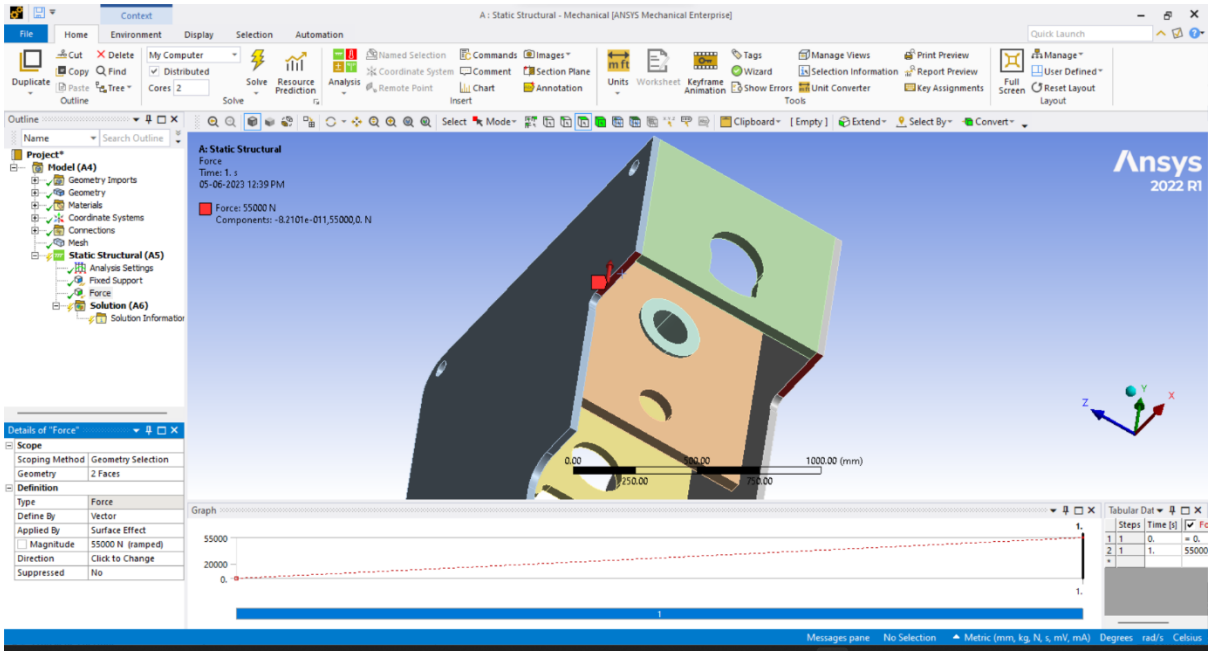

Figure 5.6 Boundary conditions of 32 mm thickness plate

- Boundary condition of 28 mm thickness plate of power press frame structure.

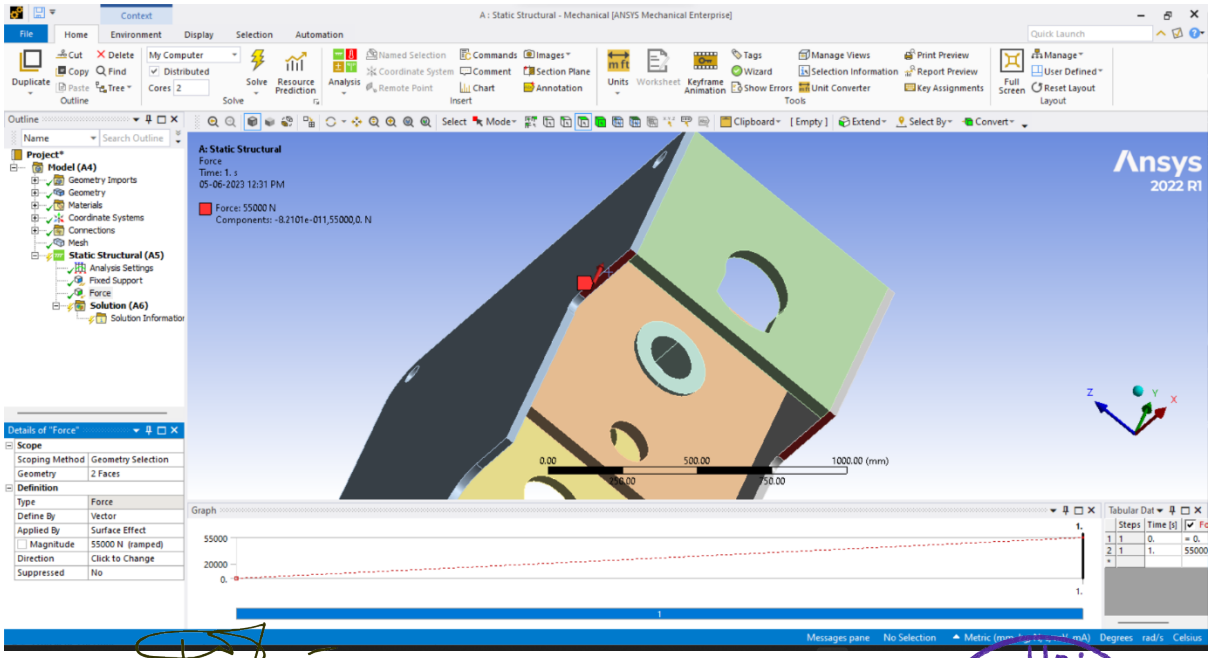

Figure 5.7 Boundary conditions of 28 mm thickness plate

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- Boundary condition of 25 mm thickness plate of power press frame structure.

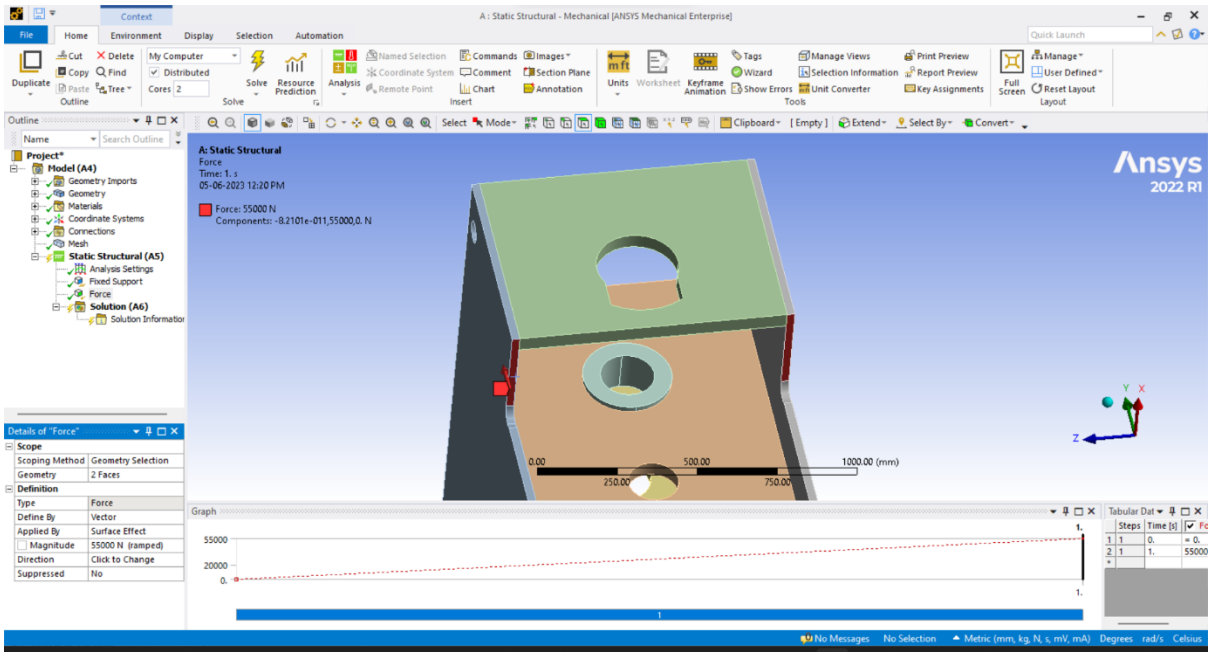

Figure 5.8 Boundary conditions of 25 mm thickness plate

- Boundary condition of 22 mm thickness plate of power press frame structure.

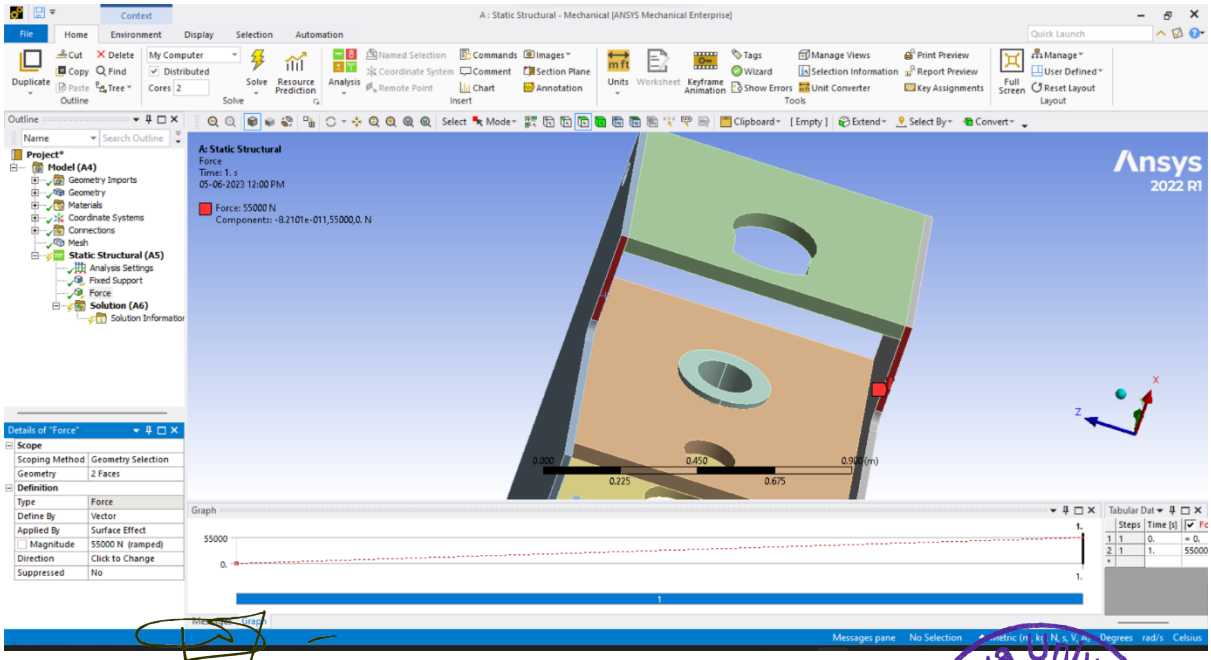

Figure 5.9 Boundary conditions of 22 mm thickness plate

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5.9.3 Effect of plate thickness on deformation

- Deformation of 32 mm thickness of plate of press frame structure is 0.093 mm.

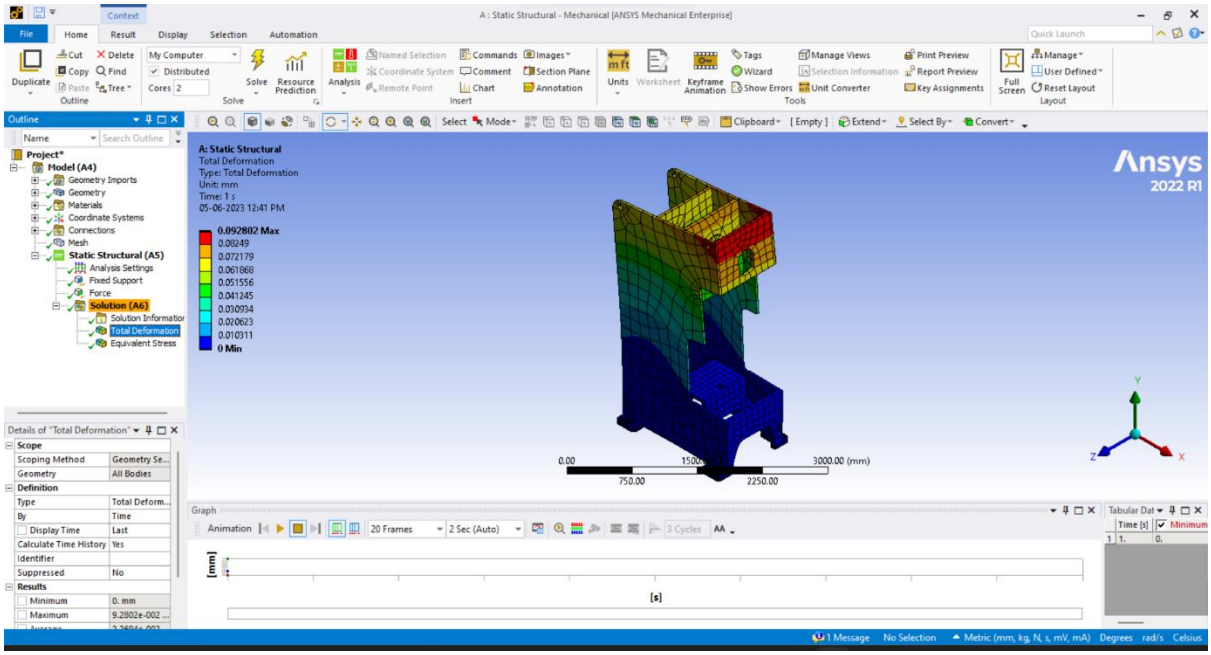

Figure 5.10 Deformation of 32 mm thickness plate

- Deformation of 28 mm thickness of plate of press frame structure is 0.102 mm.

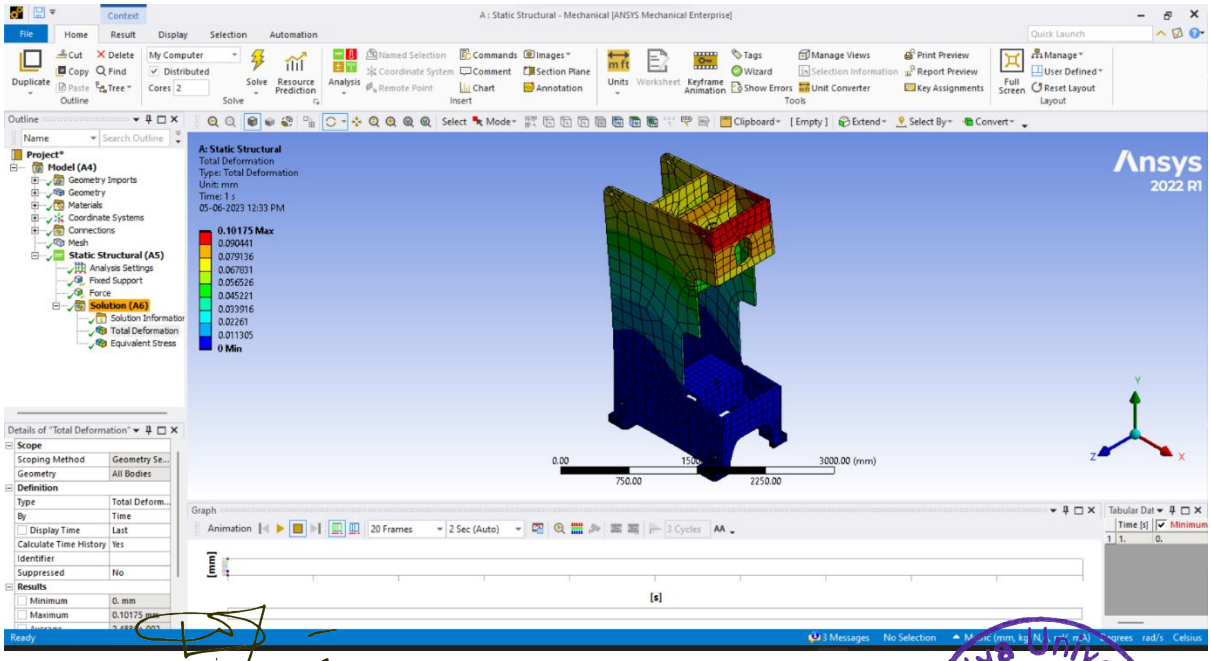

Figure 5.11 Deformation of 28 mm thickness plate

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- Deformation of 25 mm thickness of plate of press frame structure is 0.109 mm.

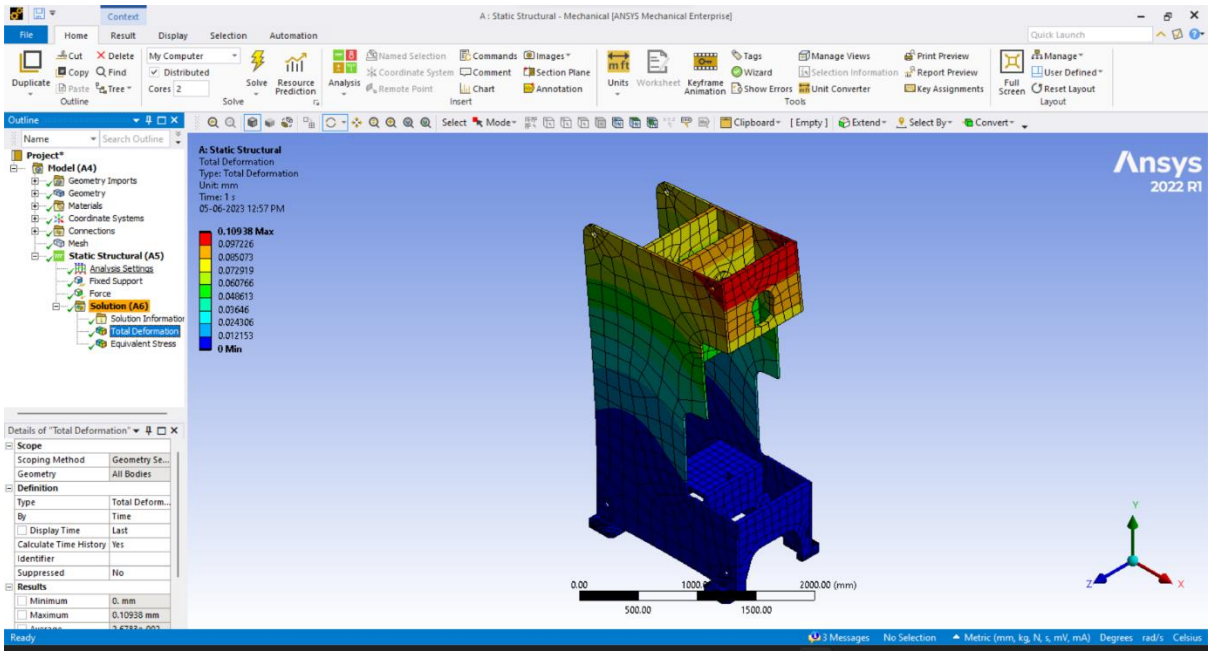

Figure 5.12 Deformation of 25 mm thickness plate

- Deformation of 22 mm thickness of plate of press frame structure is 0.114 mm.

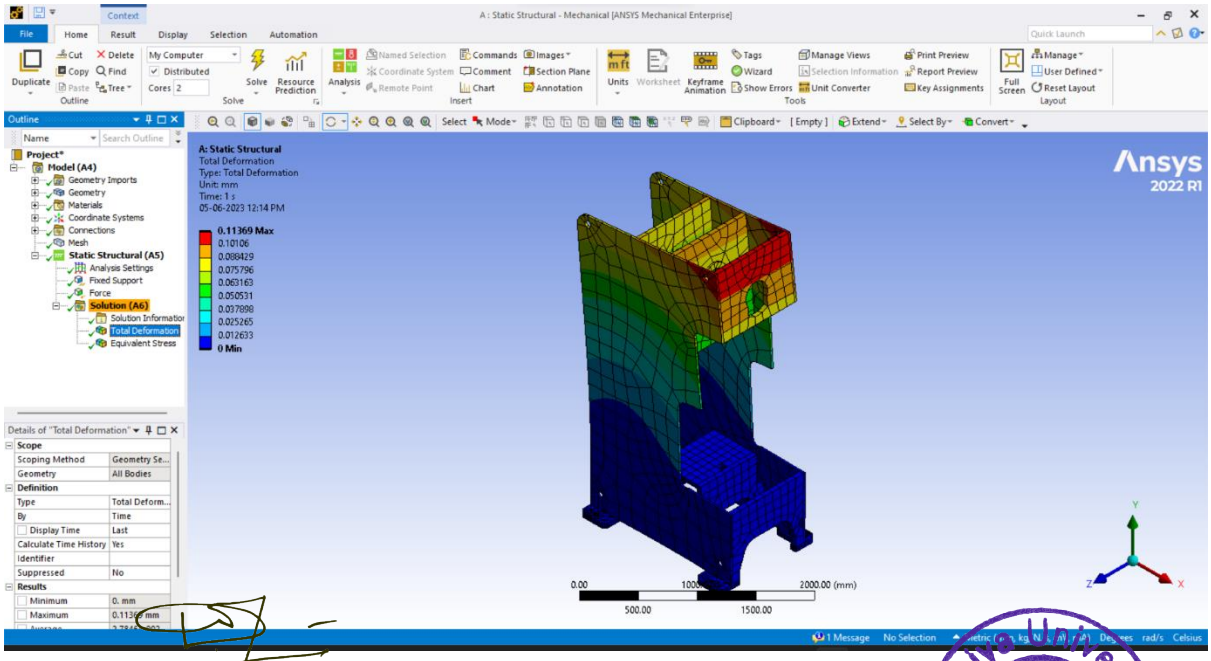

Figure 5.13 Deformation of 22 mm thickness plate

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5.9.4 Effect of plate thickness on Von Mises stress

- Von Mises stress of 32 mm thickness plate of press frame structure is 135.90 MPa.

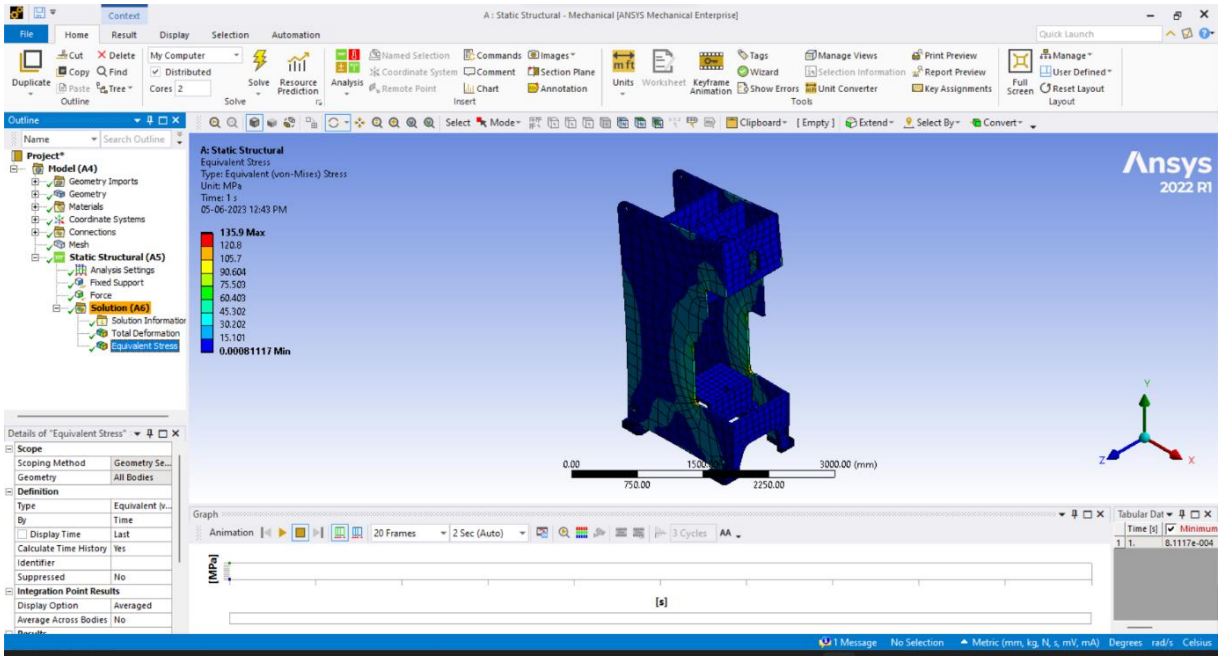

Figure 5.14 Von Mises stress of 32 mm thickness plate

- Von Mises stress of 28 mm thickness plate of press frame structure is 148.76 MPa.

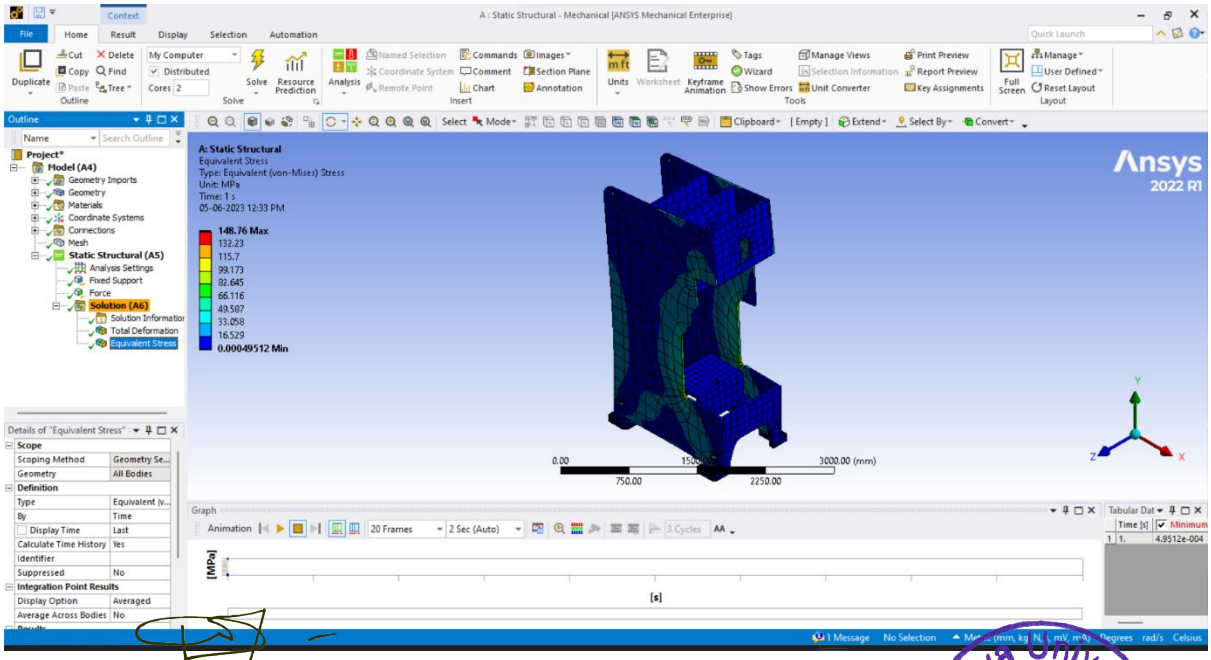

Figure 5.15 Von Mises stress of 28 mm thickness plate

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- Von Mises stress of 25 mm thickness plate of press frame structure is 170.91 MPa.

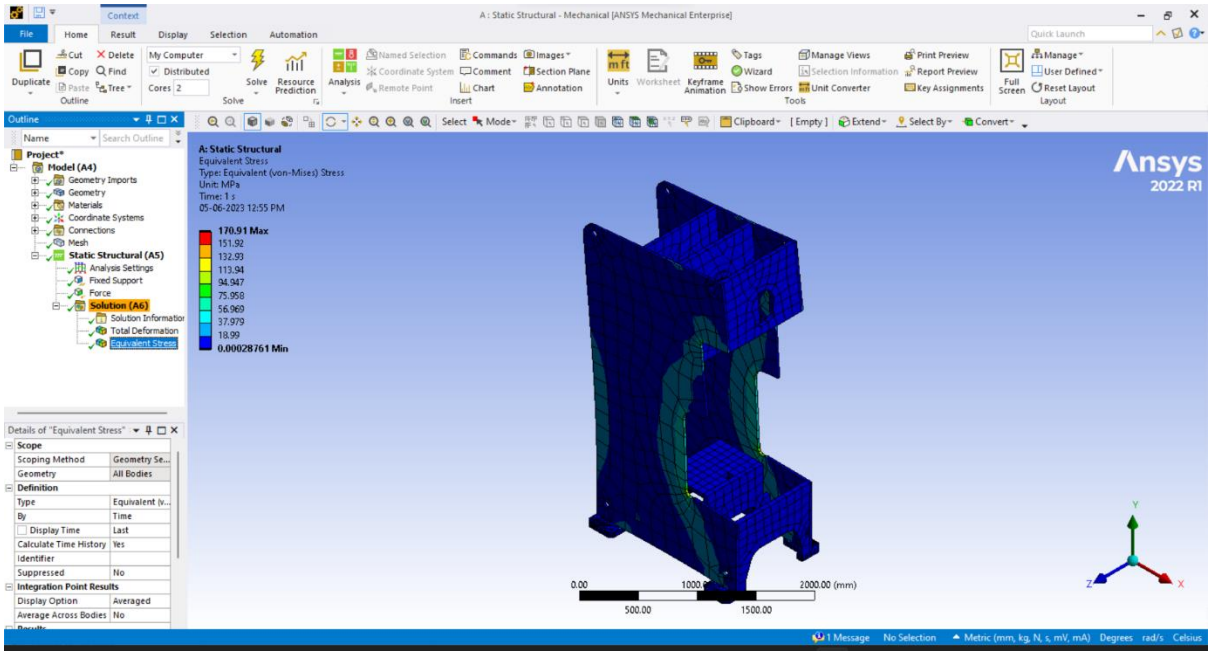

Figure 5.16 Von Mises stress of 25 mm thickness plate

- Von Mises stress of 22 mm thickness plate of press frame structure is 196.21 MPa.

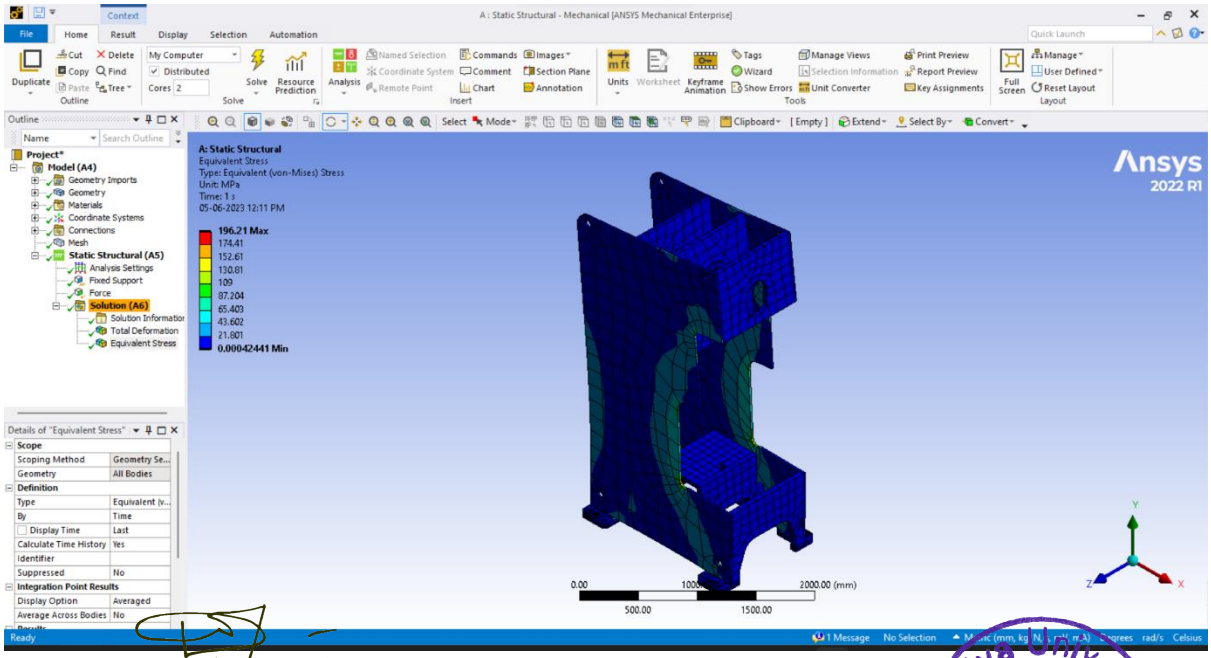

Figure 5.17 Von Mises stress of 22 mm thickness plate

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5.10 Optimization

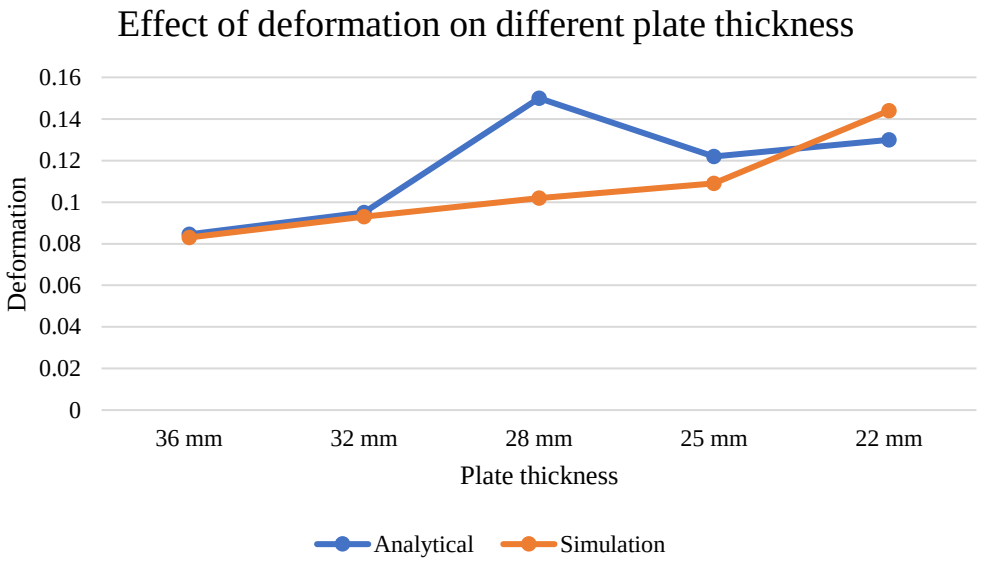
Existing frame is made from 36 mm plate thickness. Deformation of this plate 0.0845 mm in analytical calculation and 0.083 mm in software analysis Stress generated in frame is by analytical calculation 121.66 MPa and by simulation is 120.25 MPa. In 32 mm plate analytical deformation is 0.095 mm and simulation result is 0.093 mm. And stress is 136.86 MPa and 135.90 MPa respective in analytical and simulation. Analytical calculations show a 0.150 mm deflection of a 28 mm plate while software analysis shows a 0.102 mm deflection. Analytical calculations show that the stress in the frame is 156.42 MPa, whereas simulations show that it is 148.76 MPa. Analytical deformation in a 25 mm plate is 0.122 mm, whereas the simulation's output is 0.109 mm. In analytical and simulation studies, the stress is 175.19 MPa and 170.91 MPa, respectively. A 22 mm plate deflects by 0.130 mm according to analytical calculations, however software analysis indicates a deflection of 0.114 mm. The stress in the frame is 199.08 MPa according to analytical calculations, whereas simulations show that it is 196.21 MPa. All of these plate thicknesses belong within the permissible stress limit, and the deformation likewise does; however, the limit is met in the case of the 22 mm plate thickness. Therefore, a 25-mm plate thickness, which is within the range, might be preferred.

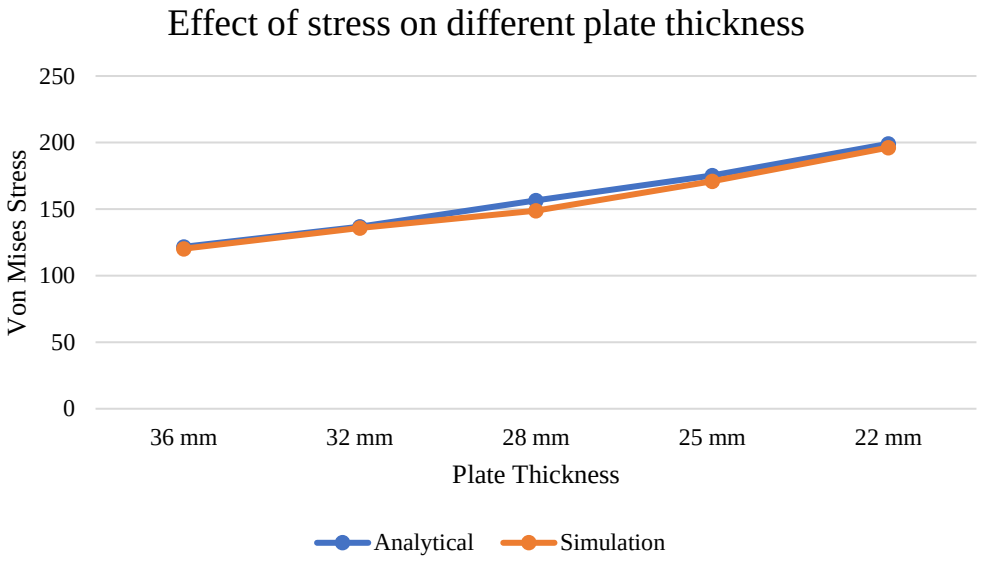
Table 5.3 Effect of plate thickness on deformation

Plate Thickness	Analytical (mm)	Simulation (mm)	Difference
22mm	0.130	0.114	1.631
25mm	0.122	0.109	1.262
28mm	0.150	0.102	4.825
32mm	0.095	0.093	0.219
36mm	0.0845	0.083	0.184

Table 5.4 Effect of plate thickness on Von Mises stress

Plate Thickness	Analytical (MPa)	Simulation (MPa)	Difference
22mm	199.08	196.21	2.87
25mm	175.19	170.91	4.28
28mm	156.42	148.76	7.66
32mm	136.86	135.90	0.96
36mm	121.66	120.25	1.41





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CHAPTER – 6

Conclusion and Future Scope

6.1 Conclusion

The conclusion is that when the plate thickness is 22 mm, the amount of deflection and stress generated at the plate increases, so the company decided to use 36 mm plate thickness without taking any design considerations into account. This prevents failure, but it uses more material and is more expensive. In conclusion, 25 mm plate thickness is safe for the specified load condition and has smaller deformation difference as compared to other plate thicknesses after doing analytical design and numerical simulation in simulation software. Weight of existing power press frame is 1208.27 kg and after reducing thickness of plates, weight of modified power press frame is 839.08 kg. So that reduction in weight of press body is around 369.19 kg and 30.56%. Industry has seen a decrease in operation costs and material costs is approximately Rs.45,645 reduced as a result of this material saving.

6.2 Future scope

In future, can change in thickness and width of other frame members and also use lightweight materials use of advanced lightweight materials, such as carbon fiber composites, can significantly reduce the weight of the frame without compromising structural integrity. Utilising optimisation techniques, the design can be generated again and more material can be saved. The design may change depending on the customer requirements.

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Appendix A: Review Card

ATMIYA UNIVERSITY
FACULTY OF ENGINEERING TECHNOLOGY
Master of Technology
(Dissertation Review Card)

Name of Student : Umaretiya Kelvin Jitendrabhai

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College Code :

Branch Name : M.Tech. CAD/CAM

Title of Thesis : Analysis and optimization of 110 Ton Frame structure of Hydraulic Press.

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Mobile No. :	9428310219

~ 1 ~

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❖ **Comments For Internal Review (21MMECCC305)** **(Semester 3)**

Exam Date : 17/12/2022

Sr. No.	Comments given by Internal review panel (Please write specific comments)	Modification done based on Comments
1)	Modify the title.	→ Title is Modified.
2)	Refer & add more Research Papers related to analysis & optimization work.	→ Research Papers are add
3)	Objectives need to be defined.	→ Objectives are redefined
4)	Identify the design Parameter important for C-type Frame of given hydraulic Press	→ Design Parameters are identified.
5	Add Domainwise, Yearwise, publisher wise Graph.	→ Added as Per suggestion
6.	Prepare Review paper	→ in Process.

(Guide Sign.)

Particulars	Internal Review Panel	
	Expert 1	Expert 2
Name :	Pratik Kikani	Dr. Keyur V. Panmar
Institute :	Atmiya University	Atmiya University
Institute Code :		
Mobile No. :	98798 58594	9909915700
Sign :		

Particulars	Internal Guide Details	
	Expert 1	Expert 2
Name :	Shivang S. Jani	Harshil N. Chauhan
Institute :	Atmiya University	Atmiya University.
Institute Code :		
Mobile No. :	8000322128	9428310219
Sign :		

-2-

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Enrollment No. of Student : 2 1 0 0 4 5 0 0 3

❖ **Comments of Dissertation Phase-1 (21MMECCC305)** **(Semester 3)**

Exam Date : 20/12/2022

Title : Analysis and Optimization of 110 Ton frame structure of Hydraulic Press

1. Appropriateness of title with proposal. (Yes/ No) Yes
2. Whether the selected theme is appropriate according to the title ? (Yes / No) Yes
3. Justify rational of proposed research. (Yes/ No) Yes
4. Clarity of objectives. (Yes/ No) Yes

-3-

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Enrollment No. of Student: 2 1 0 0 4 5 0 0 3

Exam Date : 20 / 12 / 2022

Sr. No.	Comments given by External Examiners (DP-I) : (Please write specific comments)	Modification done based on Comments
1	Need to publish review paper	→ Review Paper is under process for acceptance
2	Presentation was very poor	→ Presentation Part was improved.
3	Not clear objectives.	→ objective are redefined as per suggestion.

Hfani
(Internal Guide Sign.)

- *Approved* ☐
- *Approved with suggested recommended changes* ☑
- *Not Approved* ☐

Please tick on any on.
If approved/approved with suggession then put marks ≥ 50%.

➢ *Details of External Examiners:*

Particulars	*Full Name*	*University / College Name & Code*	*Mobile No.*	*Sign.*
Expert 1	R. L. Patel	GEC Rajkot	9998910340	
Expert 2				

~ 4 ~

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Enrollment No. of Student : 2 1 0 0 4 5 0 0 3

❖ Comments of Mid Sem Review (21MMECCC401) (Semester 4)

Exam Date : 13/04/23

Sr. No.	Comments given by External Examiners : i) The appropriateness of the major highlights of work done; State here itself if work can be approved with some additional changes. ii) Main reasons for approving the work. iii) Main reasons if work is not approved.	Modification done based on Comments
(1)	Need to check existing design	→ Existing Design has analyzed through analytical calculation & software
(2)	Need to consider all affected parameters for out put	→ All required Parameters were identified & selected the important/ critical Parameters responsible for failure of C-type frame structure of hydraulic Power Press.

Internal Guide Sign.

- *Approved* ☐
- *Approved with suggested recommended changes* ☑
- *Not Approved* ☐

Please tick on any on. If approved/approved with suggession then put marks ≥ 50 %.

➢ ***Details of External Examiners:***

Particulars	*Full Name*	*University / College Name & Code*	*Mobile No.*	*Sign.*
Expert 1	R.L.Patel	GEC Rajkot	9998910340	Patel
Expert 2				

5

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Enrollment No. of Student : ☐☐☐☐☐☐☐☐☐☐☐☐

❖ **Comments of DP-II Review ( )** **(Semester 4)**

Exam Date : ___/___/_____

Sr. No.	**Comments given by External Examiners :** i) Main reasons for approving the work. ii) Main reasons if work is not approved.	Modification done based on Comments

- *Approved* ☐
- *Not Approved* ☐

} *Please tick on anyone.* *If approved then put marks ≥ 50 %.*

➢ ***Details of External Examiners:***

Particulars	*Full Name*	*University / College Name & Code*	*Mobile No.*	*Sign.*
Expert 1				
Expert 2				

6

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Appendix B: Compliance Report

Comments given during Dissertation phase- 1 and Mid semester dissertation review are given below with required actions taken for their fulfilment.

- **Comments of Dissertation Phase – I:**

Sr. No.	Comments Given	Actions Taken
1.	Need to publish review paper	Review paper is under process for acceptance.
2.	Presentation was very poor	Presentation part was improved.
3.	Not clear objectives	Objectives are redefined as per suggestion.

- **Comments of Mid Sem Review:**

Sr. No.	Comments Given	Actions Taken
1.	Need to check existing design	Existing design was analysed through analytical calculation & software.
2.	Need to consider all affected parameters for output	All required parameters were identified & selection the important/ critical parameter responsible for failure of c-type frame structure of hydraulic power press.

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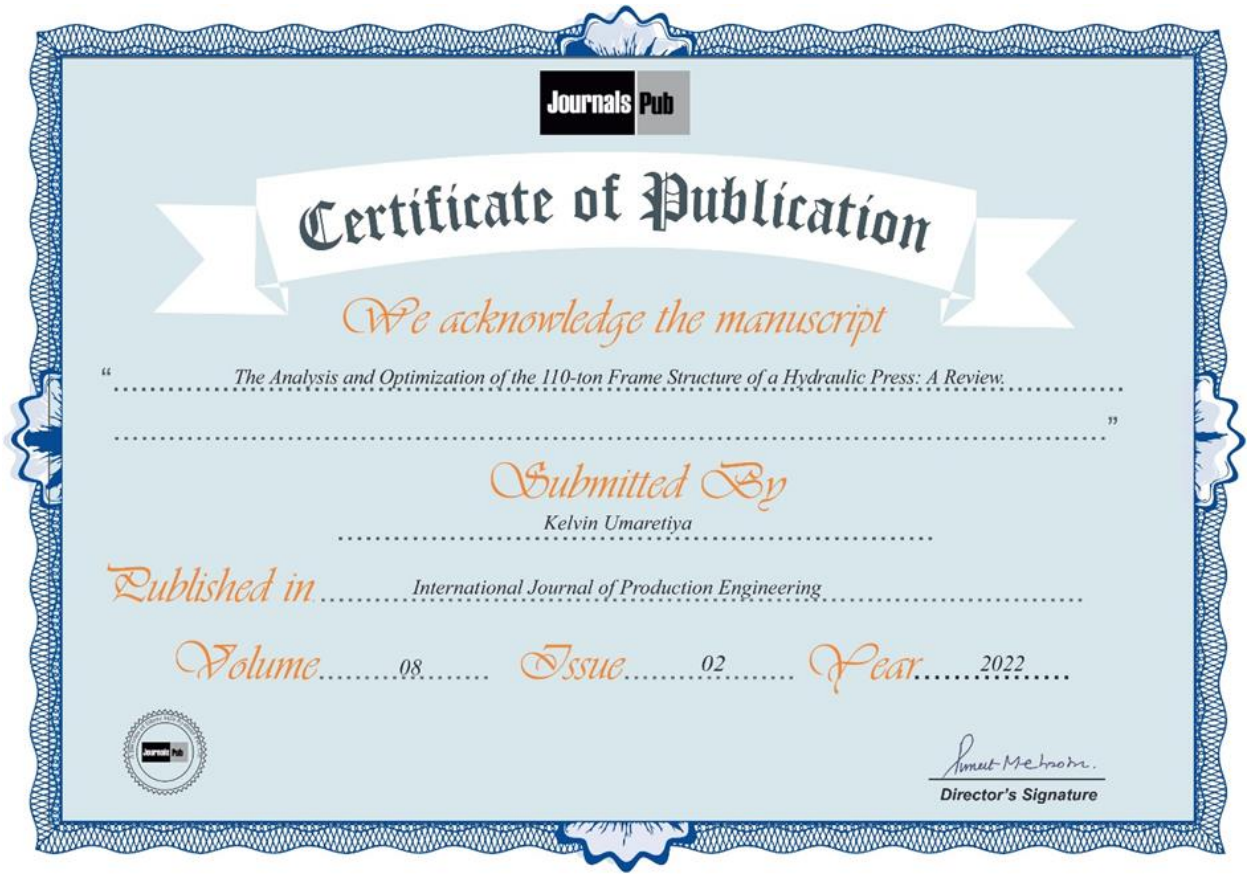
Appendix C: Paper Publication Certificate



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Appendix D: Standards

IS 1730 : 1989
Supersedes IS 1731
(Reaffirmed 2004)

Indian Standard

STEEL PLATES, SHEETS, STRIPS AND FLATS FOR STRUCTURAL AND GENERAL ENGINEERING PURPOSES — DIMENSIONS

(Second Revision)

भारतीय मानक

संरचना और सामान्य इंजीनियरिंग प्रयोजनों के लिए
उत्पात-प्लेटें, चद्दरें, पतिया तथा फलैट — आयाम

(दूसरा पुनरीक्षण)

First Reprint NOVEMBER 1991

UDC 669.14-41:006.78

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

January 1990

Price Group 4

Table 1 Standard Nominal Thickness of Plate in mm

(*Clauses* 4.1 *and* 4.2)

5·0	10	18	28	45
6·0	12	20	32	50
7·0	14	22	36	56
8·0	16	25	40	63

Table 2 Standard Nominal Sizes of Plates

(*Clause* 4.2)

Width in mm	900	950	1 000	1 100	1 200	1 250	1 400	1 500	1 600	1 800	2 000	2 200	2 500
Length in mm	Maximum Standard Nominal Thickness in mm												
2 200	63	63	63	63	63	63	63	63	63	63	63	63	63
2 500	63	63	63	63	63	63	63	63	63	63	63	63	63
2 800	63	63	63	63	63	63	63	63	63	63	63	63	63
3 200	63	63	63	63	63	63	63	63	63	63	63	63	63
3 600	63	63	63	63	63	63	63	63	63	63	63	63	63
4 000	63	63	63	63	63	63	63	63	63	63	63	63	63
4 500	63	63	63	63	63	63	63	63	63	63	63	63	63
5 000	63	63	63	63	63	63	63	63	63	63	63	63	63
5 600	63	63	63	63	63	63	63	63	63	63	63	63	56
6 300	63	63	63	63	63	63	63	63	63	63	63	56	50
7 100	63	63	63	63	63	63	63	63	63	63	56	50	45
8 000	63	63	63	63	63	63	63	63	63	56	50	45	40
9 000	63	63	63	63	63	63	63	56	56	50	45	40	36
10 000	63	63	63	63	63	63	56	50	50	45	40	36	32
11 000	63	63	63	63	56	56	50	50	45	40	36	32	28
12 500	63	63	63	56	50	50	45	40	40	36	32	28	25
13 500	63	63	56	50	50	45	40	40	36	32	28	25	25

NOTE — This table gives the values of maximum standard nominal thicknesses for each combination of length and width. This means that any standard nominal thickness (*see* Table 1) less than the maximum thickness specified in this table is available for the particular length-width combination. For example, for a length-width combination of 12 500 × 1 600 mm, 40 mm is the maximum standard nominal thickness specified. By this, it should be understood that any standard nominal thickness in the range 5 to 40 mm is available in 12 500 × 1 600 mm size.

IS 15745 : 2007

भारतीय मानक

स्ट्रेट साईडिड यांत्रिक प्रेस के डिफलेक्शन — विशिष्टि

Indian Standard

DEFLECTION FOR STRAIGHT SIDED MECHANICAL PRESSES — SPECIFICATION

ICS 25.120.10

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

June 2007

Price Group 1

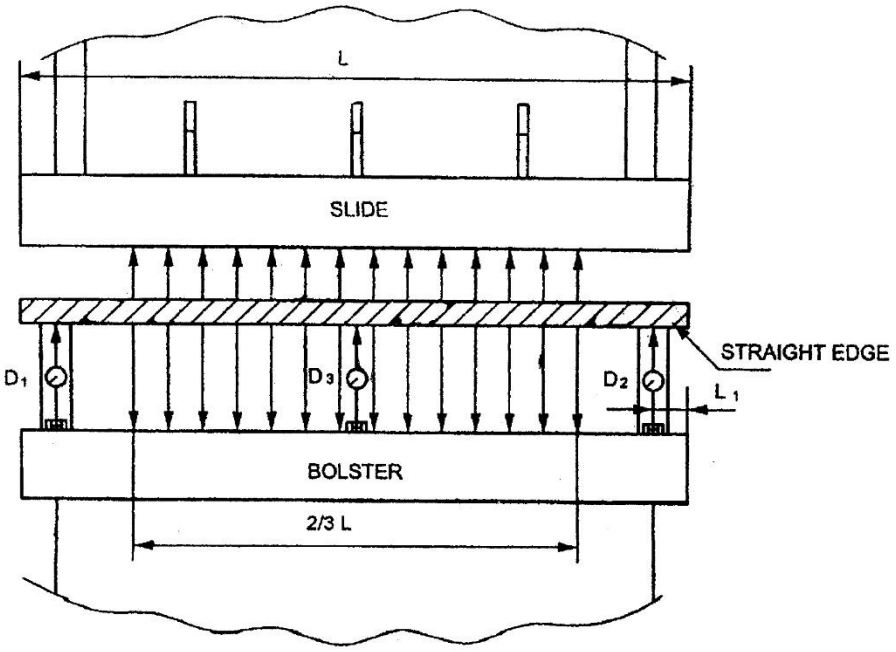

FIG. 1 STRAIGHT SIDED MECHANICAL PRESS

For slide deflection, measure the total deflection (bolster top and slide bottom) D_1, D_2, D_3 and calculate deflection/m as above.

Slide deflection/m length = Total deflection/m length – bed deflection/m length measured already

5.5 Permissible Deflection in Presses

5.5.1 Standard permissible deflection shall be 0.17 mm/1 000 mm for sheet metal forming industries.

5.5.2 Optional permissible deflection shall be 0.13 mm/1 000 mm.

The presses may be supplied with optional permissible deflection, if it has been mutually agreed to between the customer and the supplier.

R. B. அரவிந்தன்

WESTERMANN TABLES

For the Metal Trade

Materials • Numerical Quantities • Forms

REVISED TO INDIAN STANDARDS

REVISED SECOND EDITION

Edited by
Hermann Jütz
and
Eduard scharkus

PUBLISHING FOR ONE WORLD

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Specification on Structural and Heat treatable Steels

General structural steels

IS:1977–1969; IS:2062–1969
IS: 226–1969; IS: 961–1962

Designation of steel	*Tensile strength kgf/mm²*	*Yield strength for thicknesses upto 20 mm*	*20–40 mm*	*Elongation % on gauge length 5.65 $\sqrt{S_0}$, Min*	*C % Max*	*S % Max*	*P % Max*	*Typical applications*
St 32–O	32–44	—	—	26	—	0.07	0.07	Intended for general engineering purposes.
St 42–O	42–54	26.0	—	23	—	0.07	0.07	
St 42–S	42–54	26.0	24.0	23	0.25	0.055	0.055	Intended for all types of structures weldable upon certain conditions.
St 42–W	42–54	26.0	24.0	23	0.20	0.055	0.055	Can be subjected to fusion welding.
St 58–HT	58 Min	36.0	35.0	20	0.27	0.055	0.055	Intended for use in structures where fabrication is done by methods other than welding.
St 55–HTW	55 Min	36.0	35.0	20	0.20	0.055	0.055	Intended for use in structures where welding is employed for fabrication and where guaranteed weldability is required.

Standard sizes of hot-rolled products made of general structural steels

IS Number	*Product*	*Page*	*IS Number*	*Product*	*Page*
808	Beam, channel and angle sections	21	1732	Round and square bars	19
1173	Tee bars	22	1863	Bulb plates	—
1252	Bulb angles	—	1864	Unequal angles	21
1730	Plates, sheet and strip	20	3954	Channel sections for general engineering purposes	22
1731	Flats	20			

Case hardening steels

IS: 4432–1967

Designation of steel	*Case hardened Tensile strength Min kgf/mm²*	*Elongation % Min*	*Temperatures for °C Carburizing*	*Softening*	*Case hardening*	*Annealing*	*Typical applications*
C10, C14, 19 S11	50	17	900–920	650–680	760–780	—	These steels are used for components requiring high wear resistant surfaces, coupled with tough cores to resist shock loads and strength to give longer service life.
14 Mn IS14, 11Mn2	60	17	900–930	650–680	760–780	800–920	
15 Cr 65	60	13	900–930	650–680	770–800	870–900	
17 Mn 1 Cr 95	80	10	900–930	650–680	810–840	850–880	
20 Mn Cr 1	100	8	900–930	650–680	810–840	850–880	
16 Ni 80 Cr 60	70	15	880–920	650–680	780–820	850–880	
16 Ni 1 Cr 80	85	12	900–930	650–660	780–820	850–880	
13 Ni 3 Cr 80	85	12	900–930	620–650	760–780	860–880	
15 Ni 4 Cr 1	135	9	900–930	600–630	760–780	860–880	
20 Ni 2 Mo 25	85	12	880–920	650–660	760–780	—	
20 Ni55 Cr50 Mo 20	90	11	880–920	650–660	780–820	—	
15 Ni Cr 1 Mo 12	100	9	900–930	630–650	780–820	860–880	
15 Ni 2 Cr 1 Mo 15	110	9	900–930	630–650	780–820	860–880	
16 Ni Cr 2 Mo 20	135	9	900–930	630–650	800–820	850–880	

Flame and induction hardening steels

IS: 3930-1966

Designation of steel	*Properties in quenched and tempered conditions Tensile range kgf/mm²*	*0.2% proof stress, Min kgf/mm²*	*Izod impact Min. kgf.m*	*Surface hardness obtainable HRC*	*Hardening temperature For oil quench*	*For water quench*	*Typical applications*
C 30	60 to 75	36	5.5	45–50	860–890	860–890	These wrought unalloyed and alloyed steels for flame and induction hardening are used when high cold strength and good impact properties are required.
C 45	70 to 85	44	3.5	55–61	830–860	820–850	
T 70	70 to 85	40	2.8	60–63	810–840	780–810	
37 Mn 2	60 to 75	40	4.8	53–59	850–870	840–860	
40 Mn 2S 12	70 to 85	46	4.8	53–59	850–870	840–860	
35 Mn 2 Mo 45	80 to 95	56	5.5	53–59	840–860	830–850	
50 Cr 1	80 to 95	48	2.8	57–62	850–870	840–860	
50 Cr 1 V23	80 to 95	48	2.8	57–62	850–870	840–860	
40 Ni 3	80 to 95	56	5.5	54–60	830–860	840–870	
40 Ni2 Cr 1 Mo 28	90 to 105	66	5.5	54–60	830–840	810–830	
31 Ni3 Cr 65 Mo 55	90 to 105	66	5.5	49–54	850–880	820–840	

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Appendix E: Plagiarism

Ouriginal by Turnitin

Document Information

Analyzed document	Thesis form Kelvin.pdf (D171913301)
Submitted	2023-07-09 14:21:00
Submitted by	Dr. Sheetal Tank
Submitter email	librarian@atmiyauni.ac.in
Similarity	2%
Analysis address	librarian.atmiya@analysis.urkund.com

Sources included in the report

W URL: https://docplayer.net/57199210-Design-and-analysis-of-c-frame-of-40-ton-pneumatic-power-press-...
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W URL: https://www.irjet.net/archives/V2/i3/Irjet-v2i3209.pdf
Fetched: 2020-07-06 07:02:58 — 3

Entire Document

ATMIYA UNIVERSITY XV "ANALYSIS AND OPTIMIZATION OF C-TYPE FRAME STRUCTURE OF 110-TON HYDRAULIC POWER PRESS" (210045003) Mr. Kelvin J. Umaretiya Atmiya University, Rajkot. kelvin.umarretiya0409@gmail.com ABSTRACT

100% MATCHING BLOCK 1/11 W

Metal forming is one of the manufacturing processes which are almost chip less.

Machines and press tools are mostly used to carry out such operations. These procedures involve bending metal workpieces to their designed shapes and sizes by applying pressure or force. Press machines are always operating with impact loads. Structure of power press is constantly under tensile stress as a result of the continuous impact load. Continuous stress is applied to press machines, and as a result, structural problems are regularly encountered. With the use of the FEM Tool, load situation experienced by frame determines thickness of the plate.

58% MATCHING BLOCK 2/11 W

The objective of this dissertation work is to analyse and optimization of C-frame of hydraulic power press

at Singhal Engineering Works (SEW). SolidWorks software is used to design the frame. Analytical and computer-based simulations using the Ansys programme are used to evaluate design parameters. The design modification and analysis of the frame structure within the allowed parameters, including the stresses and deformation of the frame, are the subjects of this dissertation. Key Words: C-frame, Power press, FEM etc.

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Skill Training Report

At

Sanjeevani Metropolice Healthcare Ltd.

Submitted by

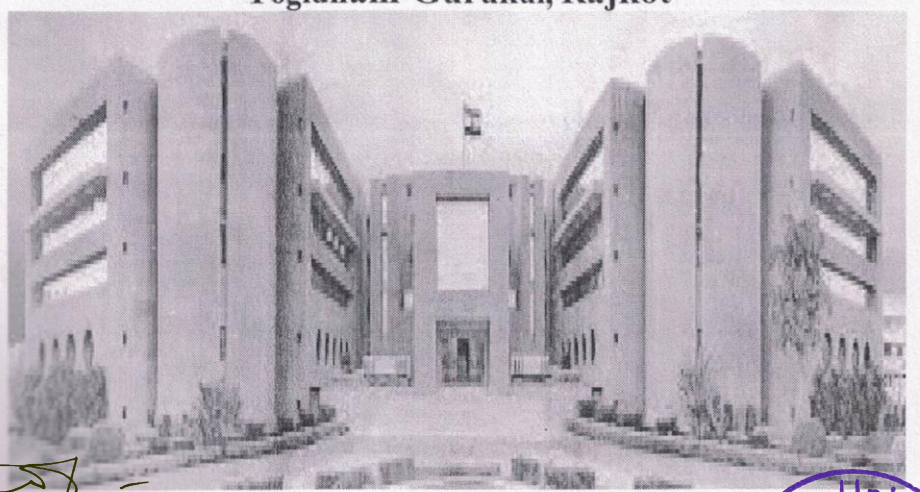
Ms. Jadeja Nandaniba D.

PG – DMLT, Sem – II

To

Department of Microbiology
Faculty of Science

Atmiya university
Yogidham Gurukul, Rajkot



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Faculty of Science
Department of Microbiology

POST GRADUATION DIPLOMA IN
MEDICAL LABORATORY TECHNOLOGY

AU/PGDMLT/2023-24 Exam Seat No. 220661021

CERTIFICATE

This is to certify that skill training has been successfully completed at **Sanjeevani Metropolis Healthcare Ltd** by **Jadeja Nandaniba Digvijaysinh** students of Postgraduate Diplomain medical laboratory technology, Department of Microbiology, Faculty ofScience, Atmiya University, Rajkot as a part of the partial fulfillment for the PG-DMLT during academic year 2022-23.

Dr. Rohan Pandya
Head
Dept. of Microbiology
Atmiya University

Head of Department
Department of Microbiology
Faculty of Science
Atmiya University
Rajkot

Dr. Krishna Joshi
Programme coordinator
PGDMLT
Dept. of Microbiology
Atmiya University

Examiner's Signature:

Date: 12/04/24

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

Date: 09th April 2024

Certificate

This is to certify that ~~Mr./~~Miss. ***JADEJA NANDANIBA*** *student of PG Diploma in Medical Laboratory Technology at Atmiya University, Rajkot has taken skill training/internship during the period of* ***01.03.2024*** *to* ***31.03.2024*** *at* ***Metropolis Healthcare Ltd, Rajkot Lab***.

During the training ~~he~~/she was exposed to observation of various laboratory tests, sample handling, and analytical techniques. His/her attendance was found to be 100 % during the tenure.

We found ~~his~~/her sincere and hard worker.

We wish ~~him~~/her all success in future endeavors.

With Good wishes!

For, ***Metropolis Healthcare Ltd.***

Metropolis Healthcare Ltd. Rajkot

(Manager- HR)

(Chief of Lab)

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Rajkot

Atmiya University Rajkot

ACKNOWLEDGEMENT

I am thankful to Atmiya University and our HOD Dr. Rohan Pandya sir and other faculties Dr. Krishna Joshi Madam, Ms. Radhika Joshi Madam & Ms. Nancy Pipaliya Madam, for all the extra efforts you make to help us grow.

You are not only our teachers, you are our authority and guide, all rolled into one person. We will always be thank full to you for your support and kindness.

First of all, I would like to thank you Dr. Kirit Patel Sir and express my gratitude to him for during my laboratory internship and for giving me advice and guidance.

I also thank laboratory incharge Dr.Hardic sir . THEY also gave me a lot of guidance to work in to the laboratory.

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INDEX

Sr. No	Title Name	Page No.
1	Introduction	
2	Reception	
3	Phlebotomy	
4	FNAC	
5	Biochemistry	
6	Histopathology	
7	hematology	

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INTRODUCTION :-

Pathology laboratory :-

These labs perform tests to monitor the prevalence of certain diseases in the community which are public health concern ,such as outbreaks of foodborne or waterborne illnesses or detection of unique infectious agent.

Flore	Department
1	*Reception*
2	*PCR*
3	*Biochemistry*
4	*Histopathology*
5	*hematology*

1.Reception:-
Phebotomy ,Bloood collection center
2. PCR :-
Molecular department
3. biochemistry:-
Elisa,fully automated assay
4.Histopathology:-
Microtome, tissue processer
5.hematology
Uri +,hematology analyzer

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RECEPTION:

- *Laboratory receptionists are professionals who are responsible for coordinating the daily administration of doctors, staff, visitors, and patients at a healthcare facility.*

- *They schedule appointments, answer patient inquiries, handle patient emergencies, and monitor stock and supplies at the healthcare facility.*

- *Patient's information for form fill:-*

1	*Name*
2	*Age*
3	*Date of collection*
4	*DOB*
5	*Gender*
6	*Email*
7	*Reference Doctor*
8	*TRF BARCODE*
9	*test*
10	*Clinical History, Treatment and last findings*
11	*Sample discription*

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Phlebotomy:-

Defination :-

A procedure in which a needle is used to take blood from a vein, usually for laboratory testing.

Phlebotomy may also be done to remove extra red blood cells from the blood, to treat certain blood disorders. Also called blood draw and venipuncture.

Phlebotomy can also be divided into two categories:

1. *therapeutic*
2. *diagnostic.*

Therapeutic phlebotomy is used to treat conditions like iron overload or polycythemia vera. Diagnostic phlebotomy is used to test for conditions like anemia or bleeding disorders.

Phlebotomy Function:-

Phlebotomy describes the act of removing blood from a patient using a needle. This can be for the purposes of laboratory testing as a diagnostic tool to narrow down a differential or can be used therapeutically for certain conditions.

Steps:-

1. *Assemble equipment.*
2. *Identify and prepare the patient.*
3. *Select the site.*
4. *Perform hand hygiene and put on gloves.*
5. *Disinfect the entry site.*
6. *Take blood.*
7. *Fill the laboratory sample tubes.*
8. *Draw samples in the correct order.*
9. *Put it in vacutainer tube as per test.*
10. *Perform test*

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FNAC:-

- ***Defination:-***

Fine Needle Aspiration Cytology (FNAC) is a simple, quick and inexpensive method that is used to sample superficial masses like those found in the neck and is usually performed in the outpatient clinic.

- ***How to perform:-***

A very thin, hollow needle with a syringe is gently inserted through the skin into the lump or organ.

The doctor uses the syringe to help suck some of the cells into the needle by gently pulling on the plunger.

Sometimes, if the lump is very small, a scanning machine is used to help guide the needle to the right place.

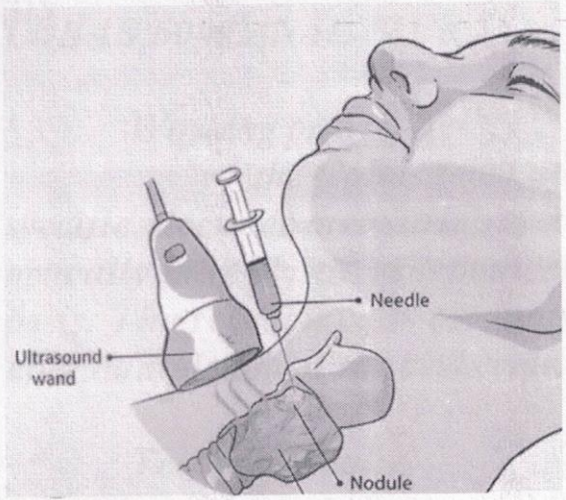

Fig :2: Fine Needle Aspiration Cytology

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Biochemistry:-

The scientific study of the chemistry of living things and the chemical structure of a living thing.

Introduction:-

Biochemistry is a discipline of Chemistry that deals with the chemical composition of living organisms. It deals with interactions between living organic cells and their surrounding fluids/matter and is the study of important chemical processes occurring within living organisms.

COBAS 6000 ANALYZER:-

Working principle:-

the Cobas 6000 utilizes spectrophotometric and ion-specific electrode measuring systems. The instrument utilizes reusable optically pure plastic reaction cells that are changed on a monthly basis. The reaction cells are automatically washed by the instrument after completion of the test cycle.

Test perfomed:-

over 110 measurements of proteins, enzymes, substrates, and electrolytes, Drugs of Abuse Testing, and therapeutic drug monitoring (TDMs).

Advantages :-

The COBAS 6000 analyzer series provides peace of mind with premium quality results.

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- *Deliver confidence with Roche's robust performance standards in a broad assay menu.*
- *Ensure sample integrity with innovative design. Clot and level detection.*

Disadvantages:-

Maintenance is overly involved.

Monthly maintenance can take 5-6 hours to complete.

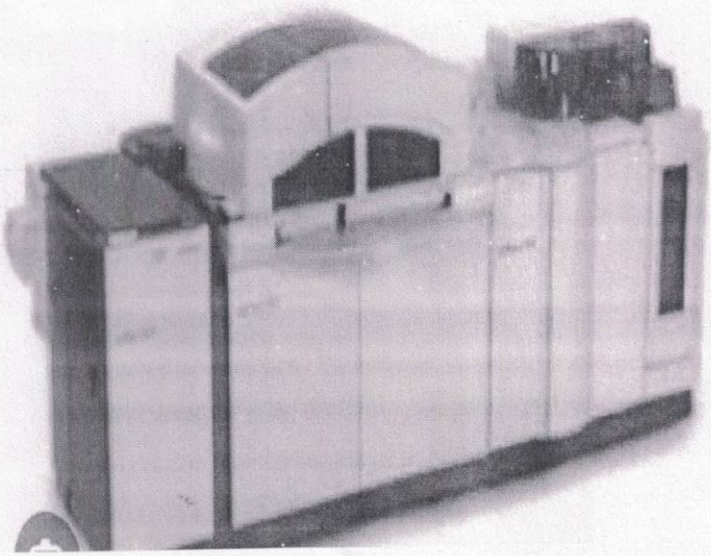

Fig :3: ROCHE COBAS 6000

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Histopathology:-

The diagnosis and study of diseases of the tissues, and involves examining tissues and/or cells under a microscope.

1.TISSUE PROCESSER

2.EMBEDDING

3.MICROTOME

4.STAIN

5.MOUNTING

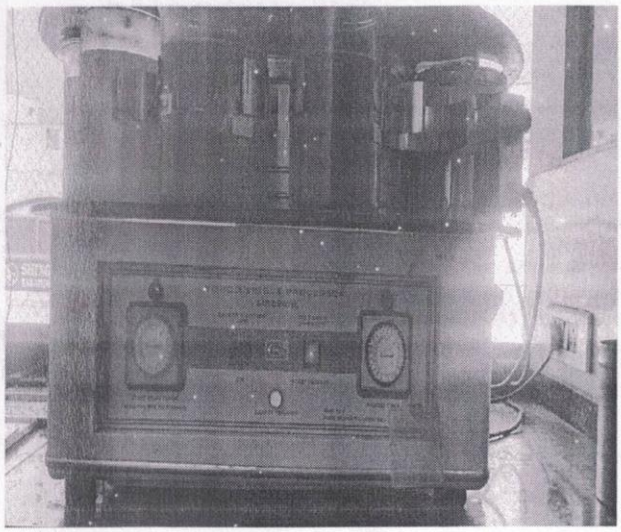

Fig:4:Semi Automated Tissuprocesser

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Tissue processer:-

1. *Obtaining a fresh specimen. Fresh tissue specimens will come from various sources.*
2. *Fixation. The specimen is placed in a liquid fixing agent (fixative) such as formaldehyde solution (formalin).*
3. *Dehydration.*
4. *Clearing.*
5. *Wax infiltration.*
6. *Embedding or blocking out*

EMBEDDING:-

Embedding is the process in which the tissues or the specimens are enclosed in a mass of the embedding medium using a mould.

Since the tissue blocks are very thin in thickness they need a supporting medium in which the tissue blocks are embedded.

The three primary means of embedding tissue for sectioning are paraffin wax, Optimal Cutting Temperature , and resin. Each has its own set of cons.

Embedding in paraffin wax by taking the tissue through three steps;

1. *Dehydration in alcohol,*
2. *Clearing in xylene and finally,*
3. *Infiltration with paraffin wax.*

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Microtome:-

A Rotary microtome cuts the sections of biological specimens into thin slices for use in microscopy.

It gets its name because of the rotary action of the handwheel used for slicing samples.

It is used to prepare thin layers of bone, mineral, teeth, and hair with section thicknesses ranging from 1-micron to 60 microns.

Microtome tissue section:

1.Rough cutting
2.Fine cutting

1. Rough couting :-
20 micro meter,
Waste material
2. Fine cutting :-
6 micrometer
For slide preparation

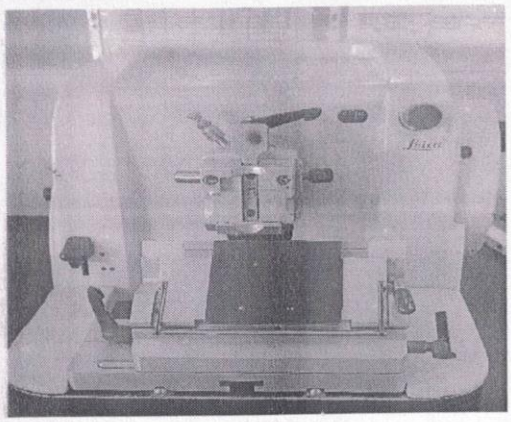

Fig :5: Semi Automated Microtome

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H&E STAIN

Xylene 1
Xylene 2
Xylene 3
100%Alcohol
75%Alcohol
50%Alcohol
Running tapn water
Hematoxyline
Running tap water
1%Acid alcohol
Running tap water
10%sodium hydrogen carbonate
Running tap water
Eosin
50%Alcohol
75%alcohol
100%Alcohol
Xylene 1
Xylene 2
Xylene 3

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Mounting :-

Mounting is the last step in the series of histological preparation of a slide. This protects the cell film from damage, air drying and stain fading.

A sufficiently thin and suitably colored slice of biological material must be placed on glass slides for examination under the microscope. A drop of mounting media is applied to the sections, and the coverslip is carefully dropped onto the sample using tweezers. This process is called mounting in histopathology.

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Sample Evaluated projects report / field work submitted by the students.

AY 2021-22

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PROJECT REPORT

"DEVELOPMENT AND EVALUATION OF HERBAL SHOWER GEL CONTAINING THYME"

Submitted to

ATMIYA UNIVERSITY

School of Pharmaceutical Sciences,

Faculty of Paramedical Sciences

By

Mr. DIPESH GAJIPARA (180501014)

8TH semester B Pharm.

Under the guidance of

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Rajkot - 360005, Gujarat, India2021-2022.

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ATMIYA UNIVERSITY

Faculty of Paramedical Sciences

School of Pharmaceutical Sciences

"Yogidham Gurukul", Kalawad Road, Rajkot – 360005. (Gujarat, India)

CERTIFICATE

This is to certify that Mr. Dipesh Girishbhai Gajipara Enrolment No.**180501014** has successfully completed project on "**Development and Evaluation of Herbal Shower Gel Containing Thyme**"as part of curriculum of **B.Pharm. Semester-VIII** in the subject **Project Work (18BPHCC803)** during the academic year 2021–22.

05/05/2022

Sign. Of Supervisor

Kurtika 05/5/22

Principal

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INDEX

Sr No.	Content	Pg No:
1	Abstract	1
2	Introduction	2
3	Rationale	10
4	Objective	10
5	Material and method	11
6	Evaluation parameters	14
7	Discussions	16
8	Results	19
9	Conclusions	20
10	References	21

INDEX FOR TABLE

Sr no.	Title	Pg no:
1	Analysis of thyme hydrosol	9
2	Formulation of shower gel	12-13
3	Foam ability of shower gel	15
4	Optimized formulation	18
5	Result of Evaluation parameter of shower gel	20

INDEX OF FIGURE

Sr no.	Title	Pg. no.
1	Structure of thymol	3
2	Thyme leaves	4
3	Thyme seeds	4
4	Preparation of hydrosol	5
5	Diluted hydrosol phase 3	8
6	Thyme hydrosol	9
7	Preparation of shower gel	11
8	Skin irritation test	14
9	Foam ability test	15
10	Foam-stability test	15
11	Phase separation	16
12	Final product	18
13	pH measurement of shower gel	19

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DEVELOPMENT AND EVALUATION OF HERBAL SHOWER GEL CONTAINING THYME

Dipesh Gajipara *

School of Pharmaceutical Sciences, near kalawad road, Nandanvan society, Yogidham, Gurukul, Rajkot, 360004

ABSTRACT

To evaluate herbal shower gel containing Thymus vulgaris hydrosol 5:1 Concentrated Floral Waters/Hydrolats are free of emulsifying agents and preservatives. to meet out growing consumer demand for cosmetic preparations that incorporate biologically active and natural ingredients. This study utilized hydrosol of thymus vulgaris to create the main scent for body wash product in place of artificial fragrance on market. Thymus vulgaris hydrosol is distilled by method of diluted 5:1 with distilled or filtered water to get the common hydrosols. The process of developing a skin emollient, foaming agent, self-preservative. The product was evaluated based on the criteria of foam ability. The result indicates that thymus vulgaris hydrosol shower gel formulae are on par with some shower gel products. The study has successfully devised a basic formulation of body wash that incorporated thymus vulgaris. Study of parameter affecting the foam ability and foam durability of the body wash product indicated following optimal parameter Foaming agent CAPB (9.292%v/v), Decyl glucoside (0.8%v/v), herbal ingredient thyme hydrosol 3 drop(0.15ml) [0.133%v/v].

Introduction:

Shower gel:

Shower gel is basically thinner, less hydrating bodies wash formula. It doesn't cling to your skin the same way, and tends to simply cleanse your skin without infusing it with moisturizing ingredients.

It's better to use shower gel when you have dry skin, when you have a chronic skin condition like rosacea, psoriasis or acne. When use shower gel, it's recommended that you use a loofah, washcloth.

Although being sometimes termed as "natural fragrance," they may some-times contain chemical ingredients that enhance the product's properties and allow the fragrance to dissolve easily with the product.

In addition, when used long term, artificial body wash may destroy collagen, reduce the ability of skin to heal itself and easily induce dry skin and wrinkle formation.

As a result, using herbal body wash cleaning the skin is one the most important measure to help prevent infection that cause disease in body.

The shower gel should be pH balanced and then avoid sulphates especially if you have sensitive skin or are seeing red patches after shower. Considering the cleansing and moisturizing function, it must take out dirt, oil and dullness from skin and the same time also moisturize and condition it. Since shower gels are about sensorial experiences, factor the fragrance in, it must give you a pleasant and lingering fragrance after bath.

Thymus vulgaris:

Thyme scientifically known as thyme vulgaris, thyme belongs to mint family and its relative of oregano genus Origanum. Thyme is herb.(1)

Thymus vulgaris is only cultivated specie of thymus genus, which contains 215 species of herbaceous perennials and subshrubs and other species growing widely.(2)

Thymus vulgaris belongs to an important aromatic and medicinal genus of family Lamiaceae. Thyme is well known historical medicinal plant from Mediterranean.

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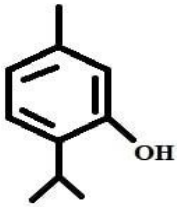

Figure no1: structure of thymol

According to essential oil composition, several chemo types of thyme have been recognized as thymol, carvacol, borneol, geraniol, linalool, sabinene hydrate and number of multiple components chemo types.

Thyme contains the main components are carvacrol (55-85%), thymol (0-5-10%), have the strongest antimicrobial action attributable to their phenolic composition.

The antimicrobial mechanism of carvacrol and thymol able to destroy bacterial cell by changing the permeability of the cell membrane and resulting leakage of cell component.

It's more effective against gram negative bacteria but with reduced activity against gram positive lactobacillus and Bifidobacterium. In folk medicine, t. vulgaris has been used as anti-asthmatic, bronchodilator, and expectorant, antiseptic, anti-spasmodic, antitussive, carminative, anthelmintic, antiprotozoal and antioxidant.

Scientific classification:

- Scientific name: thymus vulgaris
- Family: lamiaceae
- Kingdom: Plantae
- Class: Magnoliopsida
- Genus: thymus
- Biological source: dried leaves and flowering top of plant thymus vulgaris
- Geographical source: it is indigenous to western temperate Himalayas and Nilgiris. Native of thyme is southern Europe from Spain to Italy.

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Figure no 2: thyme leaves

Figure no 3: thyme seed

Indian name of thyme:

Hindi: Banajwain Malayalam: Thottathulasi Punjabi: Marizha, Masho, Rangsbur.

Hydrosol:

The water of hydrosol comes from water used for generating steam and from distilled plant biomass.

Water pumped into the system for steam generation + water contributed by the plant biomass = water remaining in the boiler (unused water) + water left over in distillation tank (residual water) + hydrosol + water absorb by the plant biomass + water lost during distillation process.(3)

Properties:

Hydrosol are highly diluted, acidic (3.5 to 6.5), mild or pleasant – scented solution.

Hydrosol should be collected in clean, aseptic container, filled up to the brim without air gap, sealed and stored in a cool place. Shelf life 1 year or more.(3)

Hydrosol of thyme:

Thyme has been used medicinally for thousands of years, well known for its antimicrobial, antitussive, spasmolytic and antioxidant activity (Ethan, 2004), and it was considered to the ancient Greeks, as a symbol of love, honour and happiness.(4)(5)

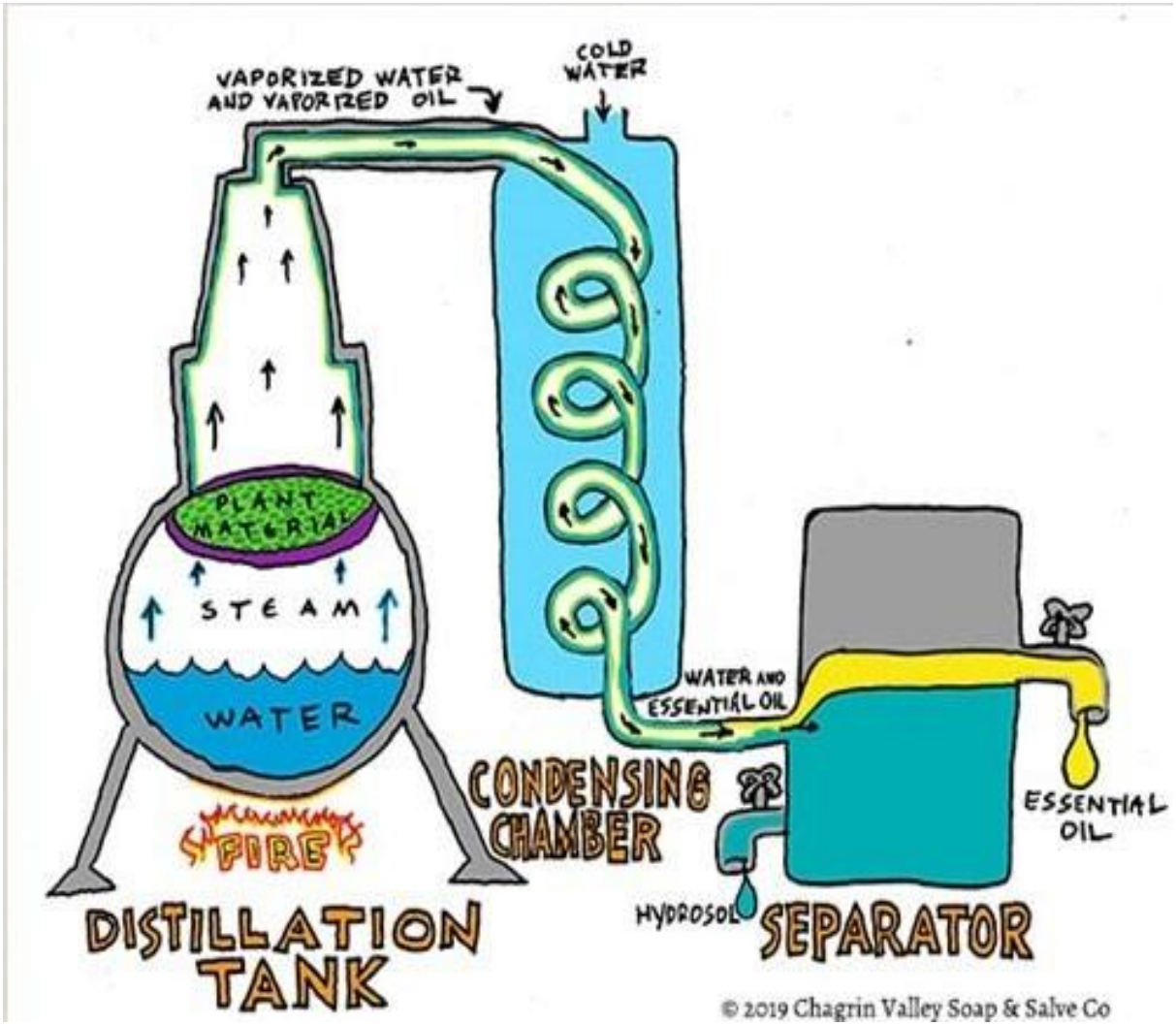

Figure no 4: preparation of hydrosol

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Mechanism of action of thyme:

Antibacterial affect:

The resistance of pathogen to biocides has led to the search and development to safe and natural antimicrobial agents, such as hydrosol. The significant antimicrobial action of thyme capitata hydrosol against both planktonic and biofilm cell of common foodborne pathogen "salmonella" which is recognized as one of the most significant foodborne bacterial pathogens. (4)

Also, the two thymes (thymus vulgaris and thymus serpyllum) were tested by for their inhibitory effect against four pathogenic bacteria (Escherichia coli), staphylococcus aureus and yersinia enterocolitica.(4) (6)

These hydrosols appeared to have bactericidal effect at concentration above 50ml/100ml.(4)

Antifungal effect:

Thyme hydrosol as antimicrobial agents can be used as an antifungal agent for food industry such as dairy and meat. It can help prevent fungi growing on the surface of foods.

Terpenes are the most important volatile compounds found in thyme hydrosol, and it was found that it is responsible of the antifungal activity of thyme (Thymus vulgaris) hydrosol and propolis extract (PE) against natural mycobiota on the surface.(4)

Inflammatory response:

The anti-inflammatory effects of the main constitutes of thyme oil and hydrosol "thymol and cavacrol (CVL)" were studied and it has showed inhibition of inflammatory oedema and leukocyte migration.(4)(7)

Blood pressure control:

Chemical principles from natural sources may contribute significantly to reducing blood pressure. Such as phenol and flavonoid contents of aqueous extract obtained from Thymus serpyllum (wild thyme,). it has antioxidant capacity, free radical scavenging activity and potential antihypertensive effect, that studied the effect of aqueous extract obtained from Thymus serpyllum (wild thyme, TE) in spontaneously hypertensive rats and in normotensive

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Wistar rats.It was found that the bolus injection of TE (100 mg/kg body weight i.v) induced significant decrease of systolic and diastolic blood pressure.(4)

Cosmetic Preparation and Uses of Thymus Vulgaris:

Parts Used: Leaves

Cosmetic Properties and Uses:

Derived from the plant leaves, this special chemo type of thyme essential oil is skin-friendly and gentle, unlike red thyme Thymus vulgaris chemo type thymol), which is hot and irritating. It has a sweet, "green," lightly medicinal aroma and is an effective antiseptic and antibacterial agent. It's healing for weeping acne and rashes resulting from poison oak, poison ivy, and sumac or general contact dermatitis.

Use it in cleansers, astringents, lotions, facial elixirs, and masks for acneic and blemish-prone skin and in sinus and cold- and flu-preventive balms, salves, and elixirs. An infusion of thyme leaves produces an astringent liquid for an oily, combination, or normal complexion or as a cleansing wound wash. Powdered thyme is a good antibacterial and deodorizing agent in body and foot powders.

Possible Substitutes: Tea tree essential oil may be substituted for Thyme essential oil, though it has a much more penetrating, medicinal Odour.

Contraindications: Avoid use of essential oil if you are pregnant or epileptic or have high blood pressure. May be a potential skin irritant for sensitive skin.(8) (9)

Thymus vulgaris /thyme thymol hydrosol information:

pH: 4.5 – 4.6

Aroma and Taste: Here be thyme! No question in the aroma or taste of this one. Strong thyme smell and very close to the fresh plant picked at the height of summer under the Mediterranean sun. The flavour is intense, quite hot, and almost burning to the mouth undiluted. When it is diluted, it becomes quite palatable, although it is still distinctly thyme and slightly warm.(8)

Stability and Shelf Life:

Very stable. Even after nearly three years this hydrosol remains in perfect condition(8)

Properties and Applications:

Antibacterial, mildly antiviral, antifungal, and antiseptic, this is the big gun of the thyme family. Like the oil, the hydrosol is hot, literally causing a burning sensation on the tongue if undiluted, although it is not dermo caustic like the oil. Choose CT thymol when you need a killer.

This hydrosol makes a great gargle or mouthwash for sore throat, tonsillitis, laryngitis, or any throat infection. Use it as strong as you can bear, given the taste and heat, two or three times a day; it usually takes only a couple of days and is rather like the old commercial suggesting that Listerine tastes lousy but it works.

In fact, Listerine contains thymol. For colds, flus, and respiratory and gastrointestinal infections, take 1 tablespoon of a 60:40 hydrosol-to-water blend, sweetened with honey if you want, every hour up to 6 P.M. during the acute phase. This is dramatic but it works, and for those who refuse to rest even when they're ill, you have the added benefit that CT thymol is quite stimulating—which is why you stop at 6 P.M.(8)(10)(11)

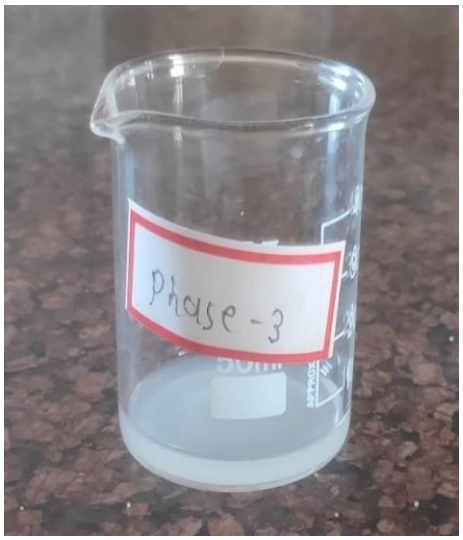

Figure 5: diluted hydrosol phase 3 (3 drops)

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Analysis Of Thyme Hydrosol

Table no 1: thyme hydrosol		
	Specification	Result
Appearance	Whitish liquid	complies
Odour	Characteristic odour	complies
Solubility	Soluble in alcohol, in soluble in oil	complies
Specific gravity	0.989 – 1.000 @ 20℃	complies
pH	2.7- 7.0 @ 20℃ (conc^{n})	complies
	3.0 – 8.0 @ 20℃ (diluted with 1:5 parts water)	
Extraction method	Steam distillation	complies

Figure no 6: thyme hydrosol

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Rationale:

The aim of present study is to prepare herbal shower gel formulation containing herbs with thyme hydrosol for bath.

By the preparation of this herbal shower gel can give various effect of chemical present in thyme extract,

Thymol – it can reduce acne causing by bacteria on skin.

Carvacrol – it has anti-inflammatory activity by cyclooxygenase inhibition.

Linalool – helps to improve the scent of cosmetic product and skincare formulation.

β caryophyllene – can affect wound healing by decrease inflammation.

As this formulation in gel form it can be easily applied with help of fingertip.it means customer compliance will be better (than soap).

Objectives:

In present cosmetic market of shower gel is not traded too much as soap for bath use.

All type of mild soaps basically does the same thing as shower gel –dislodged dirt from your skin surface the difference come in ingredients and mechanism for dirt removal.

Bar soap works by dissolving the dirt on surface of your skin as sweat and dirt mix with your body's natural oils, it can settle on your skin and breed bacteria.

Body wash use same cleaning mechanism to get dirt of your skin, but often contains mixer of ingredients meant to help treat common skin conditions.

Dryness, clogged pores and skin flaking can all be addressed with a body wash.

Shower gel is basically a thinner, less hydrating body wash a formula.it does not cling to your skin same way, and tends to simply cleans your skin without influencing it with moisturizing ingredients.

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Literature Review

Sr. No	Author	Title	Publication	Remarks
1.	Baraa Al-Mansour	Review on The Medicinal Properties of Some Aromatic Hydrosols	Zeugma Biological Science	Essential oils That Derive from Aromatic Plants Are Typically obtained by steam Distillation Known As Important Sources of Novel Therapeutic Molecules Without Changing Medicinal Potential.
2.	Merat Mahmoodi Fatema Ayoobi	Beneficial Effect of Thymus Vulgaris Extract in Experimental Autoimmune Encephalomyelitis: Clinical, Histological & Cytokine Alterations.	Elsevier	The Imbalance Between Pro & Anti-Inflammatory Cytokines Plays an Important Role in Pathogenesis of Multiple Sclerosis & Its Animal Model, Experimental Autoimmune Encephalomyelitis.
3.	Thien Hien Tran Tran Thi Kim Ngan	Formulation of An Essential Oil Based Body Wash Selection of Components &Their Effects on Product Formability & Emulsion Purability.	Asian Journal of Chemistry	To Meet-out The Growing Consumer Demand for Cosmetic Preparations That Incorporate Biologically Active & Natural Ingredients.
4.	Stephanie Tourles	Organic Body Care Recipes	Storey Publishing	Thymus Vulgaris, Chemo-type Thymol Which Is Hot & Irritating. It Has a Sweet, Green, Lightly Medicinal Aroma & Is an Effective Antiseptic & Anti-Bacterial Agent.
5.	Linda Loretz Anne Marie Api	Exposure Data for Personal Care Product: Hair Spray, Spray Perfume, Liquid Foundation Shampoo, Body Wash & Solid Anti-Per-spirant.	Elsevier	Subject Were Provided with New Container of Brand of Product They Normally Use & Kept Diaries & Recorded Detailed Daily Usage Information Over Two Week Period & Safety Criteria.

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Material and method:

Material -

Chemical ingredients:

1. Xanthan gum
2. Decyl glucoside (DC)
3. Coca amido propyl betain (CAPB)
4. Glycerine
5. Thyme hydrosol
6. Sodium chloride (NaCl)
7. Aqua

Preparation method:

Making 3 phase of shower gel.

Phase 1: Aqua + glycerine + xanthan gum

Phase 2: Aqua + coca amido propyl betain + decyl glucoside + sodium chloride

Phase 3: Aqua + thyme hydrosol (5:1)

Procedure:

Pre-wet xanthan gum with glycerine until homogeneous and stirring water.

Gently mix phase B ingredients into phase one after another.

Pre-mix phase C and add to the blend.(12)(13)

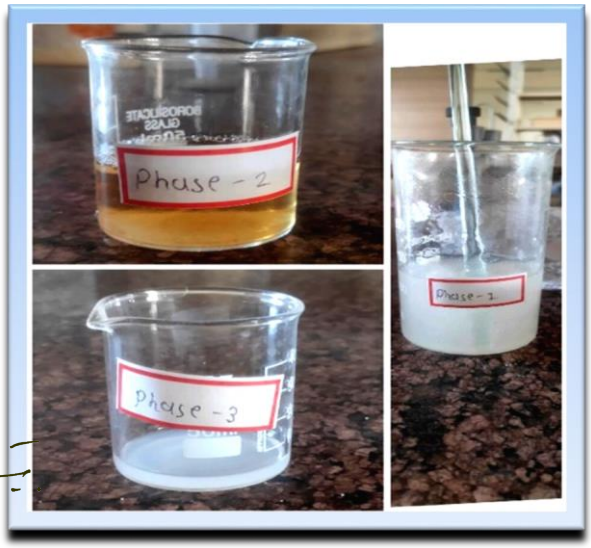

Figure no 7: preparation of shower gel

Table no 2: formulation of shower gel

Chemical	B1	B2a	B2b	B3	B4a
Xanthan gum	1gm	1gm	1gm	0.5gm	1gm
Glycerine	3ml	3ml	1ml	1ml	1ml
Coca amido Propyl betain	10.5ml	10.5ml	5.25ml	10.5ml	10.5ml
Sodium lauryl ether sulphate	1ml	0.5ml	0.5ml	-	-
Decyl glucoside	-	-	-	0.5ml	0.6 ml
Talc	1.5gm	1.5gm	1.5gm	-	-
Sodium chloride	6.75gm	6.75gm	6.75gm	6.75gm	6.75gm
Citric acid	0.25ml	0.25gm	0.25gm	-	-
Orange oil	-	-	2ml	-	-
Sodium benzoate	0.5gm	0.5gm	0.5gm	-	-
Thyme hydrosol	-	-	-	-	3 drops
water	Q.S. 100	Q.S. 100	Q.S. 100	Q.S. 100	Q.S. 100

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Table no 2a: formulation of shower gel

Chemical	B4b	B4c	B4d	B4e	B5
Xanthan gum	1gm	1 gm	1gm	1gm	1gm
Glycerine	1 ml	1 ml	1ml	1ml	1ml
Coca amido propyl betain	10.5ml	10.5	10.5ml	10.5ml	10.5ml
SLES	-	-	-	-	-
Decyl – glycoside	0.8ml	2ml	1.5ml	1.1ml	1ml
Talc	-	-	-	-	-
Sodium chloride	6.75gm	6.75gm	6.75gm	6.75gm	6.75gm
Sodium benzoate	-	-	-	-	-
Citric acid	-	-	-	-	-
Orange oil	-	2 ml	-	-	-
Thyme hydrosol	3 drops	3 drops	3 drops	3 drops	3 drops
Water	Q.S.100	Q.S.100	Q.S.100	Q.S.100	Q.S.100

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Evaluation parameters:

Physical appearance: physical parameters like appearance and colour were checked.

Clarity: the herbal shower gel wash prepared and evaluated visually for clarity in the white and black backgrounds in light.

Homogeneity: all developed gel formulation were tested for homogeneity by visual inspection after the gel have been set into the container or vial. They were tested for their presence and appearance of any aggregates.

pH measurement: pH of shower gel formulation should be such that the formulation should be stable at the pH and at the same time there would be no irritation to the customer upon applying the formulation.

Herbal shower gel formulations should have pH range in 9 to 10. The developed shower gel formulation was evaluated for pH by using pH strip.(14)

Stability study: stability studies were done with help of open and close container by placing in two separate containers, one is tightly covered with parafilm and another container kept open. Both containers placed at room temperature for one month and stability observed.

Irritation testing: irritation test can be used to determine if material chemical will cause local irritation in the skin, mucosal, ocular tissue. The test article extract is dosed or the test article applied to the animal.

Herbal shower gel formulation was not producing an irritation after applying on sensitive body part.(13)

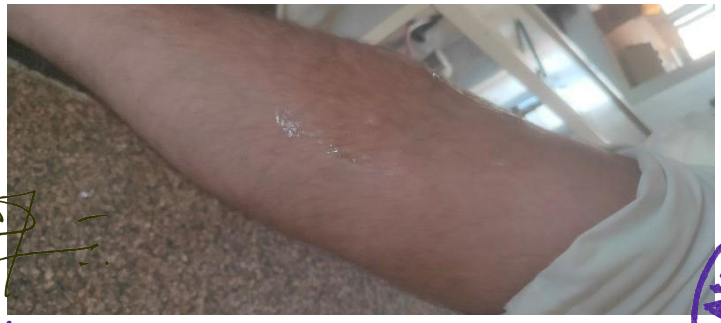

Figure 8: skin irritation test

Foam stability:

We take 1% formulation in 100 ml measuring cylinder and added 50 ml water. Shake cylinder for 1 minute (10 times) then measure height of form at t=0, after 30 minutes again measure height of form.(15)

Foam ability: foam-ability determines the sense of use of the product. This study uses the shaking test to measure foaming. The liquid is diluted 100 times and then 2 ml of solution was put into a stoppered tube, followed by shaking with a moderate force until the amount of foam generated reached maximum level, i.e., constant foam volume.(15)

Table no 3: Foam-ability of shower gel

Batch	B1	B2a	B2b	B3	B4a	B4b	B4c	B4d	B4e	B5
Foam-ability	8.7cm	5.25cm	5.4cm	6.2cm	6.75cm	6.45cm	6.65cm	6.45cm	6.75cm	6.55cm

Foam ability is calculated by the formula:

$$\frac{\varepsilon\varepsilon\varepsilon\ \varepsilon\ V(\varepsilon\varepsilon oam) -}{V(lllqulld)\ \mathrm{V}\ (\mathrm{foam})}$$

$\mathcal{E}\mathcal{E}_{\mathrm{f}}$= foaming level; $\mathrm{V}_{\mathrm{foam}}$= foam volume after shaking; $\mathrm{V}_{\mathrm{liquid}}$: original volume of liquid

Figure no 9: Foam-ability test

Figure no 10: Foam stability test

Result And Discussion :

Discussion: the discussion of study includes the number of trials required to prepare the formulation for herbal shower gel.(15)(16)

Trial 1:

In first batch, we accurately weight 1%w/v of xanthan gum, 3%v/v glycerine, 10.5%v/v coca amido propyl betain, 1%v/v SLES, 1.5%w/v talc, 6.75%w/v NaCl, 0.5%w/v sodium benzoate, 0.25%w/v citric acid.

These ingredients compounded as given in the method of preparation.

Problem: more foaming observed and phase separation observed.

Figure no 11: phase separation

Discussion: so, we changed the concentration ratio of SLES. so, we diced to change glycerine concentration in phase A and coca amido propyl betain phase B. pH range 4-6.

Trial 2:

in the second batch B2a & B2b, we accurately weight 1%w/v of xanthan gum, (3% v/v for B2a batch) (1% v/v for B2b) glycerine, (10.5% v/v for B2a) (5.25%v/v batch B2b) propyl betain, 0.5%w/v SLES, 1.5% w/v for B2a talc, 6.75%w/v NaCl, 0.5% w/v sodium benzoate, 0.25% w/v citric acid, 2% orange oil in B2b batch.

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Problem: phase separation for herbal shower gel pH should between neutral and basic.

Discussion: so, we diced to change glycerine concentration in phase A and coca amido propyl betain phase Band we found SLES is somewhat harmful for daily use and also talcum powder can produce harmful effect shows it is carcinogenic for human (causes ovarian cancer). pH range 4-6.

Trial 3:

In the third batch, we accurately weight 0.5% w/v of xanthan gum, 3% v/v glycerine, 10.5% v/v coca amido propyl betain, 0.5% v/v decyl glucoside, 6.75%w/v NaCl.

Problem: less viscous, less foaming. For herbal shower gel pH should

Discussion: so, we changed xanthan gum and decyl glucoside concentration.

Trial 4: in fourth batch, we prepare 5 formulations with different concentration of decyl glucoside 0.7%v/v, 0.8%v/v, 2%v/v, 1.5%v/v & 1.3%v/v, thyme hydrosol 0.15%v/v and in B4c batch we added 2%v/v orange oil.

Problem: we assume that above 1.5ml decyl glucoside produce more foaming and below 0.8ml decyl glucoside produce less foaming.

Discussion: we got acquired product.

Optimal formulation batch:

in fifth batch, we prepared one formulation containing 1%w/v xanthan gum, 1%v/v glycerine, 1%v/v decyl glucoside, 6.75%w/v NaCl, 0.15%v/v thyme hydrosol.

Discussion: we got acquired product.

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Table no 4: optimized formulation	
Chemical	**Quantity taken**
Xanthan gum	1gm
Glycerine	1ml
Decyl glucoside	1ml
Coca-amido propyl betain	10.5ml
Thyme hydrosol	3 drops
water	Q.S. 100

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Figure no 12: Final Product

Result:

1. Physical appearance: herbal shower gel was assessed physically and visually colour (pale yellow), transparent consistency. All formulation was evaluated for this physical parameter.

2. Stability: after batch 3 almost all formulation is stable.

3. Homogeneity: prepared shower gel was tested for homogeneity by visually inspection after the shower gels have been set into the container. It is tested for the presence and appearance of aggregates or not. Homogeneity from batch 3 to last batch is found to be good. (No aggregate found)

4. pH: the pH of shower gel is considered important for stability of formulation and skin irritation. For herbal shower gel pH range must in between 9-10. The pH of optimized B3, B4, B5 batches were determined at different storage condition (25-40 c).

For non-herbal shower gel pH range between 4-6. In batch B1& B2 we add citric acid show pH range is in between 4-6.

No significant changes in the pH value of the formulation were observed at different storage condition. So, herbal shower gel at different storage condition was in the acceptable range and there for the shower gel would probably not occur irritation hence formulation was suitable for bath.

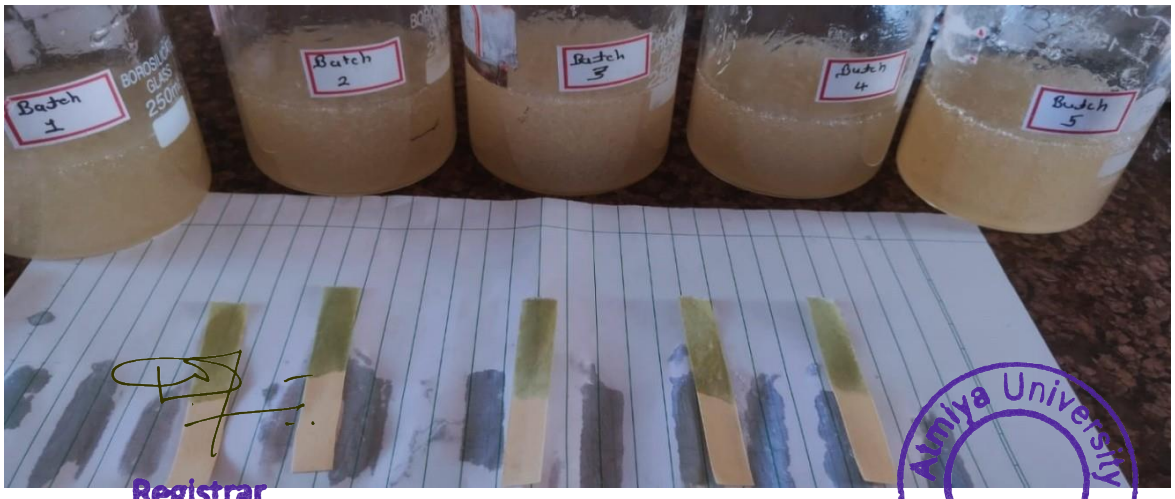

Figure no 13: pH measurement of shower gel

Table no 5: Result of evaluation parameter of shower gel		
Sr no.	Evaluation parameter	Remarks
1.	Physical appearance	Good
2.	Stability study	Good stability
3.	Homogeneity	Good (no aggregates found)
4.	pH	9-10
5.	Foam ability	Good

Conclusion:

This study has successfully devised a basic formulation of a shower gel that incorporated thyme hydrosol. A study of parameter affecting the foam ability and foam durability of shower gel indicated following optimal parameter:(15)

Surfactant decyl - glucoside 1%
Mild foaming agent CAPB 10.5%
Thyme hydrosol 0.15%
Humectant glycerine 1%
Gelling agent xanthan gum 1%.

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Fuzzy Sets and Fuzzy Logic : Theory and Application

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in partial fulfillment of the requirements
for the award of the degree of

Master of Science

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This is the record of work carried out by them under the guidance of Mr. M. R. Jadeja, during the academic year 2021-2022.

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Declaration

We hereby declare that the content embodied in this project is the bonafide record of investigations carried out by us under the guidance of ***Mr. M. R. Jadeja*** in the Department of Mathematics, Atmiya University, Rajkot. The investigations reported here have not been submitted in part or full for the award of any degree or diploma of any other institution or University.

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Contents

1 Introduction to Fuzzy Set **1**

1.1 Membership Functions of Crisp and Fuzzy Sets 1
1.2 Fuzzy Sets 3
1.3 Representation of Fuzzy Set 4
1.4 Types of Membership Functions(MF) 7
1.4.1 Triangular Membership Function 7
1.4.2 Trapezoidal Membership Function 9
1.4.3 Gaussian Membership Function 9
1.4.4 Sigmoid Membership Function 10
1.5 Certain Number Associated with a Fuzzy Set 11
1.5.1 α-*cut* and *Strong* α-*cut* 11
1.5.2 Level Set 12
1.5.3 Support, Core and Height 12
1.6 Set Theoretic Operations for Fuzzy Sets 14

2 Fuzzy Relations and Analysis **17**

2.1 Crisp Relations 17
2.2 Fuzzy Relations 18
2.3 Operations of Fuzzy Relation 19
2.3.1 Union and intersection of fuzzy relations 19
2.3.2 Composition of fuzzy relations 20
2.4 Types of Fuzzy Relations 21
2.4.1 Binary Fuzzy Relation 21
2.4.2 Domain of a Binary Fuzzy Relation 21
2.4.3 Range of a Binary Fuzzy Relation 21
2.4.4 Height of a Binary Fuzzy Relation 22
2.4.5 Representation of a Binary Fuzzy Relation 22
2.4.5.1 Properties of Binary Fuzzy Relation 23
2.5 Function on Fuzzy Set 24

3 Possibility Theory **27**

3.1 Fuzzy Measures 27
3.1.1 Description of the Axioms 28
3.1.2 Properties of Fuzzy Measure 29
3.2 Evidence Theory 29

3.2.1 Belief Measure 29
3.2.1.1 Properties of Belief Measure 30
3.2.2 Plausibility Measure 31
3.2.2.1 Property of Plausibility Measures 32
3.2.3 Relation Between Belief Measures and Plausibility Measures . . 32
3.2.4 Basic Probability Assignment 32
3.2.5 Properties of Basic Probability Assignment 33
3.2.6 Focal Elements 34
3.2.7 Body of Evidence 34
3.2.8 Total Ignorance 34
3.2.9 Dempster's Rule of Combination of Basic Assignments 34
3.3 Projection 38
3.3.1 Marginal Body of Evidence 39
3.3.2 Non-interactive 39
3.3.3 Commonality Function 42
3.4 Possibility Theory 42
3.4.1 Necessity Measure 44
3.4.2 Possibility Measure 44
3.4.2.1 Properties of Necessity and Possibility Measure . . . 44
3.4.2.2 Possibility Distribution Function Associated with Pos 45
3.4.3 Possibility Distribution Function Associated with r 47
3.4.4 Lattice of Possibility Distributions of Length n 47
3.4.5 Marginal Possibility Distributions 48
3.4.6 Non-Interactive 48
3.4.7 Possibility Measures 49
3.4.8 Necessity Measures 49
3.5 Fuzzy Sets and Possibility Theory 49
3.5.1 Associated Possibility Measure 50
3.5.2 Associated Necessity Measure 51
3.6 Possibility Theory versus Probability Theory 51
3.6.1 Probability Distribution Function 53
3.6.2 Marginal Probability Distributions 53
3.6.3 Non-Interactive 54
3.6.4 Conditional Probability Distributions 54
3.6.5 Independent Marginal Distributions 54

4 Fuzzy logic **57**
4.1 Fuzzy logic 58
4.1.1 Fuzzy IF-Then rules 58
4.1.2 Interpretation of Fuzzy IF-THEN Rules 59
4.1.3 Evaluation of Fuzzy IF-THEN Rules 62

5 Applications **65**
5.1 Air Conditioner Controller 65

Chapter 1

Introduction to Fuzzy Set

The word Fuzzy has meaning vagueness or ambiguity. Beauty, smartness, literacy, honesty etc are fuzzy terms. Fuzzy sets were introduced by Lotfi Asker Zadeh in 1965 as an extension of crisp(classical) set. Human can give satisfactory answers, which are probably true. Our system are unable to answers many questions because the system are designed based upon classical set theory.

1.1 Membership Functions of Crisp and Fuzzy Sets

Classical set theory allows the membership of the elements in the set in **binary terms (0 or 1)**. Whereas fuzzy set theory permits membership function valued in [0, 1] (which is called unit interval and denoted by I).

Classical sets contain objects that specify precise property of membership. Whereas fuzzy set contain object that satisfies imprecise properties of membership, i.e. Membership of an object in a fuzzy set can be approximate.

If A is a crisp sets then an element x in universe X is either a member of A or not. This binary membership can be represented mathematically with the help of characteristic

function,

$$\chi_A : X \to \{0.\ 1\}$$

defined as,

$$\chi_A(x) = \begin{cases} 1. & x \in A \\ 0. & x \notin A \end{cases}$$

Zadeh extended the notion of binary membership to accommodate various 'degrees of membership' on the interval [0. 1], where the endpoints 0 and 1 indicate no membership and full membership, respectively. Here the infinite number of values in between the endpoints can represent various degrees of membership for an element x in some set on universe.

For example, The set of students of class XII having heights from 3 to 5 feet is precise and the set of students of class XII having heights around 4 feet .

Suppose set A is the crisp set of all students with $3 \leq s \leq 5$ feet.

A particular student, say, s_1 has a height of 4 feet then $\chi_A(s_1) = 1$, i.e., membership of s_1 in crisp set A is 1.

Another student, say s_2 has a height 5.01 feet. The membership of this individual in A is 0. i.e., $\chi_A(s_2) = 0$ (shown in Figure 1.1)

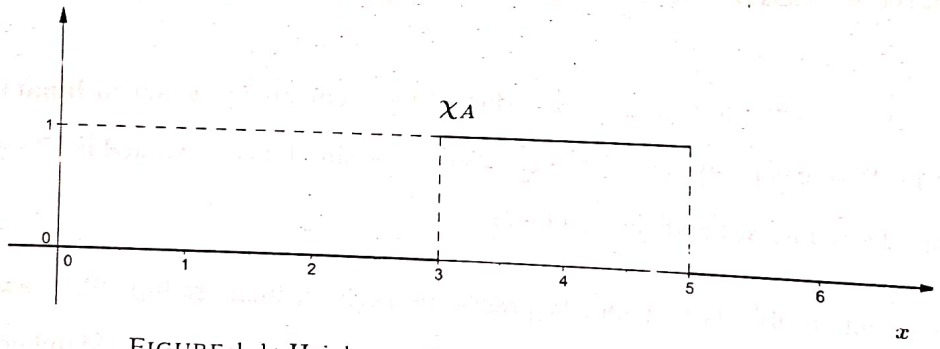


FIGURE 1.1: Height membership function for a crisp set A

Now, suppose H is a set containing heights around 4 feet. Since this property is fuzzy, there is no unique membership function for H. Let the membership function be denoted by μ_H and plausible properties of this function might be

1. $\mu_H(4) = 1$.

2. the element of H is closer to 4, the value μ_H is closer to 1.

3. numbers equidistant from 6 should have the same value of μ_H.

Such membership function is illustrated in Figure 1.2

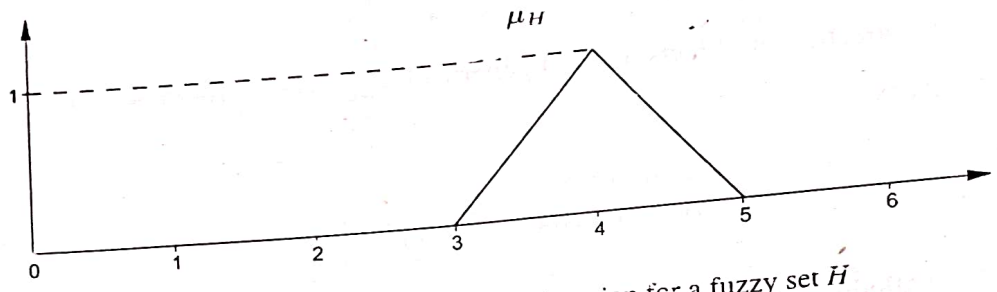


FIGURE 1.2: Height membership function for a fuzzy set H

Thus, Fuzzy theory are very useful in two general context :

1. In situations involving highly complex systems whose behaviors are not well understood.

2. In situations where an approximate, but fast, solution is warranted.

1.2 Fuzzy Sets

Two distinct notations are mostly used to denote membership functions.

First notation is defined as:

Let X is a universal set. A fuzzy set $\tilde{A}$ in X is characterized by its membership function denoted by $\mu_{\tilde{A}}$,

$$\mu_{\tilde{A}} : X \to [0,\ 1]$$

where $\mu_{\tilde{A}}$ is interpreted as the 'membership grade' of element x in fuzzy set $\tilde{A}$ for each $x \in X$.

Second notation is defined as :

Let X is universal set. A fuzzy set $\widetilde{A}$ in X is defined by a membership function denoted by A.

$$A : X \to [0,\ 1].$$

We will use second notation of membership function throughout this project report.

Definition 1.2.1. (Fuzzy Set)

If $X = \{x\}$ is a collection of objects denoted generically by x, then a fuzzy set $\widetilde{A}$ in X is a set of order pairs

$$\widetilde{A} = \{(x,\ A(x)) \mid x \in X\}$$

Where $A(x)$ is called the 'membership grade' of $x \in \widetilde{A}$ and each pair $(x,\ A(x))$ is called a singleton.

If $X = \{x_1,\ x_2,\ \ldots,\ x_n\}$ is a finite set and $\widetilde{A}$ is a fuzzy set in X, then we often use the notation

$$\begin{aligned}\widetilde{A} &= \sum_{i=1}^{n} A(x_i)/x_i \\ &= A(x_1)/x_1 + A(x_2)/x_2 + \cdots + A(x_n)/x_n\end{aligned}$$

Where the term $A(x_i)/x_i$, $i = 1,\ 2,\ \ldots,\ n$ signifies that $A(x_i)$ is the membership grade of x_i in fuzzy set $\widetilde{A}$ and the plus sign represents the union.

1.3 Representation of Fuzzy Set

1. If elements are discrete, then the fuzzy set $\widetilde{A}$ on X can be represented by

   $$\widetilde{A} = \{(x,\ A(x)) \mid x \in X\}$$

2. Suppose elements are continuous, then the fuzzy set $\widetilde{A}$ on X can be represented by

   $$\widetilde{A} = \int_X A(x)/x$$

3. $\widetilde{A} =$

x_1	x_2	...	x_n
0.7	0.1	...	0.9

Example 1.1. Show the graphically difference between the crisp and fuzzy set.

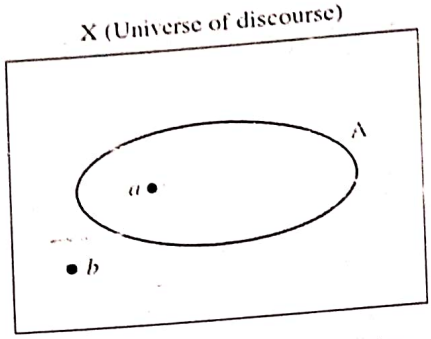


FIGURE 1.3: Crisp set boundary

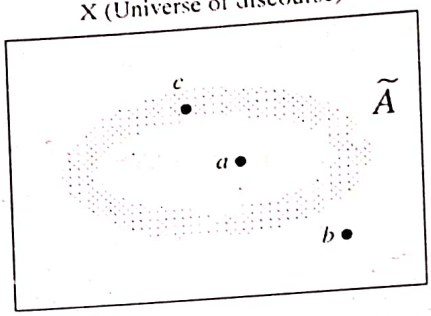


FIGURE 1.4: Fuzzy set boundary

Example 1.2. Let $X = \{a, b, c, d, e\}$ be the reference set of students. Let $\widetilde{A}$ be the fuzzy set of "smart" students, where "smart" is fuzzy term.

$$\widetilde{A} = \{(a, 1), (b, 0.8), (c, 0.5), (d, 0.9), (e, 0)\}$$

Here $\widetilde{A}$ indicates that the smartness of a is 1, b is 0.8 and so on.

Note 1.3.1. Membership function of a fuzzy set $\widetilde{A}$ ={real number near to a} is defined as

$$A(x) = \frac{1}{1+(x-a)^2}$$

Example 1.3. Define a fuzzy set $\widetilde{A}$ ={real number near to 3} it can be defined by a membership function.

$$A(x) = \frac{1}{1+(x-3)^2}$$

The membership degree of 1 is $\frac{1}{1+(1-3)^2} = \frac{1}{1+4} = 0.2.$

The membership degree of 2 is $\frac{1}{1+(2-3)^2} = \frac{1}{1+1} = 0.5.$

The membership degree of 3 is $\frac{1}{1+(3-3)^2} = \frac{1}{1+0} = 1.$

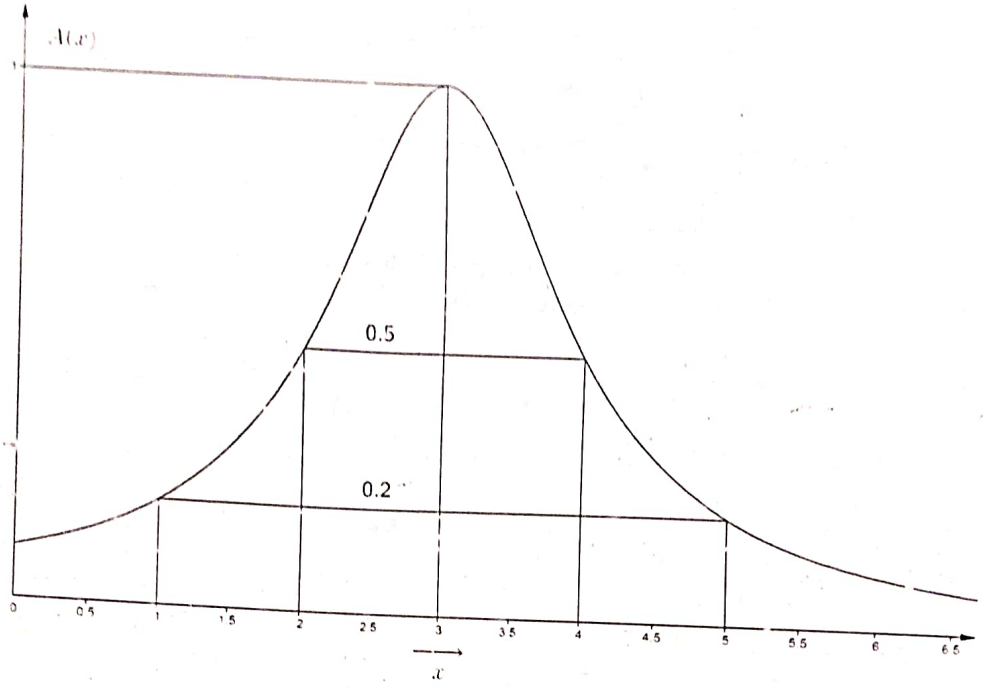


FIGURE 1.5: Membership function of fuzzy set "real number near to 3"

Example 1.4. Define a fuzzy set $\tilde{A}$ = {real number very near to 3} it can be defined by a membership function

$$A(x) = \left(\frac{1}{1+(x-3)^2}\right)^2$$

The membership degree of 1 is 0.04. that of 2 is 0.25, that of 2.5 is 0.64 as shown in Figure 1.6

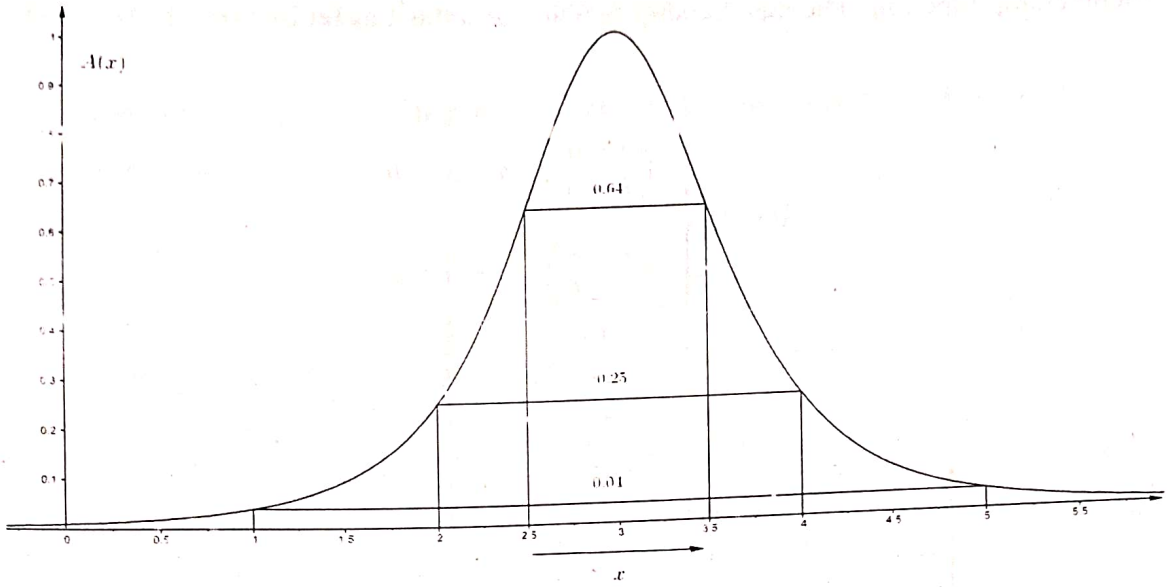


FIGURE 1.6: Membership function of fuzzy set "real number very near to 3"

1.4 Types of Membership Functions(MF)

A membership function can be any kind of function whose values are bounded between 0 and 1. The function it can be arbitrary curve. Depending on type of membership function, different types of fuzzy sets will be obtained.

These are some different types of membership functions:

1. Triangular
2. Trapezoidal
3. Gaussian
4. Sigmoid

1.4.1 Triangular Membership Function

A triangular membership function defined by three parameters a, b, c with $a < b < c$. These parameter represents x coordinates of three vertices of triangular

membership function. The membership function is defined as follow:

$$A(x) = \begin{cases} 0 & x \le a \\ \left(\frac{x-a}{b-a}\right) & a \le x \le b \\ \left(\frac{c-x}{c-b}\right) & b \le x \le c \\ 0 & c \le x \end{cases}$$

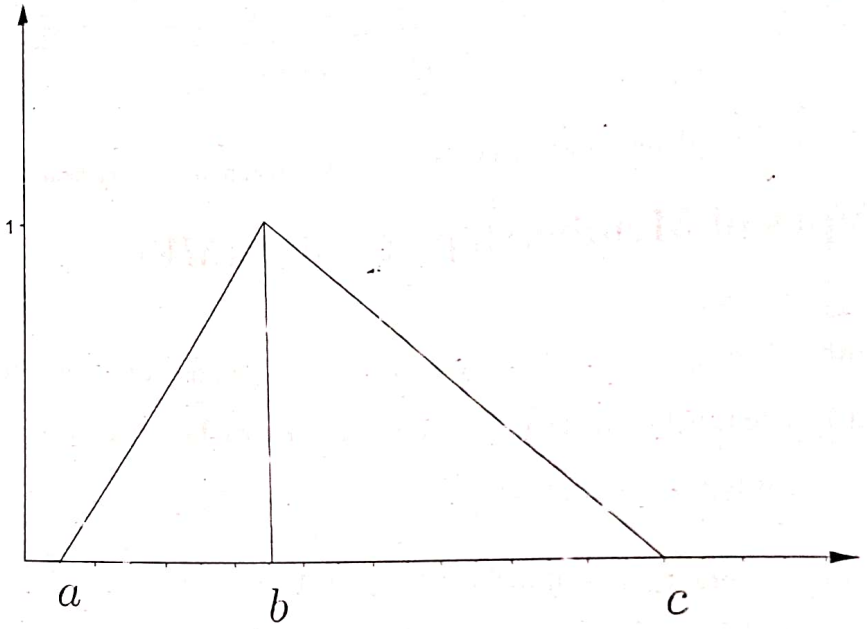


FIGURE 1.7: Triangular membership function

1.4.2 Trapezoidal Membership Function

A trapezoidal membership function is defined by four parameters $\{a.\ b.\ c.\ d\}$ with $a < b \leq c < d$ as follow:

$$T(x) = \begin{cases} 0 & x \leq a \\ \left(\frac{x-a}{b-a}\right) & a \leq x \leq b \\ 1 & b \leq x \leq c \\ \left(\frac{d-x}{d-c}\right) & c \leq x \leq d \\ 0 & d \leq x \end{cases}$$

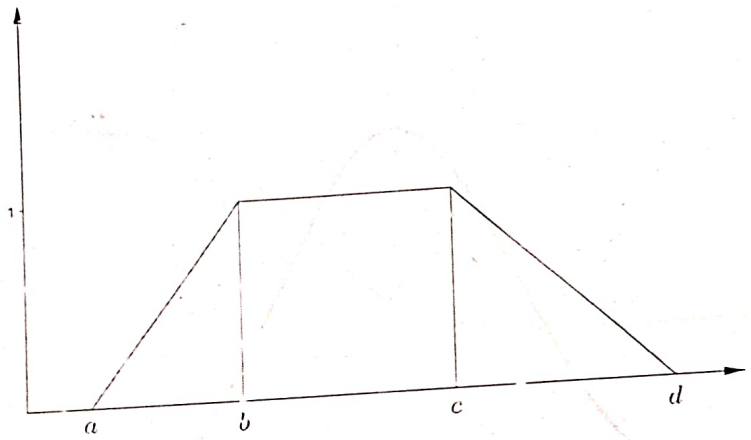


FIGURE 1.8: Trapezoidal membership function

1.4.3 Gaussian Membership Function

A Gaussian membership function defined by two parameters $\{c.\ \sigma\}$ as follow:

$$G(x) = \exp\left[-\frac{1}{2}\left(\frac{x-c}{\sigma}\right)^2\right].$$

where c represents the center and σ determines the width of membership function

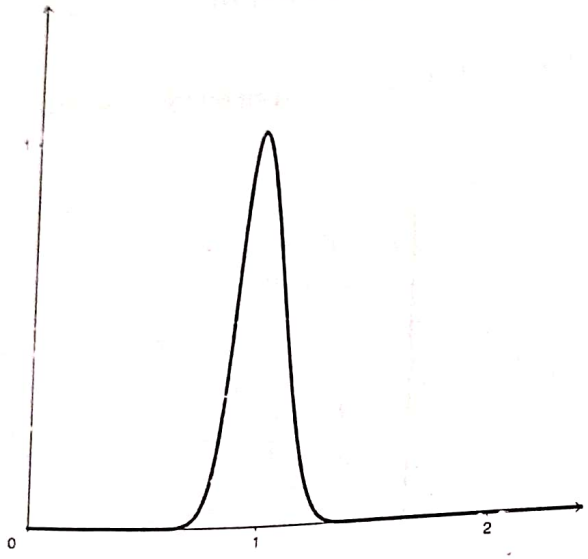


FIGURE 1.9: $c = 1\ \sigma = 0.1$

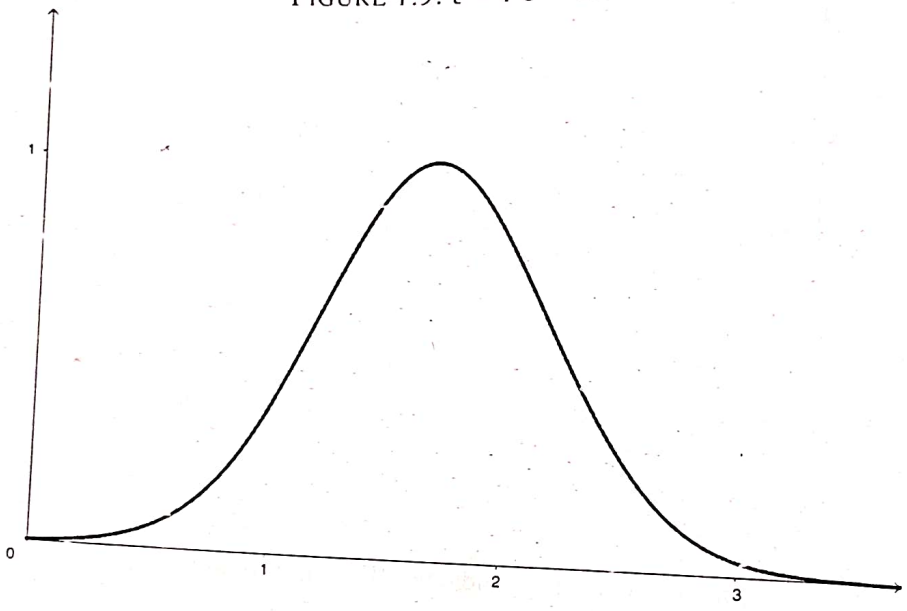


FIGURE 1.10: $c = 1.7\ \sigma = 0.5$

1.4.4 Sigmoid Membership Function

A sigmoid membership function can be given by:

$$S(x) = \frac{1}{1 + e^{-a(x-c)}}$$

Here, c defines the center of the transition area and a controls the width of the transition area.

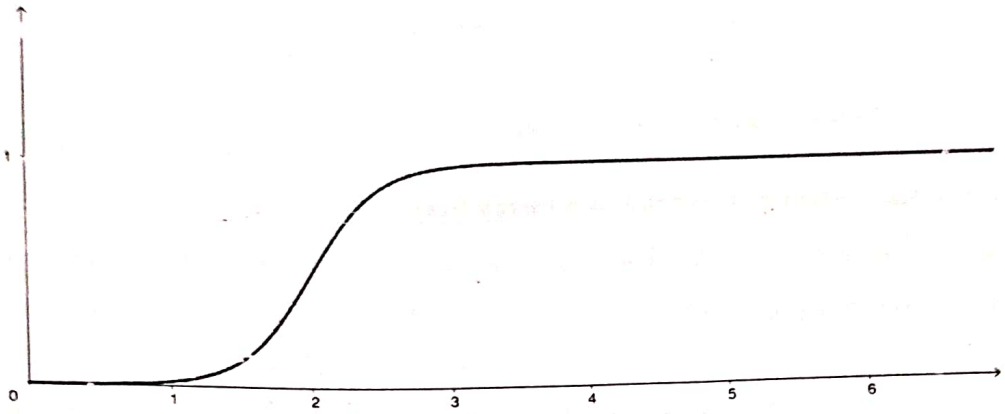


FIGURE 1.11: $a = 4$. $c = 2$

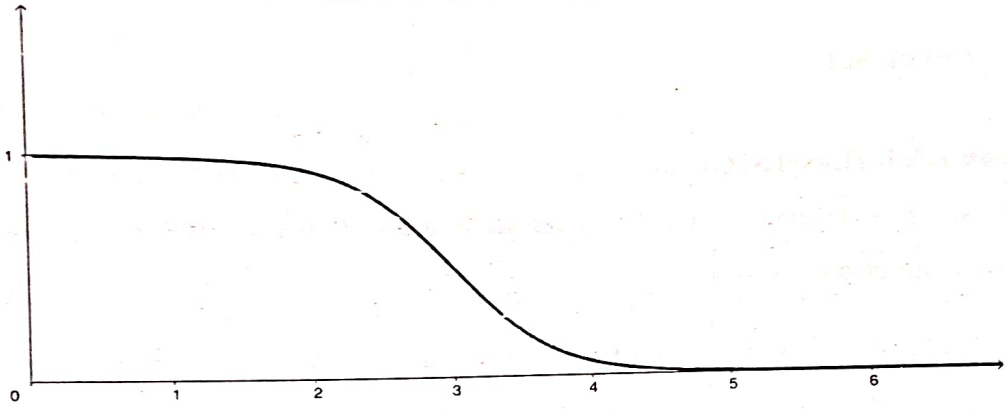


FIGURE 1.12: $a = -2.7$. $c = 3$

1.5 Certain Number Associated with a Fuzzy Set

1.5.1 α-cut and *Strong* α-cut

Definition 1.5.1. (α-cut Set of a Fuzzy Set)

A Fuzzy set $\tilde{A}$ is defined on X. The α-cut set (α-level set), ${}^{\alpha}A$ is a set of elements of X

whose membership is at least α.

$$^{\alpha}A = \{x \in X \mid A(x) \geq \alpha\},\ \alpha \in [0,\ 1]$$

The α-cut set of a fuzzy set $\widetilde{A}$ is the *crisp* set.

Definition 1.5.2. (Strong α-cut Set of a Fuzzy Set)

A Fuzzy set $\widetilde{A}$ is defined on X. The strong α-cut set, $^{\alpha^+}A$ is a set of elements of X whose membership is greater than α.

$$^{\alpha^+}A = \{x \in X \mid A(x) > \alpha\},\ \alpha \in [0,\ 1]$$

1.5.2 Level Set

Definition 1.5.3. (Level Set of $\widetilde{A}$)

A Fuzzy set $\widetilde{A}$ is defined on X. The level set is a set of all level $\alpha \in [0,\ 1]$ which represents distinct α-cuts of $\widetilde{A}$

$$\Lambda(\widetilde{A}) = \{\alpha \mid A(x) = \alpha \ for\ some\ x \in X\}$$

1.5.3 Support, Core and Height

Definition 1.5.4. (Support of Fuzzy Set)

The support of a fuzzy set $\widetilde{A}$, $S(\widetilde{A})$, is the *crisp* set of all $x \in X$ for which $A(x) > 0$.

$$i.e.\ S(\widetilde{A}) = \{x \in X \mid A(x) > 0\}$$

Definition 1.5.5. (Core of Fuzzy Set)

The core of a fuzzy set $\widetilde{A}$, $core(\widetilde{A})$, is the *crisp* set of all $x \in X$ for which $A(x) = 1$.

$$i.e.\ core(\widetilde{A}) = \{x \in X \mid A(x) = 1\}$$

Remarks 1.1.

1. $S(\tilde{A}) = {}^{0-}A$ (strong α-cut of $\tilde{A}$ for $\alpha = 0$)
2. $core(\tilde{A}) = {}^{1}A$

Definition 1.5.6. (Height of a Fuzzy Set)

The height of a fuzzy set $\tilde{A}$, $h(\tilde{A})$, is the largest value of membership function.

$$h(\tilde{A}) = \sup_{x \in X} A(x)$$

Remark 1.1.

A fuzzy set $\tilde{A}$ is said to be **normal** if $h(\tilde{A}) = 1$ or $core(\tilde{A}) \neq \phi$ and **subnormal** if $h(\tilde{A}) < 1$ or $core(\tilde{A}) = \phi$.

Example 1.5. Let $X = \{p, q, r, s, t\}$ and fuzzy set $\tilde{A} = \frac{0.3}{p} + \frac{0.5}{q} + \frac{1}{r} + \frac{0.8}{s} + \frac{0.5}{t}$ be given. Find all possible α-cut and strong α-cut sets, level set, support, core and height of $\tilde{A}$. Also determine that whether $\tilde{A}$ is normal or subnormal.

Solution:

α-cut sets

$$\begin{aligned} {}^{0.3}A &= \{p, q, r, s, t\} \\ {}^{0.5}A &= \{q, r, s, t\} \\ {}^{0.8}A &= \{r, s\} \\ {}^{1}A &= \{r\}. \end{aligned}$$

strong α-cut sets

$$\begin{aligned} {}^{0.3-}A &= \{q, r, s, t\} \\ {}^{0.5-}A &= \{r, s\} \\ {}^{0.8-}A &= \{r\}. \end{aligned}$$

Level set of $\tilde{A} = \Lambda(\tilde{A}) = \{0.3, 0.5, 0.8, 1\}$.

$S(\tilde{A}) = \{p, q, r, s, t\}$.

$core(\tilde{A}) = \{r\} = {}^{1}A$.

$h(\widetilde{A}) = 1$.

Here $h(\widetilde{A}) = \sup\{0.3, 0.5, 0.8, 1\} = 1$ and also $core(\widetilde{A}) \neq \phi$.

Thus, $\widetilde{A}$ is normal fuzzy set.

1.6 Set Theoretic Operations for Fuzzy Sets

The membership functions are very crucial component of a fuzzy set. So that the operations of fuzzy sets are defined via membership functions.

Definition 1.6.1. (Equality of Fuzzy Sets)

Let $\widetilde{A}$ and $\widetilde{B}$ be two fuzzy sets on X the they are said to be *equal* (*i.e.*, $\widetilde{A} = \widetilde{B}$) if

$$A(x) = B(x), \ \forall x \in X$$

Example 1.6. Let $\widetilde{A} = \frac{0.7}{x} + \frac{0.3}{y} + \frac{0.8}{z} + \frac{0.1}{w}$ and $\widetilde{B} = \frac{0.7}{x} + \frac{0.3}{y} + \frac{0.8}{z} + \frac{0.1}{w}$ be two fuzzy sets then $A(x) = B(x), \ \forall x \in X$. Thus, $\widetilde{A} = \widetilde{B}$.

Definition 1.6.2. (Subset of Fuzzy Set)

A fuzzy set $\widetilde{A}$ is said to be *subset* of fuzzy set $\widetilde{B}$ if

$$A(x) \leq B(x), \ \forall x \in X$$

It is denoted by $\widetilde{A} \subseteq \widetilde{B}$.

Example 1.7. Let $\widetilde{A}$ and $\widetilde{B}$ be two fuzzy sets on X is given as

$\widetilde{A} = \{(1, 0.7), (2, 0.3), (3, 0.8), (4, 0.1)\}$.

$\widetilde{B} = \{(1, 0.9), (2, 0.8), (3, 1), (4, 0.5)\}$.

Here, $A(x) < B(x), \ \forall x \in X$. Hence, $\widetilde{A} \subset \widetilde{B}$.

Definition 1.6.3. (Intersection of Fuzzy Sets)

Let $\widetilde{A}$ and $\widetilde{B}$ be two fuzzy sets on X then *intersection* $\widetilde{A} \cap \widetilde{B}$ is be defined as

$$(A \cap B)(x) = \min\{A(x), B(x)\}, \ \forall x \in X.$$

Definition 1.6.4. (Union of Fuzzy Sets)

Let $\widetilde{A}$ and $\widetilde{B}$ be two fuzzy sets on X then *union* $\widetilde{A} \cup \widetilde{B}$ is be defined as

$$(A \cup B)(x) = \max\{A(x).\ B(x)\}.\ \forall\, x \in X.$$

Definition 1.6.5. (Complement of Fuzzy Set)

Let $\widetilde{A}$ be a fuzzy sets on X. Its complement, $(\widetilde{A})^c$ is defined as

$$(A^c)(x) = 1 - A(x).\ \forall\, x \in X.$$

Example 1.8. Let $\widetilde{A}$ and $\widetilde{B}$ be two fuzzy sets on $X = 1.\ 2.\ 3.\ 4$ defined as

$\widetilde{A} = \{(1.\ 0.5).\ (2.\ 0.3).\ (3.\ 0.8).\ (4.\ 0.3)\}.$

$\widetilde{B} = \{(3.\ 0.2).\ (4.\ 0.7)\}.$ Find $\widetilde{A} \cap \widetilde{B}.\ \widetilde{A} \cup \widetilde{B}.\ (\widetilde{A})^c$ and $(\widetilde{B})^c.$

Solution:

Here, $\widetilde{B}$ can be written as

$\widetilde{B} = \{(1.\ 0).\ (2.\ 0).\ (3.\ 0.2).\ (4.\ 0.7)\}.$

Therefore,

$$\begin{aligned}
\widetilde{A} \cap \widetilde{B} &= \{(1.\ 0).\ (2.\ 0).\ (3.\ 0.2).\ (4.\ 0.3)\} \\
\widetilde{A} \cup \widetilde{B} &= \{(1.\ 0.5).\ (2.\ 0.3).\ (3.\ 0.8).\ (4.\ 0.7)\} \\
(\widetilde{A})^c &= \{(1.\ 0.5).\ (2.\ 0.7).\ (3.\ 0.2).\ (4.\ 0.7)\} \\
(\widetilde{B})^c &= \{(1.\ 1).\ (2.\ 1).\ (3.\ 0.8).\ (4.\ 0.3)\}.
\end{aligned}$$

Chapter 2

Fuzzy Relations and Analysis

Definition 2.0.6. (Cartesian Product)

Let X and Y be two non empty crisp sets then Cartesian Product is the crisp set denoted by $X \times Y$ and defined as

$$X \times Y = \{(x, y) \mid x \in X, y \in Y\}.$$

In general Cartesian product of n crisp sets $A_1, A_2, \ldots, A_n$ is the crisp set of all n-tuple $(a_1, a_2, \ldots, a_n)$ such that $a_i \in A_i$ for $i = 1, 2, \ldots, n$ and denoted as $A_1 \times A_2 \times \cdots \times A_n$.

2.1 Crisp Relations

A crisp relation represents the presence or absence of association, interconnectedness between the elements of two or more sets.

Definition 2.1.1. (Crisp Relation)

A relation among crisp sets $A_1, A_2, \ldots, A_n$ is a subset of the Cartesian product $A_1 \times A_2 \times \cdots \times A_n$. It is denoted by either $R(A_1, A_2, \ldots, A_n)$ or simply by R,

i.e. $R(A_1, A_2, \ldots, A_n) \subseteq A_1 \times A_2 \times \cdots \times A_n$.

For $n = 2$ is a subset of the Cartesian product $A_1 \times A_2$. Which is called *binary relation* from A_1 to A_2.

Let X and Y be two universes and let R be any relation from X to Y then the strength of this relationship between ordered pairs of elements is measured by the characteristic function,

$$\chi_R(x, y) = \begin{cases} 1, & (x, y) \in R \\ 0, & (x, y) \notin R \end{cases}$$

That is, value 1 indicates complete relationship and a 0 indicates no relationship.

For example, let $X = \{x, y\}$ and $Y = \{a, b\}$ be two universes and let a relation $R \subset X \times Y$ defined as $R = \{(x, a), (x, b), (y, b)\}$. The relation can be represented by relational matrix,

$$i.e.\ R = \begin{array}{c} \\ x \\ y \end{array} \begin{array}{c} \begin{array}{cc} a & b \end{array} \\ \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix} \end{array}$$

2.2 Fuzzy Relations

Definition 2.2.1. (Cartesian product of fuzzy sets)

Let $\widetilde{A}$ and $\widetilde{B}$ be two fuzzy sets on X and Y respectively. The Cartesian product of fuzzy sets is a fuzzy set represented by $\widetilde{A} \times \widetilde{B}$ and can be defined via membership function as

$$\widetilde{A} \times \widetilde{B} = \{((x, y), (A \times B)(x, y)) | (x, y) \in X \times Y\}$$

where, $(A \times B)(x, y) = \min\{A(x), B(y)\}$

Definition 2.2.2. (Fuzzy Relation)

Fuzzy relations in general are fuzzy sets. Let $\widetilde{A}$ and $\widetilde{B}$ be two fuzzy sets on X and Y respectively, then the Cartesian product between fuzzy sets $\widetilde{A}$ and $\widetilde{B}$ will result in a fuzzy relation $\widetilde{R}$.

$$i.e.,\ \widetilde{R} = \widetilde{A} \times \widetilde{B}$$

Where the fuzzy relation $\tilde{R}$ has membership function

$$R(x,y) = \min\{A(x),\ B(y)\}$$

The membership values indicates the strength of the relation of ordered pairs.

Example 2.1. Let $\tilde{A} = \frac{0.7}{a} + \frac{0.2}{b} + \frac{0.4}{c}$ be a fuzzy set on X and $\tilde{B} = \frac{0.2}{m} + \frac{0.5}{n}$ be a fuzzy set on Y then by Definition 2.2.2 fuzzy relation $\tilde{R}$ with membership function $R(x,y) = \min\{A(x),\ B(y)\}$ can be determined as follow:

$$\begin{aligned}
R(a,m) &= \min\{A(a),\ B(m)\} = \min\{0.7,\ 0.2\} = 0.2\\
R(a,n) &= \min\{A(a),\ B(n)\} = \min\{0.7,\ 0.5\} = 0.5\\
R(b,m) &= \min\{A(b),\ B(m)\} = \min\{0.2,\ 0.2\} = 0.2\\
R(b,n) &= \min\{A(b),\ B(n)\} = \min\{0.2,\ 0.5\} = 0.2\\
R(c,m) &= \min\{A(c),\ B(m)\} = \min\{0.4,\ 0.2\} = 0.2\\
R(c,n) &= \min\{A(c),\ B(n)\} = \min\{0.4,\ 0.5\} = 0.4
\end{aligned}$$

Thus, $\tilde{R} = \{((a,m),0.2),\ ((a,n),0.5),\ ((b,m),0.2),\ ((b,n),0.2),\ ((c,m),0.2),\ ((c,n),0.4)\}$

fuzzy relations can also be defined by matrices

$$\tilde{R} = \begin{array}{c} \\ a \\ b \\ c \end{array} \begin{array}{c} \begin{array}{cc} m & n \end{array} \\ \begin{bmatrix} 0.2 & 0.5 \\ 0.2 & 0.2 \\ 0.2 & 0.4 \end{bmatrix} \end{array}$$

2.3 Operations of Fuzzy Relation

2.3.1 Union and intersection of fuzzy relations

For two fuzzy relations $\tilde{R}$ and $\tilde{T}$ defined on the same product set, their union and intersection denoted by $\tilde{R} \cup \tilde{T}$ and $\tilde{R} \cap \tilde{T}$ respectively.

For $(a,b) \in A \times B$ membership functions are defined by

$$(R \cup T)(a,b) = \max\{R(a,b), T(a,b)\}$$

$$(R \cap T)(a,b) = \min\{R(a,b), T(a,b)\}$$

2.3.2 Composition of fuzzy relations

Let $\widetilde{R}$ and $\widetilde{T}$ be two fuzzy relations on $X \times Y$ and $Y \times Z$ respectively. Then fuzzy max-min composition is denoted by $\widetilde{R} \circ \widetilde{T}$ (say $\widetilde{S}$) on $X \times Z$. Which is defined by

$$S(x,z) = \max_{y \in Y}\{\min\{R(x,y), T(y,z)\}\}$$

Example 2.2. Let $X = \{x_1, x_2\}$, $Y = \{y_1, y_2\}$ and $Z = \{z_1, z_2, z_3\}$. Define $\widetilde{R}$ on $X \times Y$ and $\widetilde{S}$ on $Y \times Z$ as following

$$\widetilde{R} = \begin{array}{c} \\ x_1 \\ x_2 \end{array} \begin{array}{c} \begin{array}{cc} y_1 & y_2 \end{array} \\ \begin{bmatrix} 0.7 & 0.5 \\ 0.8 & 0.4 \end{bmatrix} \end{array} \qquad \widetilde{S} = \begin{array}{c} \\ y_1 \\ y_2 \end{array} \begin{array}{c} \begin{array}{ccc} z_1 & z_2 & z_3 \end{array} \\ \begin{bmatrix} 0.9 & 0.6 & 0.2 \\ 0.1 & 0.7 & 0.5 \end{bmatrix} \end{array}$$

Then $\widetilde{T} = \widetilde{R} \circ \widetilde{S}$, defined on $X \times Z$, can be found by max-min composition as follow

$T(x_1, z_1) = \max\{\min(0.7, 0.9), \min(0.5, 0.1)\} = 0.7$

$T(x_1, z_2) = \max\{\min(0.7, 0.6), \min(0.5, 0.7)\} = 0.6$

$T(x_1, z_3) = \max\{\min(0.7, 0.2), \min(0.5, 0.5)\} = 0.5$

$T(x_2, z_1) = \max\{\min(0.8, 0.9), \min(0.4, 0.1)\} = 0.8$

$T(x_2, z_2) = \max\{\min(0.8, 0.6), \min(0.4, 0.7)\} = 0.6$

$T(x_2, z_3) = \max\{\min(0.8, 0.2), \min(0.4, 0.5)\} = 0.4$

Thus, relation matrix of $\widetilde{T}$ can be given as

$$\widetilde{T} = \begin{array}{c} \\ x_1 \\ x_2 \end{array} \begin{array}{c} \begin{array}{ccc} z_1 & z_2 & z_3 \end{array} \\ \begin{bmatrix} 0.7 & 0.6 & 0.5 \\ 0.8 & 0.6 & 0.4 \end{bmatrix} \end{array}$$

2.4 Types of Fuzzy Relations

2.4.1 Binary Fuzzy Relation

Binary relations $\tilde{R}(X,Y)$ from X to Y, may assign to each element of X two or more elements of Y.

2.4.2 Domain of a Binary Fuzzy Relation

The domain of a fuzzy relation $\tilde{R}(X,Y)$ denoted by dom$\tilde{R}$ is a fuzzy set on X, whose membership function is defined as follow:

$$domR(x) = \max_{y \in Y}\{R(x,y)\}. \quad \forall x \in X$$

That is, each element of set X belongs to the domain of $\tilde{R}$ to the degree equal to the strength of it's strongest relation to any member of set Y.

Note 2.4.1. Domain of $\tilde{R}(X,Y)$ is the row wise maximum membership grade in $\tilde{R}$.

2.4.3 Range of a Binary Fuzzy Relation

The range of a fuzzy relation $\tilde{R}(X,Y)$ denoted by ran$\tilde{R}$ is a fuzzy set on Y,whose membership function is defined as follow:

$$ranR(y) = \max_{x \in X}\{R(x,y)\}. \quad \forall y \in Y$$

That is, the strength of the strongest relation that each element of Y has to an element of X is equal to the degree of that elements membership in the range of $\tilde{R}$.

Note 2.4.2. Range of $R(X,Y)$ is the column wise maximum membership grade in $\tilde{R}$.

2.4.4 Height of a Binary Fuzzy Relation

The height of a fuzzy relation $\tilde{R}(X,Y)$ is a number denoted by $h(R)$ and defines as follow:

$$h(R) = \max_{y \in Y} \max_{x \in X} \{R(x,y)\}$$

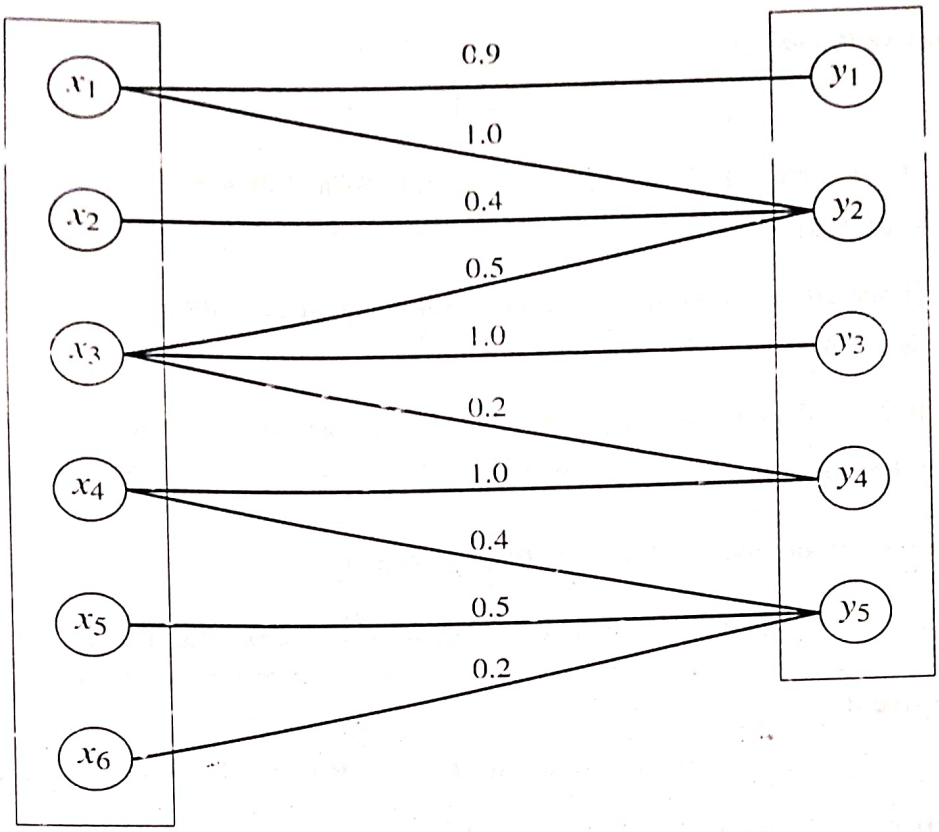
That is, $h(R)$ is the largest membership grade attained by any pair (x,y) in $\tilde{R}$.

2.4.5 Representation of a Binary Fuzzy Relation

I. Membership Matrix representation: A binary relation $R(X,Y)$ can be represented by the membership matrices denoted by $\tilde{R} = [r_{xy}]$, where $r_{xy} = R(x,y)$

$$\tilde{R} = \begin{array}{c} \\ x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \end{array} \begin{array}{c} \begin{array}{ccccc} y_1 & y_2 & y_3 & y_4 & y_5 \end{array} \\ \begin{bmatrix} 0.9 & 1.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.4 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.5 & 1.0 & 0.2 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.4 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.5 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.2 \end{bmatrix} \end{array}$$

II. Sagittal Diagram Representation: A binary relation $\tilde{R}(X, Y)$ can also be represented by sagittal diagram. In which, each of the sets X, Y is represented by a set of nodes in the diagram; nodes corresponding to one set are clearly distinguished from nodes representing the other set, Elements of $X \times Y$ with nonzero membership grades in $\tilde{R}(X, Y)$ are represented in the diagram by lines connecting



Definition 2.4.1. Inverse of a Binary Fuzzy Relation

The inverse of a fuzzy relation $\widetilde{R}(X,Y)$, which is denoted by $\widetilde{R}^{-1}(Y,X)$, is a relation on $Y \times X$ defined by

$$R^{-1}(y,x) = R(x,y)$$

Note 2.4.3. For all $x \in X$ and for all $y \in Y$, a membership matrix $\widetilde{R}^{-1} = [r_{yx}^{-1}]$, where $r_{yx}^{-1} = R^{-1}(y,x)$ is the transpose of the matrix $\widetilde{R} = [r_{xy}]$, where $r_{xy} = R(x,y)$.

Clearly, $(\widetilde{R}^{-1})^{-1} = \widetilde{R}$.

2.4.5.1 Properties of Binary Fuzzy Relation

A fuzzy relation $\widetilde{R}$ on a single universe X, $\widetilde{R}(X, X)$ is a relation from X to X then, the relation is said to be,

1. Reflexive if and only if

$$R(x, x) = 1 \ \forall x \in X. \tag{2.1}$$

   (a) If for some $x \in X$ condition (2.1) is not satisfied then the relation is called irreflexive.

   (b) If for all $x \in X$ condition (2.1) is not satisfied then the relation is called anti-reflexive.

   (c) If $R(x, x) \geq \varepsilon$, $(0 < \varepsilon < 1)$ for all $x \in X$ then the relation is called ε - reflexive.

2. Symmetric if and only if $R(x, y) = R(y, x)$. $\forall x, y \in X$.

3. Antisymmetric if and only if $R(x, y) > 0$ then $R(x, y) = 0$. $\forall x, y \in X$, $x \neq y$.

4. Transitive if

$$R(x, z) \geq \max_{y \in Y} \min[R(x, y), R(y, z)] \tag{2.2}$$

   (a) If some $x \in X$ does not satisfy condition (2.2) then relation is called non-transitive.

   (b) If $R(x, z) < \max_{y \in Y} \min[R(x, y), R(y, z)]$ then the relation is called antitransitive.

2.5 Function on Fuzzy Set

A fuzzy function is a generalization of the concept of a classical function. A classical function f is a mapping from the domain D of definition of function into a space $S : f(D) \subset S$ is called the range of f.

There can be a crisp mapping from a fuzzy set that carries along the fuzziness of the domain and therefor generates a fuzzy set. The image of crisp argument would again be crisp. The mapping itself can be fuzzy, thus blurring the image of crisp argument. This is called a fuzzy function. These are called "fuzzifying functions" by Dubois and

Prade.

Definition 2.5.1. Classical function

A calssical function $f : X \to Y$ maps from a fuzzy domain $\widetilde{A}$ in X into a fuzzy range $\widetilde{B}$ in Y iff

$$\forall x \in X.\ B(f(x)) \geq A(x)$$

Given a classical function $f : X \to Y$ and a fuzzy domain $\widetilde{A}$ in X, the extension principle yield the fuzzy range $\widetilde{B}$ with the membership function

$$B(y) = \sup_{x \in f^{-1}(y)} A(x)$$

Example 2.3. Let X be the set of temperatures, Y the possible demands for energy of house holds, $\widetilde{A}$ the fuzzy set "low temperatures" and $\widetilde{B}$ the fuzzy set "high energy demands."

The assignment "low temperatures" $\to$ "high energy demands" is then a fuzzy function, and the additional constraint in above definition means "the lower the temperatures, the higher the energy demands."

The correspondence between a fuzzy function and a fuzzy relation becomes even more obvious when looking at the following definition.

Definition 2.5.2. Fuzzy Function

Let X and Y be universe and $\widetilde{P}(Y)$ the set of all fuzzy sets in Y (power set). $\widetilde{f} : X \to \widetilde{P}(Y)$ is a mapping $\widetilde{f}$ is a fuzzy function iff

$$f(x)(y) = R(x,y). \forall (x,y) \in X \times Y$$

where $R(x,y)$ is the membership function of a fuzzy relation.

Example 2.4.

Let X be the set of all workers of a plant, $\widetilde{f}$ the daily output, and x the number of processe work pieces. A fuzzy function could then be

$$\tilde{f}(x) = y$$

b. $\tilde{a}, \tilde{b} \in \mathcal{L}(\mathbb{R})$

$X = R$

$\tilde{f} : x \to \tilde{a}x + \tilde{b}$ is a fuzzy function.

c. X = set of all one-mile runners,

$\tilde{f}$ = possible record times,

$\tilde{f}(x) = \{y \mid y$ is achieved record times$\}$.

Definition 2.5.3. Maximizing Set

Let f be a real-valued function in X. Let f be bounded from below by $\inf(f)$ and from above by $\sup(f)$. The fuzzy set $\tilde{M} = \{(x, M(x))\}$, $x \in X$ with

$$M(x) = \frac{f(x) - \inf(f)}{\sup(f) - \inf(f)}$$

is then called the maximizing set.

Example 2.5. Find the maximizing set of sin fuenction

$$f(x) = \sin x$$

$$M(x) = \frac{\sin x - \inf(\sin)}{\sup(\sin) - \inf(\sin)} = \frac{\sin x - (-1)}{1 - (-1)}$$

$$= \frac{\sin x + 1}{2} = \frac{1}{2}\sin x + \frac{1}{2}$$

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Chapter 3

Possibility Theory

3.1 Fuzzy Measures

The fuzzy measure, assigns a value to each crisp set of the universal set, signifying the degree of evidence or belief that a particular element belongs in the set. The concept of a fuzzy measure was introduced by Sugeno [1974, 1977].

Definition 3.1.1. Let X be a universal set and $\mathcal{P}(X)$ be a non-empty family of subsets of X, and then a fuzzy measure on $(X, \mathcal{P}(X))$ is a function

$$g : \mathcal{P}(X) \rightarrow [0, 1]$$

which satisfies the following axioms:

g_1: **Boundary Conditions:**

$$g(\phi) = 0 \text{ and } g(X) = 1$$

g_2: **Monotonicity:**

For all $A, B \in \mathcal{P}(X)$, if $A \subseteq B$, then

$$g(A) \leq g(B)$$

g_3: **Continuity from Below:**

For any increasing sequence $A_1 \subset A_2 \subset \ldots$ in $\mathcal{P}(X)$, if $\bigcup_{i=1}^{\infty} A_i \in \mathcal{P}(X)$, then

$$\lim_{i \to \infty} g(A_i) = g\left(\bigcup_{i=1}^{\infty} A_i\right)$$

g_4: **Continuity from Above:**

For any decreasing sequence $A_1 \supset A_2 \supset \ldots$ in $\mathcal{P}(X)$, if $\bigcap_{i=1}^{\infty} A_i \in \mathcal{P}(X)$, then

$$\lim_{i \to \infty} g(A_i) = g\left(\bigcap_{i=1}^{\infty} A_i\right)$$

3.1.1 Description of the Axioms

1. the boundary conditions state that, regardless of our evidence, we always know that the element in question definitely does not belong to the empty set and the universal set.

2. The monotonicity states that, the evidence of the membership of an element in a set must be at great as the evidence of the element belongs to any subset of that set.

3. The continuity conditions are applicable only to an infinite universal set.

3.1.2 Properties of Fuzzy Measure

1. Since both $A \cap B \subseteq A$ and $A \cap B \subseteq B$ for any two sets A and B, it follows from the monotonicity of fuzzy measures that every fuzzy measure g satisfies the inequality

$$g(A \cap B) \leq \min[g(A), g(B)]$$

for any three sets A, B, $A \cap B \in \mathcal{P}(X)$.

2. Since both $A \subseteq A \cup B$ and $B \subseteq A \cup B$ for any two sets, the monotonicity of fuzzy measures implies that every fuzzy measure g satisfies the inequality

$$g(A \cup B) \geq \max[g(A), g(B)]$$

for any three sets A, B, $A \cup B \in \mathcal{P}(X)$.

3.2 Evidence Theory

Evidence theory is based on two dual non-additive measure: belief measure and plausibility measures. A form associated with preconceived notions is called a belief measure. A form associated with information that is possible or plausible is called a belief measure. A form associated with information that is possible or plausible is called a plausibility measure. The intersection of belief measures and plausibility measure will be a probability. The mathematics theory of evidence that is based on the complementary belief and plausibility measure was originated and developed by Glen Shafer[1976].

3.2.1 Belief Measure

Let X be a finite universal set, a belief measure is a function denoted by

$$Bel : \mathcal{P}(X) \to [0,1]$$

such that $Bel(\phi) = 0$, $Bel(X) = 1$, and

$$Bel(A_1 \cup A_2 \cup \cdots \cup A_n) \geq \sum_j Bel(A_j) - \sum_{j<k} Bel(A_j \cap A_k) + \cdots + (-1)^{n+1} Bel(A_1 \cap A_2 \cap \cdots \cap A_n) \tag{3.1}$$

for all possible families of subsets of X.

Note 3.2.1.

1. Due to inequality (3.1), belief measure are called supper-additive.
2. When X is infinite, function Bel is also required to be condition from above.
3. For each $A \in \mathcal{P}(X)$, $Bel(A)$ is interpreted as the degree of belief that a given element of X belongs to the set A.
4. The probability measures are special cases of belief measures for which the equality (3.1) is always satisfied.

3.2.1.1 Properties of Belief Measure

1. We can show that the inequality (3.1) implies the monotonicity of fuzzy measures.

   For all $A, B \in \mathcal{P}(X)$ let $A \subseteq B$ and let $C = B - A$.

   Then,

   $$A \cup C = B \;\&\; A \cap C = \phi.$$

   Applying now A and C to (3.1) for $n = 2$, we obtain

   $$Bel(A \cup C) = Bel(B) \geq Bel(A) + Bel(C) - Bel(A \cap C).$$

   Since $A \cap C = \phi$ and $Bel(\phi) = 0$, we have

   $$Bel(B) \geq Bel(A) + Bel(C)$$

and, therefore

$$Bel(B) \geq Bel(A)$$

Hence, $A \subseteq B$. then $Bel(A) \leq Bel(B)$.

2. Let $A_1 = A$ and $A_2 = A^c$ in (3.1) for $n = 2$.

   Then, we can drive the fundamental property of belief measures:

$$\begin{aligned} Bel(A \cup A^c) &\geq Bel(A) + Bel(A^c) - Bel(A \cap A^c) \\ Bel(X) &\geq Bel(A) + Bel(A^c) - Bel(\phi). \end{aligned}$$

   Since $Bel(X) = 1$ and $Bel(\phi) = 0$. we have

$$\begin{aligned} 1 &\geq Bel(A) + Bel(A^c) \\ Bel(A) + Bel(A^c) &\leq 1 \end{aligned} \tag{3.2}$$

3.2.2 Plausibility Measure

A plausibility measure is a function

$$Pl : \mathcal{P}(X) \to [0, 1].$$

such that $Pl(\phi) = 0. Pl(X) = 1$. and

$$Pl(A_1 \cap A_2 \cap \cdots \cap A_n) \leq \sum_j Pl(A_j) - \sum_{j<k} Pl(A_j \cup A_k) + \cdots + (-1)^{n-1} Pl(A_1 \cup A_2 \cup \cdots \cup A_n) \tag{3.3}$$

for all possible families of subsets of X.

Note 3.2.2.

1. Due to inequality (3.3), plausibility measures are called subadditive.
2. When X is infinite, then the function Pl is also required to be continuous from below.

3.2.2.1 Property of Plausibility Measures

Let A_1 and $A_2 = A^c$ for $n = 2$ in (3.3). Then, we obtain the fundamental property of plausibility measures:

$$\begin{aligned} Pl(A \cap A^c) &\leq Pl(A) + Pl(A^c) - Pl(A \cup A^c) \\ Pl(\phi) &\leq Pl(A) + Pl(A^c) - Pl(X) \end{aligned}$$

Since $Pl(X) = 1$ *and* $Pl(\phi) = 0$, we have

$$\begin{aligned} 0 &\leq Pl(A) + Pl(A^c) - 1 \\ Pl(A) + Pl(A^c) &\geq 1. \end{aligned} \tag{3.4}$$

3.2.3 Relation Between Belief Measures and Plausibility Measures

The plausibility measure is associated with each belief measures, which is defined by the equation

$$Pl(A) = 1 - Bel(A^c) \tag{3.5}$$

for all $A \in \mathcal{P}(X)$. Similarly

$$Bel(A) = 1 - Pl(A^c). \tag{3.6}$$

Thus, belief measures and plausibility measures are mutually dual.

3.2.4 Basic Probability Assignment

Belief and plausibility measures can be characterized by a function m, that is called a basic probability assignments (BPA), defined by

$$m : \mathcal{P}(X) \to [0, 1].$$

such that $m(\phi) = 0$ and

$$\sum_{A \in \mathcal{P}(X)} m(A) = 1. \tag{3.7}$$

For each set $A \in \mathcal{P}(X)$ the measure $m(A)$ is the degree of belief that a specific element x of X belong to one set A, but not to any specific subset of A.

3.2.5 Properties of Basic Probability Assignment

Using the definition of basic probability assignment, we see that the $m(A)$ satisfies the following properties:

1. It is not required that $m(X) = 1$.
2. It is not required that $m(A) \leq m(B)$ when $A \subseteq B$.
3. No relationship between $m(A)$ and $m(A^c)$ is required.

Note 3.2.3.

1. The basic probability assignment are not fuzzy measures.
2. The basic probability assignment can be used to determine a belief measure and a plausibility measure for all set $A \in \mathcal{P}(X)$ by the formulas

$$Bel(A) = \sum_{B : B \subseteq A} m(B). \tag{3.8}$$

$$Pl(A) = \sum_{B : A \cap B \neq \phi} m(B). \tag{3.9}$$

3. A belief measure Bel, the corresponding BPA m is determined for all $A \in \mathcal{P}(X)$ by the formula

$$m(A) = \sum_{B : B \subseteq A} (-1)^{A-B} Bel(B). \tag{3.10}$$

4. $$Pl(A) \geq Bel(A). \ \forall A \in \mathcal{P}(X). \tag{3.11}$$

3.2.6 Focal Elements

Every set $A \in \mathcal{P}(X)$ for which $m(A) > 0$ is called a focal element of m. Focal elements are subsets of X on which the available evidence focuses. When X is finite, m can be characterized by a list of its focal elements A with the corresponding values $m(A)$.

3.2.7 Body of Evidence

The pair $(\mathcal{F}, m)$ is called a body of evidence, in which $\mathcal{F}$ and m denote a set of focal elements and the associated basic assignment, respectively.

3.2.8 Total Ignorance

The expression in term of basic assignment by $m(X) = 1$ and $m(A) = 0$, $\forall A \neq X$. is called total ignorance.

That is, we know that the element is in the universal set X, but we have no evidence about location in any subset of X.

The expression of total ignorance in term of the corresponding belief measure is exactly the same.

$$Bel(X) = 1 \text{ and } Bel(A) = 0, \forall A \neq X.$$

However, the expression of total ignorance in term of the associated plausibility measure is quite different:

$$Pl(\phi) = 0 \text{ and } Pl(A) = 1, \forall A \neq \phi.$$

3.2.9 Dempster's Rule of Combination of Basic Assignments

Evidence obtained in the same context from two independent sources and expressed by two basic assignments m_1 and m_2 on some power set $\mathcal{P}(X)$ must be combined

to obtain a joint basic Assignment denoted by $m_{1,2}$. The standard way of combining evidence is defined by the formula

$$m_{1,2}(A) = \frac{\sum_{B \cap C = A} m_1(B) \cdot m_2(C)}{1 - K} \tag{3.12}$$

for all $A \neq \phi$ and $m_{1,2}(\phi) = 0$, where

$$K = \sum_{B \cap C = \phi} m_1(B).m_2(C) \tag{3.13}$$

where $m_1(B)$ is the degree of evidence from the first source that focuses on set $B \in \mathcal{P}(X)$ and $m_2(C)$ is the degree of evidence from the second source that focuses on set $C \in \mathcal{P}(X)$ are combined by taking the product $m_1(B) \cdot m_2(C)$, which focuses on the intersection $B \cap C$. This formula is known as Dempster's rule of combination.

Note 3.2.4.

1. Since some intersections of focal elements from the first and second source may result in the same set A, we must add the corresponding products to obtain $m_{1,2}(A)$.

2. If some of the intersections may be empty, then the value K is not included in the definition of joint basic assignment $m_{1,2}$, since it is required that $m_{1,2}(\phi) = 0$. It means that, the sum of products $m_1(B) \cdot m_2(C)$ for all focal elements B of m_1 and all focal elements C of m_2 such that $B \cap C \neq \phi$ is equal to $1 - K$.

3. To obtain a normalized basic assignment $m_{1,2}$, as required, we must divide each of these products by this factor $1 - K$, as in equation (3.12).

Example 3.1. Assume that an old painting was discovered which strongly resembles paintings by Ram. Such a discovery is likely to generate various questions regarding the status of the painting. Assume the following three questions:

1. Is the discovered painting a genuine painting by Ram?

2. Is the discovered painting a product of one of Ram's many disciples?

3. Is the discovered painting a counterfeit?

Solution:

Let R, D, and C are the subsets of universal set X (the set of all painting), which contain the set of all paintings by Ram, the set of all paintings by disciples of Ram and the set of all counterfeits of Ram's paintings, respectively. Let us suppose that two experts performed careful examinations of the painting and subsequently provided us with basic assignments m_1 and m_2, specified in Table 3.1. These are the degrees of evidence which each expert obtained by the examination and which support the various claims that the painting belongs to one of the sets of our concern. For example, $m_1(R \cup D) = 0.15$ is he degree of evidence obtained by the first expert that the painting was done by Ram himself or that the painting was done by one of his disciples. Now we can calculate the total evidence, Bel_1 and Bel_2, in each set.

	Expert 1		Expert 2		Combined evidence		
Focal elements	m_1	Bel_1	m_2	Bel_2	$m_{1,2}$	$Bel_{1,2}$	$Pl_{1,2}$
R	0.05	0.05	0.15	0.15	0.21	0.21	0.84
D	0	0	0	0	0.01	0.01	
C	0.05	0.05	0.05	0.05	0.09	0.09	
$R \cup D$	0.15	0.2	0.05	0.2	0.12	0.34	
$R \cup C$	0.1	0.2	0.2	0.4	0.2	0.5	
$D \cup C$	0.05	0.1	0.05	0.1	0.06	0.16	
$R \cup D \cup C$	0.6	1	0.05	1	0.31	1	

TABLE 3.1: Combination of degrees of evidence from two independent sources

Applying Dempster's rule to m_1 and m_2 we obtain the joint basic assignment $m_{1,2}$. To determine the values of $m_{1,2}$, we calculate the normalization factor $1 - K$ first. We have

$$
\begin{aligned}
K &= m_1(R)\cdot m_2(D) + m_1(R)\cdot m_2(C) + m_1(R)\cdot m_2(D\cup C) + m_1(D)\cdot m_2(R) \\
&\quad + m_1(D)\cdot m_2(C) + m_1(D)\cdot m_2(R\cup C) + m_1(C)\cdot m_2(R) + m_1(C)\cdot m_2(D) \\
&\quad + m_1(C)\cdot m_2(R\cup D) + m_1(R\cup D)\cdot m_2(C) + m_1(R\cup C)\cdot m_2(D) + m_1(D\cup C)\cdot m_2(R) \\
&= 0.05\times 0 + 0.05\times 0.05 + 0.05\times 0.05 + 0\times 0.15 + 0\times 0.05 + 0\times 0.2 + 0.05\times 0.15 \\
&\quad + 0.05\times 0 + 0.05\times 0.05 + 0.15\times 0.05 + 0.1\times 0 + 0.05\times 0.15 \\
&= 0.0025 + 0.0025 + 0.0075 + 0.0025 + 0.0075 + 0.0075 \\
&= 0.03
\end{aligned}
$$

$\therefore$ Normalization factor $1 - K = 1 - 0.03 = 0.97$

Now, calculating $m_{1,2}$

$$
\begin{aligned}
m_{1,2}(R) &= [m_1(R)\cdot m_2(R) + m_1(R)\cdot m_2(R\cup D) + m_1(R)\cdot m_2(R\cup C) \\
&\quad + m_1(R)\cdot m_2(R\cup D\cup C) + m_1(R\cup D)\cdot m_2(R) \\
&\quad + m_1(R\cup D)\cdot m_2(R\cup C) + m_1(R\cup C)\cdot m_2(R) \\
&\quad + m_1(R\cup C)\cdot m_2(R\cup D) + m_1(R\cup D\cup C)\cdot m_2(R)]/0.97 \\
&= 0.21 \\
m_{1,2}(D) &= [m_1(D)\cdot m_2(D) + m_1(D)\cdot m_2(R\cup D) + m_1(D)\cdot m_2(D\cup C) \\
&\quad + m_1(D)\cdot m_2(R\cup D\cup C) + m_1(R\cup D)\cdot m_2(D) \\
&\quad + m_1(R\cup D)\cdot m_2(D\cup C) + m_1(D\cup C)\cdot m2(D) \\
&\quad + m_1(D\cup C)\cdot m_2(R\cup D) + m_1(R\cup D\cup C)\cdot m_2(D)]/0.97 \\
&= 0.01 \\
m_{1,2}(R\cup C) &= [m_1(R\cup C)\cdot m_2(R\cup C) + m_1(R\cup C)\cdot m_2(R\cup D\cup C) \\
&\quad + m_1(R\cup D\cup C)\cdot m_2(R\cup C)]/0.97 \\
&= 0.2
\end{aligned}
$$

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$$
\begin{aligned}
m_{1,2}(R\cup D\cup C) &= [m_1(R\cup D\cup C)\cdot m_2(R\cup D\cup C)]/0.97\\
&= 0.31\\
Bel_1(R\cup\bar{D}) &= m_1(\bar{R})+m_1(\bar{D})+m_1(\bar{R}\cup\bar{D})\\
&= 0.05+0+0.15\\
&= 0.2\\
Bel_1(R\cup C) &= m_1(R)+m_1(C)+m_1(R\cup C)\\
&= 0.05-0.05-0.10\\
&= 0.2\\
Pl_{1,2}(R) &= m_{1,2}(R)+m_{1,2}(R\cup D)+m_{1,2}(R\cup C)+m_{1,2}(R\cup D\cup C)\\
&= 0.21+0.12+0.2+0.31\\
&= 0.84
\end{aligned}
$$

and similarly for the remaining focal elements C, $R\cup\bar{D}$, and $D\cup C$. The joint basic assignment can now be used to calculate the joint belief $Bel_{1,2}$ (Table 3.1) and joint plausibility $Pl_{1,2}$.

3.3 Projection

Consider now a basic assignment m defined on the Cartesian product $Z = X \times Y$; that is,

$$m : \mathcal{P}(X \times Y) \to [0, 1].$$

Each focal element of m is, in this case, a binary relation R on $X \times Y$. Let R_X denote the projection of R on X. Then

$$R_X = \{x \in X \mid (x, y) \in R \text{ for some } y \in Y\}.$$

Similarly,

$$R_Y = \{y \in Y \mid (x, y) \in R \text{ for some } x \in X\}$$

defines the projection of R on Y. We can now define the projection m_X of m on X by the formula

$$M_X(A) = \sum_{R \mid A = R_X} m(R), \ \forall A \in \mathcal{P}(X). \tag{3.14}$$

Similarly,

$$M_Y(A) = \sum_{R \mid B = R_Y} m(R), \ \forall B \in \mathcal{P}(Y). \tag{3.15}$$

defines the projection of m on Y.

3.3.1 Marginal Body of Evidence

Let m_X and m_Y be the marginal basic assignments, then $(\mathcal{F}_X, m_X)$ and $(\mathcal{F}_Y, m_Y)$ is called the associated marginal bodies of evidence.

3.3.2 Non-interactive

Two marginal bodies of evidence $(\mathcal{F}_X, m_X)$ and $(\mathcal{F}_X m_X)$ are said to be non-interactive iff for all $A \in \mathcal{F}_X$ and all $B \in \mathcal{F}_Y$

$$m(A \times B) = m_X(A) \cdot m_Y(B) \tag{3.16}$$

and

$$m(R) = 0, \ \forall R \neq A \times B.$$

That is, two marginal bodies of evidence are non-interactive iff the only focal elements of the joint body of evidence are Cartesian products of focal elements of the marginal bodies and if the joint basic assignment is determined by the product of the marginal basic assignments.

Example 3.2. The body of evidence given in Table 3.2. Focal elements are subsets of the Cartesian product $X \times Y$, where $X = \{1.2.3\}$ and $Y = \{a.b.c\}$ they are defined in the table by their characteristic functions. To emphasize that each focal element is in

fact, a binary relation on $X \times Y$, they are labeled $R_1, R_2, \ldots, R_{12}$. Find the marginal bodies of evidence.

	1a	1b	1c	2a	2b	2c	3a	3b	3c	$m(R_i)$
R_1	0	0	0	0	1	1	0	1	1	0.0625
R_2	0	0	0	1	0	0	1	0	0	0.0625
R_3	0	0	0	1	1	1	1	1	1	0.125
R_4	0	1	1	0	0	0	0	1	1	0.0375
R_5	0	1	1	0	1	1	0	0	0	0.075
R_6	0	1	1	0	1	1	0	1	1	0.075
R_7	1	0	0	0	0	0	1	0	0	0.0375
R_8	1	0	0	1	0	0	0	0	0	0.075
R_9	1	0	0	1	0	0	1	0	0	0.075
R_{10}	1	1	1	0	0	0	1	1	1	0.075
R_{11}	1	1	1	1	1	1	0	0	0	0.15
R_{12}	1	1	1	1	1	1	0	1	1	0.15

TABLE 3.2: Joint body of evidence

Solution:

Marginal bodies of evidence:

$$\begin{aligned} m_X(\{1.\ 2\}) &= m(R_5) + m(R_8) + m(R_{11}) \\ &= 0.075 + 0.075 + 0.15 \\ &= 0.3 \\ m_X(\{1.\ 3\}) &= m(R_4) + m(R_7) + m(R_{10}) \\ &= 0.0375 + 0.0375 + 0.075 \\ &= 0.15 \\ m_X(\{2.\ 3\}) &= m(R_1) + m(R_2) + m(R_3) \\ &= 0.0625 + 0.0625 + 0.125 \\ &= 0.25 \\ m_X(\{1.\ 2.\ 3\}) &= m(R_6) + m(R_9) + m(R_{12}) \\ &= 0.075 + 0.075 + 0.15 \\ &= 0.3 \end{aligned}$$

$$
\begin{aligned}
m_Y(\{a\}) &= m(R_2) + m(R_7) + m(R_3) + m(R_9) \\
&= 0.0625 + 0.0375 + 0.075 + 0.075 \\
&= 0.25 \\
m_Y(\{b, c\}) &= m(R_1) + m(R_4) + m(R_5) + m(R_6) \\
&= 0.0625 + 0.0375 + 0.075 + 0.075 \\
&= 0.25 \\
m_Y(\{a, b, c\}) &= m(R_3) + m(R_{10}) + m(R_{11}) + m(R_{12}) \\
&= 0.5
\end{aligned}
$$

We can easily verify that the joint basic assignment m is uniquely determined in this case by the marginal basic assignments. The marginal bodies of evidence are thus non-interactive.

$$
\begin{aligned}
m(R_1) &= m_X(\{2, 3\}) \cdot m_Y(\{b, c\}) \\
&= 0.25 \times 0.25 \\
&= 0.0625
\end{aligned}
$$

Observe that $\{2, 3\} \times \{b, c\} = \{2b, 2c, 3b, 3c\} = R_1$.

Similarly,

$$
\begin{aligned}
m(R_{10}) &= m_X(\{1, 3\}) \cdot m_Y(\{a, b, c\}) \\
&= 0.15 \times 0.5 \\
&= 0.075
\end{aligned}
$$

Where $R_{10} = \{1.3\} \times \{a.b.c\} = \{1a, 1b, 1c, 3a, 3b, 3c\}$.

3.3.3 Commonality Function

The function $Q(A)$ defined by

$$Q(A) = \sum_{B : A \subseteq B} m(B). \tag{3.17}$$

is called a commonality function. For each $A \in \mathcal{P}(X)$, the value $Q(A)$ represents the total portion of belief that can move freely to every point of A.

Note 3.3.1. Each commonality function defined on the power set of a body of evidence on the power set.

	m	Bel	Pl	Q
$m(A) =$	$m(A)$	$\sum_{B \subseteq A} (-1)^{\lvert A-B \rvert} Bel(B)$	$\sum_{B \subseteq A} (-1)^{\lvert A-B \rvert} [1 - Pl(A^c)]$	$\sum_{A \subseteq B} (-1)^{\lvert B-A \rvert} Q(B)$
$Bel(A) =$	$\sum_{B \subseteq A} m(B)$	$Bel(A)$	$1 - Pl(A^c)$	$\sum_{B \subseteq A^c} (-1)^{\lvert B \rvert} Q(B)$
$Pl(A) =$	$\sum_{B \cap A \neq \emptyset} m(B)$	$1 - Bel(A^c)$	$Pl(A)$	$\sum_{\emptyset \neq B \subseteq A^c} (-1)^{\lvert B \rvert + 1} Q(B)$
$Q(A) =$	$\sum_{A \subseteq B} m(B)$	$\sum_{B \subseteq A} (-1)^{\lvert B \rvert} Bel(B^c)$	$\sum_{\emptyset \neq B \subseteq A} (-1)^{\lvert B \rvert + 1} Pl(B)$	$Q(A)$

TABLE 3.3: Conversion formulas in evidence theory

3.4 Possibility Theory

A Possibility theory is a branch of evidence theory that deals only with bodies of evidence whose focal elements are nested. The belief measures and plausibility measures in possibility theory are exactly like to necessity measures and possibility measures, respectively. Possibility theory was originally introduced in the context of fuzzy sets by Zadeh [1978].

Theorem 3.4.1. Let a given finite body of evidence $(\mathcal{F}, m)$ be nested. Then, for all $A, B \in \mathcal{P}(X)$, we have

1. $Bel(A \cap B) = \min[Bel(A), Bel(B)]$
2. $Pl(A \cup B) = \max[Pl(A), Pl(B)]$.

Proof.

1. Since the focal elements in $\mathcal{F}$ are nested, they may be linearly ordered by the subset relationship.

   Let $\mathcal{F} = \{A_1, A_2, \ldots, A_n\}$ such that $A_i \subset A_j$ when $i < j$.

   Let us suppose A and B be any two arbitrary subsets of X.

   Let i_1 be the largest integer i such that $A_i \subseteq A$ and let i_2 be the largest integer i such that $A_i \subseteq B$.

   Then, $A_i \subseteq A$ and $A_i \subseteq B$ iff $i \leq i_1$ and $i \leq i_2$, respectively.

   Moreover, $A_i \subseteq A \cap B$ iff $i \leq min(i_1, i_2)$.

   Therefore,

$$\begin{aligned} Bel(A \cap B) &= \sum_{i=1}^{\min(i_1, i_2)} m(A_i) \\ &= \min\left[\sum_{i=1}^{i_1} m(A_i), \sum_{i=1}^{i_1} m(A_i)\right] \\ &= \min\{Bel(A), Bel(B)\} \end{aligned}$$

2. Since we know that

$$\begin{aligned} Pl(A \cup B) &= 1 - Bel((A \cup B)^c) = 1 - Bel(A^c \cap B^c) && (by\ De\ Morgan's\ law) \\ &= 1 - \min[Bel(A^c), Bel(B^c)] && (by (1)) \\ &= \max[1 - Bel(A^c), 1 - Bel(B^c)] \\ &= \max[Pl(A), Pl(B)], \ \forall\ A, B \in \mathcal{P}(X). \end{aligned}$$

□

Note 3.4.1. The necessity measures and possibility measures are denoted by the symbols *Nec* and *Pos*, respectively. Then, we have the following results for every $A, B \in \mathcal{P}(X)$.

$$Nec(A \cap B) = \min[Nec(A), Nec(B)] \tag{3.18}$$

$$Pos(A \cup B) = \max[Pos(A), Pos(B)] \tag{3.19}$$

3.4.1 Necessity Measure

A fuzzy measure on $(X, \mathcal{P}(X))$ is called necessity measure iff

$$Nec\left(\bigcap_{k \in K} A_k\right) = \inf_{k \in K} Nec(A_k) \tag{3.20}$$

for any family $\{A_k : k \in K\}$ in $\mathcal{P}(X)$ such that $\bigcap_{k \in K} A_k \in \mathcal{P}(X)$, where K is an arbitrary index set.

3.4.2 Possibility Measure

A fuzzy measure on $(X, \mathcal{P}(X))$ is called possibility measure iff

$$Pos\left(\bigcup_{k \in K} A_k\right) = \sup_{k \in K} Pos(A_k) \tag{3.21}$$

for any family$\{A_k : k \in K\}$ in such that $\bigcup_{k \in K} A_k \in \mathcal{P}(X)$, where K is an arbitrary index set.

3.4.2.1 Properties of Necessity and Possibility Measure

The Necessity measures and Possibility measures are special belief measures and special plausibility measures, respectively, they satisfy the following properties:

$$Nec(A) + Nec(A^c) \leq 1 \tag{3.22}$$

$$Pos(A) + Pos(A^c) \geq 1 \tag{3.23}$$

$$Nec(A) = 1 - Pos(A^c)$$

$$Pos(A) = 1 - Nec(A^c) \tag{3.24}$$

$$\min[Nec(A), Nec(A^c)] = 0 \tag{3.25}$$

$$\max[Pos(A), Pos(A^c)] = 1 \tag{3.26}$$

Theorem 3.4.2. For every $A \in \mathcal{P}(X)$, any necessity measure Nec on $\mathcal{P}(X)$ and the associated possibility measure Pos satisfy the following implications:

1. $Nec(A) > 0 \Rightarrow Pos(A) = 1$

2. $Pos(A) < 1 \Rightarrow Nec(A) = 0$.

Proof.

1. Let $Nec(A) > 0$ for some $A \in \mathcal{P}(X)$. Then,

$$Nec(A^c) = 0 \qquad (by\ (3.25))$$

and

$$Pos(A) = 1 - Nec(A^c) = 1.$$

2. Let $Pos(A) < 1$ for some $A \in \mathcal{P}(X)$ Then,

$$Pos(A^c) = 1 \qquad (by\ (3.26))$$

and

$$Nec(A) = 1 - Pos(A^c) = 0$$ □

3.4.2.2 Possibility Distribution Function Associated with Pos

Given a possibility a measure Pos on $\mathcal{P}(X)$, let function

$$r : X \to [0,\ 1]$$

such that

$$r(x) = 1 - Pos(\{x\}),\ \forall\, x \in X$$

be called a possibility distribution function associated with Pos.

Theorem 3.4.3. Every possibility measure Pos, on a finite power set $\mathcal{P}(X)$ is uniquely determined by a possibility distribution function

$$r : X \to [0, 1]$$

via the formula

$$Pos(A) = \max_{x \in A} r(x) \tag{3.27}$$

for each $A \in \mathcal{P}(X)$.

Proof. We shall prove this theorem by mathematical induction method on the cardinality of set A.

Let us first suppose $|A| = 1$.

Then, $A = \{x\}$, where $x \in X$. The result (3.27) is trivially satisfied.

Now, assume that Eq.(3.27) is satisfied for $|A| = n - 1$, and let $A = \{x_1, x_2, \ldots, x_n\}$.

Then by Eq.(3.19),

$$\begin{aligned} Pos(A) &= \max(Pos(\{x_1, x_2, \ldots, x_{n-1}\}), Pos(\{x_n\})] \\ &= \max(max[Pos(\{x_1\}), Pos(\{x_2\}), \ldots, Pos(\{x_{n-1}\})], Pos(\{x_n\})] \\ &= \max(Pos(\{x_1\}), Pos(\{x_2\}), \ldots, Pos(\{x_n\})] \\ &= \max_{x \in A} r(x). \end{aligned}$$

Hence, the result is true for $|A| = n$. Therefore, by the mathematical induction, the result is true for all n.

□

Note 3.4.2. When X is not finite, Eq. (3.27) must be replaced with the more general equation

$$Pos(A) = \sup_{x \in A} r(x). \tag{3.28}$$

3.4.3 Possibility Distribution Function Associated with r

The possibility distribution function r is defined on the finite universal set $X = \{x_1, x_2, \ldots, x_n\}$. Then, the n-tuple

$$r = (r_1, r_2, \ldots, r_n).$$

where $r_i = r(x_i)$, $\forall x_i \in X$, is called a possibility distribution associated with the function r.

Note 3.4.3. The number of components in a possibility distribution is called its length.

3.4.4 Lattice of Possibility Distributions of Length n

Let ${}^nR$ denote the set of all ordered possibility distributions of length n, and let

$$\mathcal{R} = \bigcup_{n \in \mathbb{N}} {}^n\mathcal{R}$$

Given two possibility distributions,

$${}^1r = ({}^1r_1, {}^1r_2, \ldots, {}^1r_n) \in {}^n\mathcal{R}$$

and

$${}^2r = ({}^2r_1, {}^2r_2, \ldots, {}^2r_n) \in {}^n\mathcal{R}.$$

for some $n \in \mathbb{N}$, we define

$${}^1r \leq {}^2r \Leftrightarrow {}^1r_i \leq {}^2r_i, \forall i \in \mathbb{N}_n.$$

This ordering on ${}^n\mathcal{R}$ is partial and forms a lattice whose join ($\vee$) and meet ($\wedge$) are defined, respectively, as

$${}^i r \vee {}^j r = (\max({}^i r_1, {}^j r_1), \max({}^i r_2, {}^j r_2), \ldots, \max({}^i r_n, {}^j r_n))$$

and

$$ {}^{i}r \wedge {}^{j}r = (\min({}^{i}r_1, {}^{j}r_1), \min({}^{i}r_2, {}^{j}r_2), \ldots, \min({}^{i}r_n, {}^{j}r_n)), \forall {}^{i}r, {}^{j}r \in {}^{n}\mathcal{R} $$

For each $n \in \mathbb{N}$, $({}^{n}\mathcal{R}, \leq)$ is called a *lattice of possibility distributions of length n.*

3.4.5 Marginal Possibility Distributions

Let r be the joint possibility distributions defined on the Cartesian product $X \times Y$. Projections r_X and r_Y of r, which are called marginal possibility distributions, are defined by the formulas

$$ r_X(x) = \max_{y \in Y} r(x, y) \tag{3.29} $$

for each $x \in X$ and

$$ r_Y(y) = \max_{x \in X} r(x, y) \tag{3.30} $$

for each $y \in Y$.

3.4.6 Non-Interactive

Nested bodies of evidence on X and Y represented by possibility distribution functions r_x and r_y, respectively, are called non-interactive iff

$$ r(x, y) = min[r_X(x), r_Y(y)] \tag{3.31} $$

for all $x \in X$ and all $y \in Y$.

3.4.7 Possibility Measures

Let Pos_X, Pos_Y and Pos denote the possibility measures corresponding to r_X, r_Y and r. Then Pos can be calculated from Pos_X and Pos_Y by the equation

$$Pos(A \times B) = min[Pos_X(A), Pos_Y(B)] \tag{3.32}$$

for all $A \in \mathcal{P}(X)$ and all $B \in \mathcal{P}(Y)$, where

$$Pos_X(A) = \max_{x \in A} r_X(x),$$

$$Pos_Y(A) = \max_{y \in B} r_Y(y),$$

$$Pos(A \times B) = \max_{x \in A,\ y \in B} r(x, y).$$

3.4.8 Necessity Measures

Let Nec_X, Nec_Y and Nec are the necessity measures associated with possibility measures Pos_X, Pos_Y and Pos, respectively. Then Nec can be calculated from Nec_X and Nec_Y by the equation

$$Nec(A + B) = max[Nec_X(A), Nec_Y(B)] \tag{3.33}$$

for all $A \in \mathcal{P}(X)$ and all $B \in \mathcal{P}(Y)$ and $(A + B)$ is the cartesian product $(A^c \times B^c)^c$.

3.5 Fuzzy Sets and Possibility Theory

A consonant is a belief structure that is nested. A fundamental property of consonant belief structures is that plausibility measures are possibility measures. Possibility theory can be formulated not only in terms of nested bodies of evidence, but also in

terms of fuzzy sets. In this equivalence, the membership grade of an element X corresponds to the plausibility of the singletons consisting of that X. This alternative formulation of possibility theory is also suggestive since fuzzy sets, similar to possibilistic bodies of evidence, are also based on families of nested sets, the appropriate α -cuts. Possibility measures are directly connected with fuzzy sets via the associated possibility distribution functions. This connection be explain as:

Let $\mathcal{V}$ denote a variable that takes values in a universal set V, and let the equation $\mathcal{V} = v$, where $v \in V$ be used for describing the fact that the value $\mathcal{V}$ and v. Again, let F be a fuzzy set on V that expresses an elastic constraint on values that may be assigned to V. Then, for a particular value $v \in \mathcal{V}$, $F(v)$ is called the degree of compatibility of v. Further, given the proposition "$\mathcal{V}$ is F" based upon F, it is more meaningful to interpret $F(v)$as the degree of possibility that $\mathcal{V} = v$. That is, given a fuzzy set F on V and the proposition "$\mathcal{V}$ is F", the possibility, of $r_F(v)$, of $\mathcal{V} = v$ for each $v \in V$ is numerically equal to the degree $F(v)$ to which v belongs to F. Formally.

$$r_F(v) = F(v), \forall v \in V. \tag{3.34}$$

Function $r_F : V \to [0, 1]$ is called a possibility distribution function on V.

3.5.1 Associated Possibility Measure

The associated possibility measure, Pos_F is defined for all $A \in \mathcal{P}(V)$ by the equation

$$Pos_F(A) = \sup_{v \in A} r_F(v) \tag{3.35}$$

This measure express the uncertainty regarding the actual value of variable $\mathcal{V}$ under incomplete information given in terms of the proposition "$\mathcal{V}$ is F".

3.5.2 Associated Necessity Measure

The associated necessity measure, Nec_f can be calculated for all $A \in \mathcal{P}(V)$ by the equation

$$Nec_F(A) = 1 - Pos_F(A^c). \tag{3.36}$$

where A are normal fuzzy sets.

3.6 Possibility Theory versus Probability Theory

We know that a probability measure , Pro, is satisfy the equation

$$Pro(A \cup B) = Pro(A) + Pro(B) \tag{3.37}$$

for all sets A, $B \in \mathcal{P}(X)$ such that $A \cap B = \phi$ This is known as the additivity axiom of probability measure. This axiom is stronger than the superadditivity axiom of belief measures.

Note 3.6.1.

1. Probability measure is a special type of belief measure.
2. The dual belief and plausibility measure under the additive axiom of probability measure,
$$i.e.,\ Bel(A) = Pl(A) = \sum_{x \in A} P(x).$$
3. Belief measure and plausibility measures may also be interpreted as lower and upper probability estimates.
4. Belief measure and plausibility measure overlap when they both become probability measures.
5. Possibility, necessity and probability measure overlap only for one special measure, the measure of one focal element that is a singleton.

6. Possibility, necessity and probability measure became equal when one element of the universal set is assigned a value of unity and all the other elements in the universe are assigned a value of zero.

Theorem 3.6.1. A belief measure Bel on a finite power set $\mathcal{P}(X)$ is a probability measure if and only if the associated basic probability assignment function m is given by $m(x) = Bel(x)$ and $m(A) = 0$ for all subsets of X that are not singletons.

Proof. Let us suppose that Bel is a probability measure. For empty set ϕ , the theorem is trivially true because $m(\phi) = 0$. Now we assume that $A \neq \phi$ and assume $A = \{x_1, x_2, \ldots, x_n\}$. Then, we have

$$\begin{aligned} Bel(A) &= Bel(\{x_1\}) + Bel(x_2, x_3 \ldots, x_n) \\ &= Bel(\{x_1\}) + Bel(\{x_2\}) + Bel(\{x_3, x_4, \ldots, x_n\}) \\ &= \ldots \\ Bel(A) &= Bel(\{x_1\}) + Bel(\{x_n\}). \end{aligned}$$

Now, since $Bel(x) = m(\{x_1\})$ *for any* $x \in X$.

Then, we have $Bel(A) = \sum_{i=1}^{n} m(\{x_i\})$.

This shows that Bel is defined in terms of a basic assignment that focuses only on singletons. Conversely, Let us suppose that a basic probability assignment function μ is given such that

$$\sum_{x \in X} m(\{x\}) = 1.$$

Thus , for any sets A, $B \in \mathcal{P}(X)$ such that $A \cap B = \phi$, we have

$$\begin{aligned} Bel(A) + Bel(B) &= \sum_{x \in A} m(\{x\}) + \sum_{x \in B} m(\{x\}) \\ &= \sum_{x \in A \cup B} m(\{x\}) \\ &= Bel(A \cup B). \end{aligned}$$

Hence, Bel is a probability measure.

3.6.1 Probability Distribution Function

The probability measures on finite sets are represented by a function

$$p : X \to [0,\ 1]$$

such that $p(x) = m(x)$. This function is called a probability distribution function. Let $p = \{p(x) : x \in X\}$ be a probability distribution on X. When the basic probability assignment function focuses only on singletons, as required for probability measures, then

$$Bel(A) = Pl(A) = \sum_{x \in A} m(\{x\})$$

for all $A \in \mathcal{P}(X)$. This can be written, by utilizing the notion of a probability distribution function, as

$$Bel(A) = Pl(A) = \sum_{x \in A} p(x).$$

Let us denote probability measures by Pro. Then

$$Pro(A) = \sum_{x \in A} p(x) \tag{3.38}$$

for all $A \in \mathcal{P}(X)$.

3.6.2 Marginal Probability Distributions

When a probability distribution p is defined on the Cartesian product $X \times Y$, it is called a joint probability distribution. Projection P_X and P_y of **p** on X and Y, respectively, are called marginal Probability distributions. They are defined by the formulas

$$P_X(x) = \sum_{y \in Y} p(x,\ y) \tag{3.39}$$

for each $x \in X$ and

$$P_X(x) = \sum_{x \in Y} p(x, y) \tag{3.40}$$

for each $y \in Y$.

3.6.3 Non-Interactive

The marginal distributions are called non-interactive with respect to p iff

$$p(x, y) = p_X(x) \cdot p_Y(y) \tag{3.41}$$

for all $x \in X$ and all $y \in Y$.

3.6.4 Conditional Probability Distributions

Two conditional probability distributions, $P_{X|Y}$ and $P_{Y|X}$ are defined in terms of a joint distribution p by the formulas

$$p_{X|Y}(x|y) = \frac{p(x, y)}{p_Y(y)} \tag{3.42}$$

and

$$p_{Y|X}(y|x) = \frac{p(x, y)}{p_X(x)} \tag{3.43}$$

for all $x \in X$ and all $y \in Y$.

3.6.5 Independent Marginal Distributions

The two marginal distributions are called independent iff

$$p_{X|Y}(x|y) = p_X(x) \tag{3.44}$$

$$p_{Y|X}(y|x) = p_Y(y) \tag{3.45}$$

for all $x \in X$ and all $y \in Y$. Since the joint probability distributions is defined by

$$p(x, y) = p_{X,Y}(x|y).p_Y(y) = p_{Y|X}(y|x).p_X(x) \tag{3.46}$$

we see that the marginal distributions are independent iff they are non-interactive.

Chapter 4

Fuzzy logic

In the fuzzy expression(formula), a fuzzy proposition can have its truth value in the interval [0. 1]. The fuzzy function is a mapping function from [0. 1] to [0. 1].

$$F : [0.\ 1] \rightarrow [0.\ 1].$$

If we generalize the domain in n-dim the function becomes as follows:

$$F : [0.\ 1]'' \rightarrow [0.\ 1].$$

Definition 4.0.1. Fuzzy Expression

The fuzzy logic is a logic represented by the fuzzy expression(formula) which satisfies the following properties:

1. Truth values, 0 and 1, and variable x_i ($\in [0.\ 1].\ i = 1.\ 2.\ \ldots\ n$) are fuzzy expression.
2. If p is a fuzzy expression, $\bar{p}$ (negative operator) is also a fuzzy expression.
3. If p and q are fuzzy expressions, $p \wedge q$ and $p \vee q$ are fuzzy expression.

4.1 Fuzzy logic

4.1.1 Fuzzy IF-Then rules

fuzzy logic operations and, or, not, implication, and equivalence:

$a \wedge b,\ a \vee b,\ \bar{a}\ ,\ a \Rightarrow b,\ a \Leftrightarrow b$

and their evaluations on a fuzzy set $\widetilde{A}$ with the membership function $A(\cdot)$

$$\begin{aligned} A(a \wedge b) &= A(a) \wedge A(b) = min\{A(a),\ B(b)\} \\ A(a \vee b) &= A(a) \vee A(b) = max\{A(a),\ B(b)\} \\ A(\bar{a}) &= A^c(a) = 1 - A(a) \\ A(a \Rightarrow b) &= A(a) \Rightarrow A(b) = min\{1,\ 1 + A(b) - A(a)\} \\ A(a \Leftrightarrow b) &= A(a) \Leftrightarrow A(b) = 1 - |A(a) - A(b)| \end{aligned}$$

we also discussed fuzzy relations between elements of two subsets $\widetilde{A}$ and $\widetilde{B}$, on which a membership function $(A \times B)(a,b)$ is defined, with $a \in A$ and $b \in B$. It is clear that one can consider the above fuzzy logic operations as some special fuzzy relations, with $\widetilde{A} = \widetilde{B}$ and $A \times A = A$.

In this section, we take a closer look at the implication relation $a \Rightarrow b$ and its application in fuzzy logic rules.

The implication relation $a \Rightarrow b$ can be interpreted, in linguistic terms, as "If a is true THEN b is true." Of course, this is valid for both the classical (two-valued) logic and the fuzzy (multi-valued) logic. For fuzzy logic performed on a fuzzy subset $\widetilde{A}$, we have a membership function A describing the truth values of $a \in A$ and $b \in A$. In this case, a more complete linguistic statement would be

"IF $a \in A$ is true with a truth value $A(a)$ THEN $b \in A$ is true with a truth value $A(b)$ which has a truth value $A(a \Rightarrow b) = \min\{1,\ 1 + A(b) - A(a)\}$."

In the above, both a and b belong to the same fuzzy subset $\widetilde{A}$ and share the same membership function A. If they belong to different fuzzy subsets $\widetilde{A}$ and $\widetilde{B}$ with different membership functions A and B, then we have a nontrivial fuzzy relation, which can be quite complicated. In most cases, however, the implication relation $a \Rightarrow b$, performed on fuzzy subsets $\widetilde{A}$ and $\widetilde{B}$, where $a \in A$ and $b \in B$, is simply defined in linguistic terms as

"IF $a \in A$ is true with a truth value $A(a)$ THEN $b \in B$ is true with a truth value $B(b)$."

Throughout this project report, we often consider this kind of implication. Because such statements have a standard format and their meaning is clear, it is common to write them in the following simple form:

"IF a is A THEN b is B."

A fuzzy logic implication statement of this form is usually called a fuzzy IF-THEN rule.

To be more general, let $\widetilde{A}_1, \ldots, \widetilde{A}_n$, and $\widetilde{B}$ be fuzzy subsets with membership functions $A_1, \ldots, A_n$, and B, respectively.

4.1.2 Interpretation of Fuzzy IF-THEN Rules

In the classical two-valued logic, the IF-THEN rule can be easily interpreted,

"IF a is A THEN b is B"

For example, a statement "IF a is positive THEN b is negative" is crisp and non-vague.

In fuzzy multi-valued logic, however, both $\widetilde{A}$ and $\widetilde{B}$ are fuzzy subsets associated with fuzzy membership functions A and B. Depending on $A(a)$ for $a \in A$ and $B(b)$ for $b \in B$, both the condition "a is A" and the conclusion "b is B" can have various interpretations. It will be more clear by following example.

Example 4.1. Let $X = [0, 3]$, $Y = [-3, 0]$ and let define real-valued invertible function $f : X \to Y$, $f(x) = y$ defined as shown in figure 4.1. For crisp value x we get $y = f(x)$ and for crisp value y we have $x = f^{-1}(y)$.

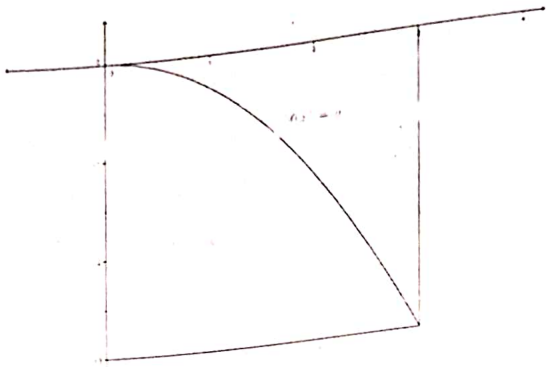


FIGURE 4.1: Real-valued invertible function $f : X \to Y$

Now, suppose that we don't know the exact expression of f. Let define membership functions on X and Y as follows,
$S(\cdot)$, $M(\cdot)$ and $L(\cdot)$ which describes small, medium and large respectively. (As shown in figure 4.2)

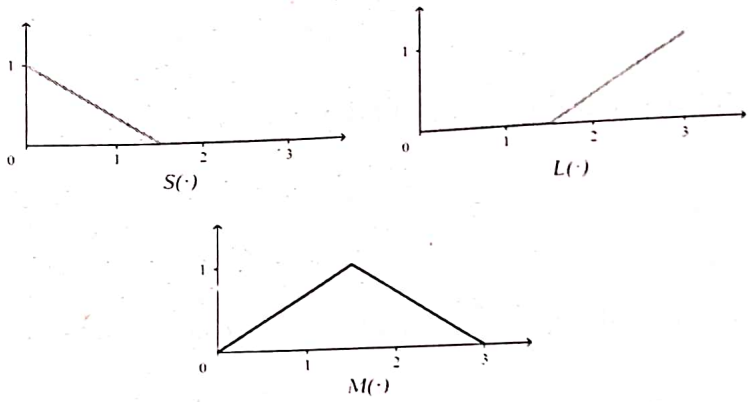


FIGURE 4.2: Membership functions $S(\cdot)$, $M(\cdot)$ and $L(\cdot)$

So, we can approximate given real-valued function $f(x) = y$ by fuzzy rule base which are as given as below,

1. "IF x is positive small THEN y is negative small."
2. "IF x is positive medium THEN y is negative medium."
3. "IF x is positive large THEN y is negative large."

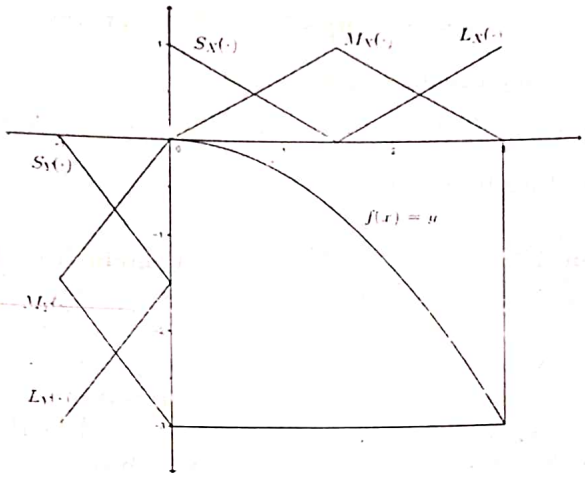


FIGURE 4.3: Approximating a real function by a fuzzy rule base.

To distinguish membership functions for X and Y we consider notations S_X. M_X. and L_X for X and for Y consider S_Y. M_Y. and L_Y.

Now, comparing it to classical two-valued logic inference,
i.e., "IF x is positive THEN y is negative" or "IF x is small THEN y is small"
we need the following statement from the classical logic to express the same meaning of the fuzzy logic inference 1.
"IF x is positive AND x is small THEN y is negative AND y is small."

The classical logic can only be used to determine "x is small" or "x is not small," while the fuzzy membership function $S(\cdot)$ gives infinitely many different truth values to describe how small x is.
Note that in this example we only use one membership function for one evaluation. if we are interested in the fuzzy implication statement 1. then we only apply the membership function $S(\cdot)$ to both x and y, but the other two membership functions $M(\cdot)$ and $L(\cdot)$ are not used.
We also note that this example gives only some interpretations to a fuzzy IF-THEN rule. If different membership functions are used, say we remove $L(\cdot)$ and change $S(\cdot)$ and $M(\cdot)$ for the values of $y \in Y = [-4.0]$, then the above fuzzy implication statements 1-3 will be changed.

That is, a fuzzy IF-THEN rule can be interpreted in different ways:

It depends on the membership functions that we use.

In other words, it depends on the definitions of the fuzzy subsets involved in the condition and the conclusion of the implication.

Condition (IF)	Conclusion (THEN)
a is A	b is B
a is very A	b is very B
a is very A	b is B
a is more or less A	b is more or less B
a is more or less A	b is B
a is not A	b is unknown
a is not A	b is not B

TABLE 4.1: Interpretation of Fuzzy IF-THEN Rules

Table 4.1 lists some interpretations of fuzzy IF-THEN rules, where the first and the last ones are classical logic implication rules that are special cases of fuzzy logic rules.

4.1.3 Evaluation of Fuzzy IF-THEN Rules

In this subsection, we discuss the problem of evaluating a fuzzy IF-THEN rule

$$(A \Rightarrow B)(a, b) = A(a) \Rightarrow B(b). \qquad a \in A,\ b \in B.$$

For the classical two-valued logic, this evaluation is simple:

$$B(b) = \begin{cases} 1. & A(a) = 1 \\ 0. & A(a) = 0 \end{cases} \qquad \text{and} \qquad B^c(b) = \begin{cases} 1. & A^c(a) = 1 \\ 0. & A^c(a) = 0 \end{cases}$$

That is, $a \in A \Rightarrow b \in B$ That is, $a \notin A \Rightarrow b \notin B$

For fuzzy logic, we have the following options for the IF-THEN rule $A(a) \Rightarrow B(b)$

(a) $(A \Rightarrow B)(a, b) = \min\{A(a),\ B(b)\}$

(b) $(A \Rightarrow B)(a, b) = A(a) \cdot B(b)$

(c) $(A \Rightarrow B)(a,b) = \min\{1,\ 1 + B(b) - A(a)\}$

(d) $(A \Rightarrow B)(a,b) = \max\{\min\{A(a),\ B(b)\},\ 1 - A(a)\}$

(e) $(A \Rightarrow B)(a,b) = \max\{1 - A(a),\ B(b)\}$

(f) Goguen's formula : $(A \Rightarrow B)(a,b) = \begin{cases} 1, & A(a) \le B(b) \\ \dfrac{B(b)}{A(a)}, & A(a) \ge B(b) \end{cases}$

Remarks 4.1.

1. Different formulas give different resulting values, which imply different degrees of inference based on different logical systems, but not the validness of the answers.

2. Formulas (a) and (b) are very simple to use, but they are the same as the logical AND operation $\wedge$.

3. The most common one in applications is formula (c)

4. For the following general fuzzy IF-THEN rule,

   "IF a_1 is A_1 AND ... AND a_n is A_n THEN b is B"

   we first evaluate the condition part by either

   $A(a_1, \ldots, a_n) = \min\{A_1(a_1), \ldots, A_n(a_n)\}$ or

   $A(a_1, \ldots, a_n) = A_1(a_1) \ldots A_n(a_n)$

   and then evaluate

   $$\begin{aligned} A(a_1, \ldots, a_n) \Rightarrow B(b) &= (A \Rightarrow B)(a_1, \ldots, a_n, b) \\ &= \min\{1,\ 1 + B(b) - A(a_1, \ldots, a_n)\} \end{aligned}$$

Chapter 5

Applications

5.1 Air Conditioner Controller

The system comprises a dial to control the flow of hot or cold air and thermometer to measure the room temperature ($T°C$). When the dial is turned positive, warm/hot air is supplied from the air conditioner and if it is turned negative, cool/cold air is supplied. If set to zero, no air is supplied.

A person now noticed the difference in temperature ($\Delta T°C$) between the room temperature ($T°C$) as measured by the thermometer and the desired temperature ($T_0°C$) at which the room is desired to be kept (set-point). The problem now is to determine to what extent the dial should be turned so that the appropriate supply of air (hot/warm/cool/cold) will nullify the change in temperature.

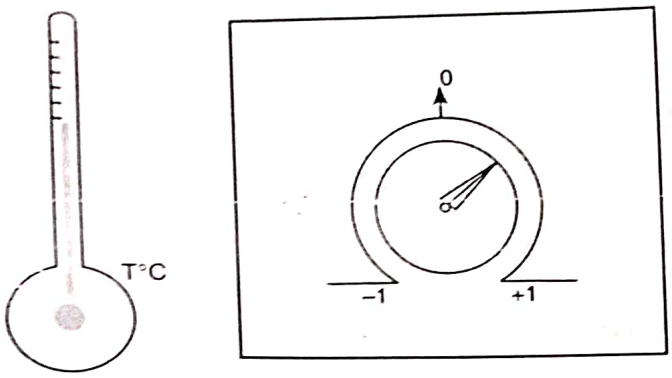
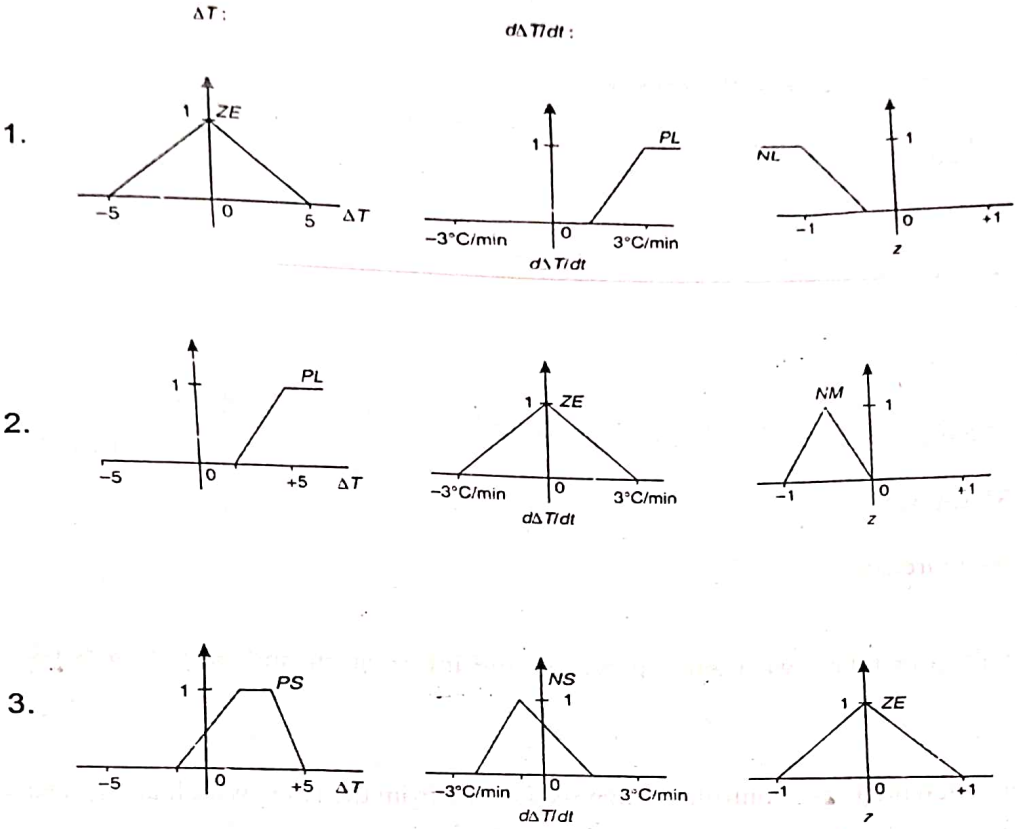


FIGURE 5.1: Air conditioner control system

Sr. No.	Fuzzy rule(descriptive)	Fuzzy rule(Notational)
1	If the room temperature is approximately equal to the set point $T_0^\circ C$. $\Delta T^\circ C$ is approximately zero(ZE) and the temperature is rapidly changing higher. i.e., $\frac{d\Delta T}{dt}$ is positively large (PL) then blow cold air rapidly. i.e., turn the dial negative large(NL).	If ΔT is ZE and $\frac{d\Delta T}{dt}$ is PL then dial should be NL.
2	If the room temperature is approximately equal to the set point $T_0^\circ C$. $\Delta T^\circ C$ is approximately zero(ZE) and the temperature is rapidly changing higher. i.e., $\frac{d\Delta T}{dt}$ is positively large (PL) then blow cold air rapidly. i.e., turn the dial negative large(NL).	If ΔT is ZE and $\frac{d\Delta T}{dt}$ is PL then dial should be NL.
3	If the room temperature is approximately equal to the set point $T_0^\circ C$. $\Delta T^\circ C$ is approximately zero(ZE) and the temperature is rapidly changing higher. i.e., $\frac{d\Delta T}{dt}$ is positively large (PL) then blow cold air rapidly, i.e., turn the dial negative large(NL).	If ΔT is ZE and $\frac{d\Delta T}{dt}$ is PL then dial should be NL.



5.2 Washing Machine Controller

Washing machines are a common feature today in the Indian household. The most important utility a customer can derive from a washing machine is that he saves the effort he/she had to put in brushing, agitating and washing the cloth.

When one uses a washing machine, the person generally select the length of wash time based on the amount of clothes he/she wish to wash and the type and degree of dirt cloths have. To automate this process, we use sensors to detect these parameters (i.e. volume of clothes, degree and type of dirt). The sensor system provides external input signals into the machine from which decisions can be made.

The two inputs are:

1. Degree of dirt (Dirtiness of clothes)
   (a) Large
   (b) Medium
   (c) Small
2. Type of dirt
   (a) Greasy
   (b) Medium
   (c) Non Greasy

The fuzzy controller takes two inputs, processes the information and outputs a wash time.

The decision which the fuzzy controller makes is derived from the rules which are stored in the database. Basically the rules are if-then statements that are intuitive and easy to understand, since they are nothing but common English statements.

1. If dirtiness of clothes is *Large* and type of dirt is *Greasy* then wash time is *Very-Long*.
2. If dirtiness of clothes is *Medium* and type of dirt is *Greasy* then wash time is *Long*.
3. If dirtiness of clothes is *Small* and type of dirt is *Greasy* then wash time is *Long*.
4. If dirtiness of clothes is *Large* and type of dirt is *Medium* then wash time is *Long*.
5. If dirtiness of clothes is *Medium* and type of dirt is *Medium* then wash time is *Medium*.
6. If dirtiness of clothes is *Small* and type of dirt is *Medium* then wash time is *Medium*.

7. If dirtiness of clothes is *Large* and type of dirt is *NotGreasy* then wash time is *Medium*.

8. If dirtiness of clothes is *Medium* and type of dirt is *NotGreasy* then wash time is *Short*.

9. If dirtiness of clothes is *Small* and type of dirt is *NotGreasy* then wash time is *VeryShort*.

By the use of fuzzy logic control we have been able to obtain a wash time for different type of dirt and different degree of dirt.

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Exploration of Metal Toxicity Resistance Actinobacteria

A Dissertation Report submitted

for the partial fulfilment of the Degree of Master of Science

By

Chhatrala Vishwa Prafulbhai

[M.Sc. Microbiology, IV Semester]

Under the supervision of

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CERTIFICATE

This is to certify that this dissertation work entitled "**Exploration of Metal Toxicity Resistance Actinobacteria**" was successfully carried out by **Chhatrala Vishwa P.** towards the partial fulfilment of requirements for the degree of Master of Science in Microbiology of Atmiya University Rajkot. It is an authentic record of her own work, carried out by her under the guidance of **Dr. Mousumi Das** during the academic year of 2021-22 The content of this report, in full or in parts, has not been submitted for the award of any other degree or certificate in this or any other University.

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31/21/2022

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DECLARATION

I hereby declare that the work incorporated in the present dissertation report entitled "Exploration of metal toxicity resistance Actinobacteria" is my own work and is original.

This work (in part or in full) has not been submitted to any University for the award of a any Degree or a Diploma.

Vishwa...

Chhatrala Vishwa P.

Date:- 30/03/2022

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ABSTRACT:-

In environment heavy metal contamination increase due to various agricultural activity and rapid industrialization . Actinobacteria can employ the mechanisms of tolerance and detoxification of heavy metals, produce chelating agents that bound metals and reduce their toxicity. This study is an attempt to explore the potent zinc and copper resistance actinomycetes to reduce soluble zinc and copper levels to enhance degradation. An efficient screening study had been exploited by various media combination and plate, as well as broth assay to identify the metal tolerance potency with Zinc and copper heavy metals at its different concentrations. All 3 potent strains of actinomycetes were found to be promising with respect to its satisfactory result of metal tolerance in broth and plate culture. Preliminary identification had turned out to represent the strain tentatively as streptomyces and non-streptomyces genera.

Keywords:-Metal tolerance, Actinomycetes, Duxbury agar, Zinc dust, Cupric sulphate.

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INTRODUCTION:

Pollution of heavy metal is one of the most important environmental problem, and it's spread through increased anthropogenic activity, modern practices especially the most important if heavy metals exist at high concentrations(Soraia et al., 2015)(Singh et al., 2016). Heavy metals have more than 5 g/cm^3 specific density and it's majorly affect living organism and surroundings (Singh et al., 2014). Heavy metal has an adverse effect on the human body, causing major health issues(Jaishankar et al., 2014). Soil has become more contaminated as a result of anthropogenic activity, and this has a direct impact on plants, food chains, and human health(Chibuike & Obiora, 2014). Actinobacteria have high G+C content and it's a Gram-positive bacteria. Actinobacteria widely present in terrestrial and aquatic ecosystem where it's recycle or transform organic and inorganic substances (Anandan *et.al.*,2016) Bioremediation is a technique in which organisms can remove toxins from the soil and change them from a hazardous to a non-toxic state (Kapahi *et.al.*,2019). Soil sample collected at Veraval coastal region Gujarat. Heavy metal tolerance actinobacterial work currently being performed is yet not done at Veraval costal region. Aim of my work deals with the isolation and screening of heavy metals resistant actinobacteria, their potential capacity to accumulate heavy metals, and both morphological and molecular characterization of resistant and accumulating isolated strains.

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MATERIALS & METHODS:-

3.1 Collection of Soil Sample:-

For systematic screening for isolation of Actinobacteria Veraval costal region, Gujarat soil sample collected from top 6 cm soil profile where maximum microbial activity is observed. Around 200g of soil sample were collected using sterile spatula and sterile polythene bag. Soil sample were stored at -20°C until pre-treatment was given(Arifuzzaman et al., 2010).

3.1.1. Pre-treatment of Soil Sample:-

Pre-treatment of soil to revive actinomycetes isolates by either removing most undesirable bacteria or stimulating actinomycetes growth. Actinomycetes spores are more resistant to evaporation than Gram negative bacteria, hence dry heat at 120°C for 1 hour is recommended(Shivabai & Gutte, 2019).

3.2 Isolation and identification of soil Actinomycetes:-

1 gram of pretreated soil sample were suspended in 10 ml of N-saline and mix properly and make a serial dilution up to 10^{-5}. Spread on 0.1ml aliquots on starch casein agar plate. Plates were incubated at 30°C for 7 days.(Kuster and Williams,1964; Sridevi et al., 2018)

The isolated colonies were identified based on it's morphological characters and microscopic overview of structural details.(Shirling and Gottlieb,1966;Gram,1884). Collected isolates naming according to first initial of author names and place name respectively in sequential manner.

3.3 Primary Screening of metal tolerant Actinomycetes by plate assay method:-

In primary screening heavy metal Zinc and Cupric sulphate stock solution was prepared at different ppm concentrations 100ppm, 200ppm, 300ppm, 400ppm, 500ppm, 600ppm respectively with an increment of 100.

Actinobacteria isolated from Veraval, Gujarat soil sample was assessed against Zn and $CuSO_4$ metals in duplicate with different concentrations as stated earlier (Soraia et al., 2015). Plates were incubated at 35°C for 7-days.

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3.4 Secondary Screening of metal tolerant Actinobacteria by broth assay method:-

In secondary screening Duxbury broth was prepared and added 20µl heavy metal stock solutions employing selected actinobacterial colony and turbidity was checked at 540nm for 7 days with the help of Spectrophotometer (BioEra). Positive result in terms of turbidity checking and comparison was done.(Singh et.al.,2014)

3.5 Morphological characterization selected isolates:-

Followed by Gram staining for preliminary characterization ,capsule and endospore staining was also performed for further revealing morphological characteristics of the selected actinobacterial isolates.(Hughes *et.al*,2007)

3.6 Biochemical Characterization of selected isolates:-

Myriad biochemical tests were performed by standard procedure. Such as, catalase activity (3% hydrogen peroxide), carbon utilization property, citrate utilization activity, starch hydrolysis, gelatin hydrolysis respectively. In carbon utilization test, Andrade peptone water containing 0.1% Andrade indicator add incubate at 35°C. Determination of citrate utilization was observed by change in colour of media(Malviya et al., 2013). Determination of gelatine hydrolysis was observed by colour change in medium.(Qinyuan *et.al*.,2016)

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RESULTS & DISCUSSIONS :

4.1 Collected soil sample & it's properties:-

Only 1 soil sample was collected and the following Table 1 represents the important soil characteristics for further studies to be carried out. The collected soil found to be recorded pH 7.0 ,the colour of the soil is blackish brown and its moist in nature ,

Location	pH	Colour	Consistency
Veraval coastal region, Gujarat	7	Blackish brown	Moist

There are many reports on soil actinobacteria and its standard isolation tech from various hereby metal leached sites. As per the data of Alghnmi et.al.(2015) collected heavy metal contaminated soil sample from Saudi Arabia , measured pH and soil conductivity. There are also reports on actinobacteria isolated form Veraval coast , Gujarat region and its work about protease enzyme producing actinobacterial morphological, cultural & microscopic characters check & screening of extracellular protease enzyme activity(Majithiya et.al.,2020).

4.2. Isolated Actinomycetes & it's features:-

A total no. of 10 actinobacterial isolates is obtained on starch casein agar medium. Selected isolates are found to be Gram positive, branched filament, the spore is oval in shape having singly or short-long chain arrangement. Tentatively the selected isolates were streptomyces and non-streptomyces based on preliminary identification. The following Fig. 1 had shown 10 number of actinobacterial colonies and its properties are represented in Table 2.

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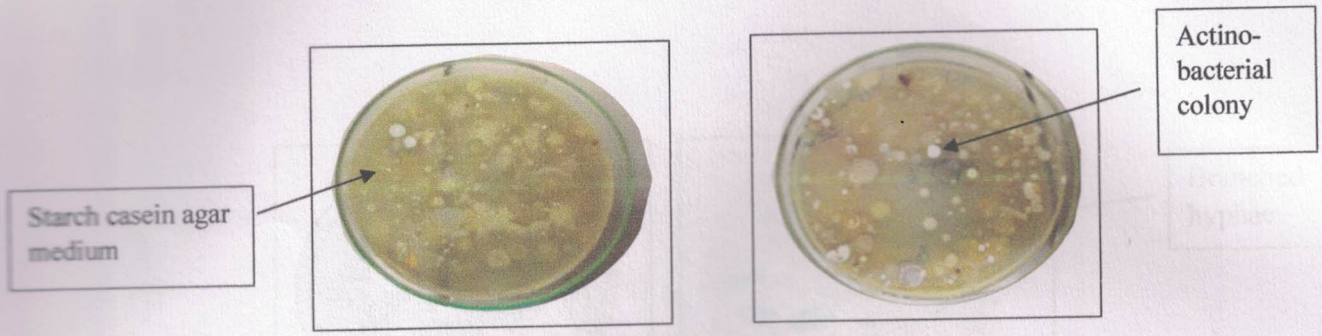

Fig 1. Isolated colonies from serial dilution plates of Starch Casein Agar

Table 2. Properties of the colonies isolated from Veraval coastal region, Gujarat.

Colony Name	Colony Characteristic Features							
	Size	Shape	Colour	Margin	Texture	Elevation	Opacity	Gram Staining Property
ACMV1	Small	Circular	White	Entire	Powdery	Raised	Opaque	Gram positive
ACMV2	Medium	Circular	White	Entire	Powdery	Raised	Opaque	Gram positive
ACMV3	Small	Circular	White	Entire	Powdery	Raised	Opaque	Gram positive
ACMV4	Small	Circular	Cream	Entire	Powdery	Raised	Opaque	Gram positive
ACMV5	Medium	Circular	Grey	Entire	Powdery	Raised	Opaque	Gram positive
ACMV6	Small	Circular	White	Entire	Powdery	Raised	Opaque	Gram positive
ACMV7	Small	Circular	White	Entire	Powdery	Raised	Opaque	Gram positive
ACMV8	Small	Circular	Cream	Entire	Powdery	Raised	Opaque	Gram positive
ACMV9	Small	Circular	White	Entire	Powdery	Raised	Opaque	Gram positive
ACMV10	Small	Circular	White	Entire	Powdery	Raised	Opaque	Gram positive

From Table 2 the diversity of actinobacterial colonies are observed as, size range from small to medium, shape is circular, grey, white, creamish , with even margin, dry texture, raised, opaque and Gram positive in nature with (Fig 2) branched or unbranched properties.

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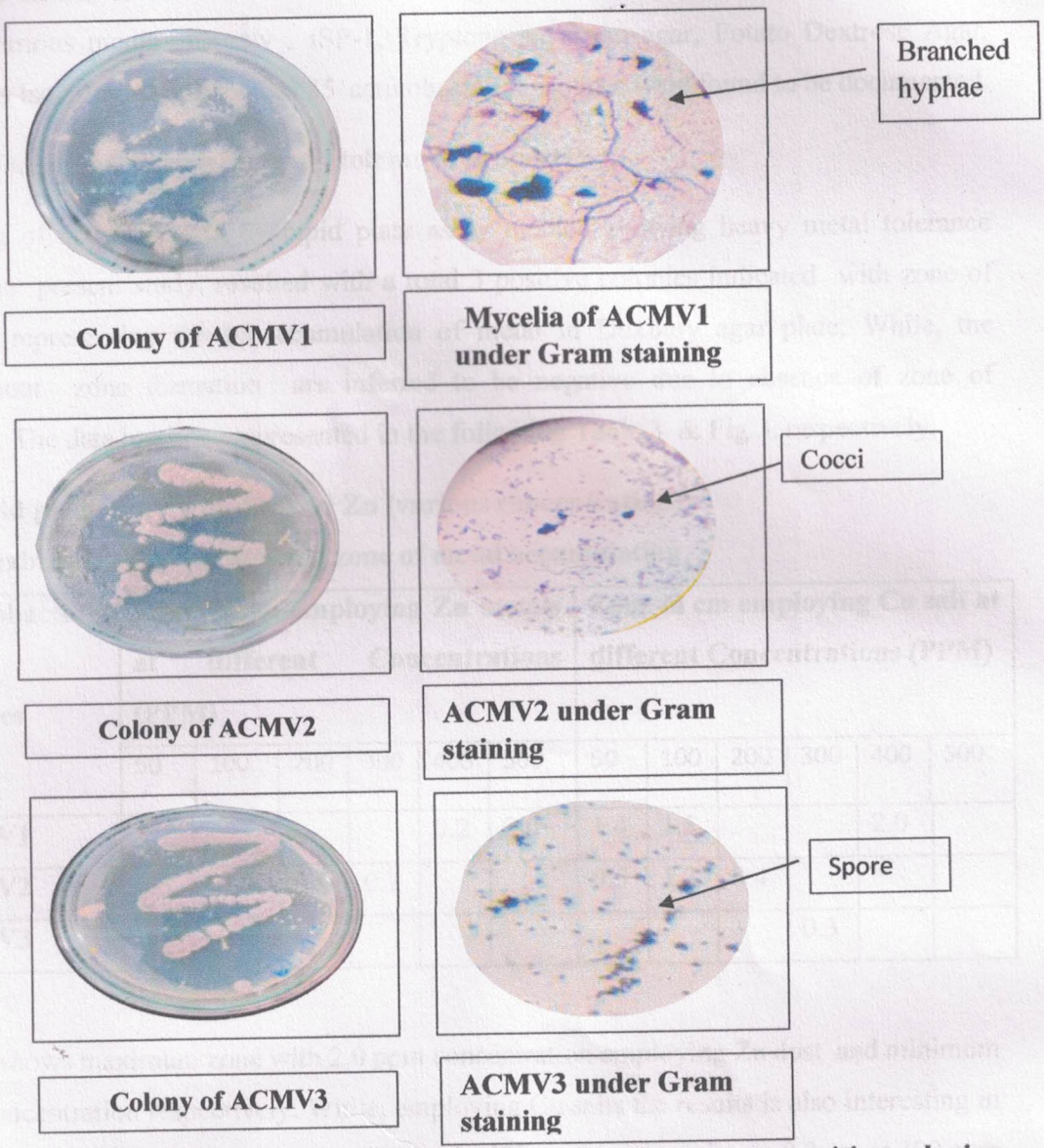

Fig 2. Colony characteristics and Gram staining properties of the potent positive colonies having property of metal tolerance

A good number of research reports are found to be recorded with similar type of data. As per the report of Sheik et.al.(2017), using actinomycetes isolation agar medium 7 potent isolates were recorded. As per the reported data of, Sayed et.al.(2011), using starch -nitrate agar, malt extraction agar ,inorganic salt-yeast extract agar and Glycerol- L-asparagine agar medium a good number of Streptomyces strains from agricultural soil found to be isolated. As per the documentation of Baz

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et.al.(2014), isolation of actinomycetes carried out employing the Bennett's medium with 59 actinobacterial strains as an outcome. While, in the research data of Malaviya et.al.(2012), employing various media namely , ISP-1, Tryptone soyabean agar, Potato Dextrose Agar, Actinomycetes Isolation Agar a total of 35 actinobacterial isolates were found to be documented.

4.3. Screened actinobacteria with metal tolerance property:-

The screening of actinobacteria by rapid plate assay method showing heavy metal tolerance property in the present study, resulted with a total 3 positive colonies indicated with zone of accumulation representing the bioaccumulation of metal in Duxbury agar plate. While, the colonies without zone formation are inferred to be negative due to absence of zone of accumulation. The data has been represented in the following Table 3 & Fig 3. respectively.

Table 3. Rapid plate assay with Cu and Zn (various concentrations) in Duxbury agar plate showing zone of metal accumulation

Sr. No.	Actinobacterial colonies	Zone in cm employing Zn metals at different Concentrations (PPM)						Zone in cm employing Cu salt at different Concentrations (PPM)					
		50	100	200	300	400	500	50	100	200	300	400	500
1	ACMV1					0.2	2.0	1.4	1.5			2.0	
2	ACMV2	0.3	0.9	0.6	0.7			0.5	1.3	0.4			
3	ACMV3										0.3		

The Table 3. shows maximum zone with 2.0 ppm concentration employing Zn dust and minimum at 0.2 ppm concentration respectively. While, employing Cu salts the results is also interesting in terms of zones (cm) observed maximum as 2.0 cm in 400 ppm , and minimum 0.3 cm at 300 ppm concentrations respectively.

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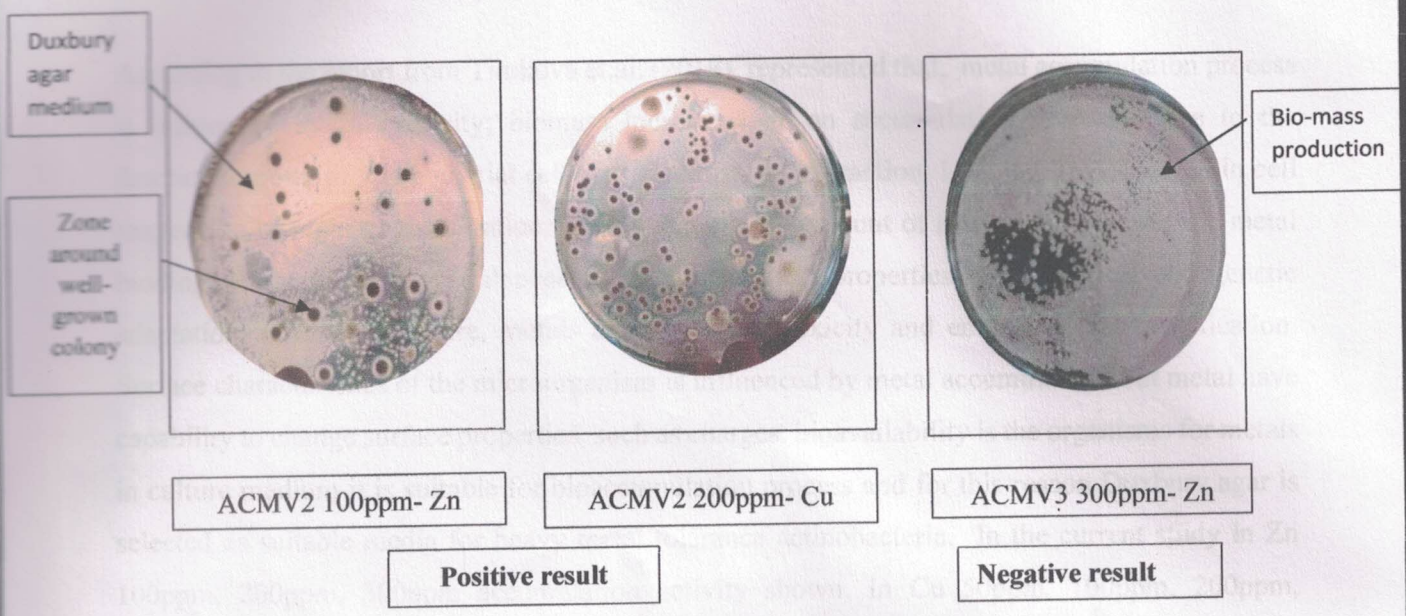

Fig 3. Representative Duxbury Agar plate showing zone of accumulation with Zn and $CuSO_4$ salts.

Table 4: Morphological characterization for potent heavy metal tolerance colonies.

	ACMV1	ACMV2	ACMV3
Size	Small	Small	Medium to small
Shape	Circular	Circular	Circular
Colour	Grey	Cream	White
Margin	Entire	Entire	Entire
Texture	Powdery	Powdery	Powdery
Elevation	Raised	Flat	Raised
Opacity	Opaque	Opaque	Opaque
Gram's Nature	Positive	Positive	Positive

As per the data of Baz et.al. (2014), if zone appear around well grown colony it is showing accumulation action and if absence of zone around colony it indicating no accumulation activity.

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According to the report from Timkova et.al. (2018), represented that, metal accumulation process is influenced by cell density; biomass increase with an accumulation decreases due to the functional group of the bacterial cell wall electrostatic interaction. Linkage was observed in cell suspension of higher concentration, while reducing the amount of active sites showed the metal binding. Bioaccumulation is dependent on biochemical properties, physiological and genetic adaptation, intrinsic structure, metals avalibility and toxicity and environmental modification. Surface characteristics of the microorganism is influenced by metal accumulation, but metal have capability to change surface properties, such as charges. bioavailability is the organisms for metals in culture medium it is suitable for bioaccumulation process and for this reason Duxbury agar is selected as suitable media for heavy metal tolerance actinobacteria. In the current study in Zn 100ppm, 200ppm, 300ppm accumulation activity shown. In Cu 50ppm, 100ppm, 200ppm, 300ppm, 400ppm accumulation activity shown.

Heavy metal tolerant actinobacteria and its influence on agriculture to promote plant growth and combatting metal stresses in soil is not a new avenue of research but the physiological challenges of desirable strains often restricts to find luxuriously a good number of isolates from the respective soil sampling sites. In the present study, an attempt of exploring heavy metal (Zn and Cu) tolerant potent actinomycetes strains from Veraval coastal region of Gujarat site was found to be satisfactory employing Duxbury agar medium. Incorporation of the Minimal and Duxbury media for this exploration has revealed an interesting fact of influential role of media components. Employing a lucid technique of plate assay method the positive actinobacterial colonies has indicated the principle of bioaccumulation. This property justify the presence of heavy metal tolerance feature in thew desired strains. While, the colonies without any zone of heavy metal accumulation are considered to be negative and indicates only the property of biomass production due to linkage of functional groups in bacterial cell resulting from electrostatic interactions. Due to more diffusivity the growth was observed in more in Duxbury agar plate and less growth was observed in Duxbury broth. According to observation, I can conclude that potent isolates had capacity to tolerate heavy metal concentration.

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4.4.Quantitative analysis of Heavy metal tolerance:-

The quantitative analysis of actinobacteria by broth assay method showing heavy metal tolerance property in the present study, resulted with increase turbidity and colour change of Duxbury broth with time, but decrease O.D. after 72 hours.

Table 5: Broth diffusion study for accessing heavy metal tolerance potent isolates of Actinobacteria.

Growth at different concentration of Zn					
Hours of incubation period	**100ppm ACMV1**	**100ppm ACMV2**	**100ppm ACMV3**	**200ppm ACMV1**	**200ppm ACMV2**
0 hours	0.24	0.202	0.083	0.03	0.048
24 hours	0.195	0.313	0.409	0.442	0.347
48 hours	0.766	0.816	0.356	0.430	0.524
72 hours	0.897	0.841	0.462	0.572	0.934
96 hours	0.751	0.763	0.535	0.590	0.575

Growth at different concentration of Cu						
Hours of incubation period	**50ppm ACMV1**	**100ppm ACMV1**	**100ppm ACMV2**	**200ppm ACMV2**	**200ppm ACMV1**	**300ppm ACMV1**
0 hours	0.061	0.068	0.207	0.028	0.193	0.191
24 hours	0.445	0.355	0.491	0.222	0.366	0.333
48 hours	2.973	0.679	4.00	2.240	0.496	0.375
72 hours	1.192	0.837	1.422	1.480	1.07	0.736
96 hours	0.874	0.660	1.183	1.231	0.640	0.564

As per the report of Singh et.al.(2014) 500µl Cu, Zn, Pb metal salt solution added on Starch casein medium if the solution get turbid it shows resistant toward heavy metal and if the solution get not

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turbid it shows sensitive to the heavy metal. As per the data of Lakshmipathy et.al.(2010) metal salt solution added on ISP-1 medium if solution get turbid it indicates that resistance towards heavy and if not turbid that indicate sensitive to the heavy metal. In current work 0 to 72 hours O.D. increase but after 72 hours O.D. decrease. Due to more diffusivity the less growth was observed in Duxbury broth as compare to Duxbury agar plate.

4.5.Morphological & Biochemical identification of Heavy metal resistance Actinomycetes.

Heavy metal resistance actinomycetes potent colonies shows non endo-spore former and non-capsulated. Heavy metal resistance actinomycetes potent colonies in myriad metal treated Duxbury plate properties shows table-6.

Table-6: Colony characterization of selected actinobacterial isolates showing heavy metal tolerance property.

Various parameters of Colony characteristics	Properties of Potent colonies in myriad metal treated Duxbury plate	
	treatment with Zn dust	treatment with CuSO4
Size	Large	Medium
Shape	Circular	Circular
Colour	Grey, Cream	Grey
Margin	Entire	Entire
Texture	Powdery	Powdery
Elevation	Raised	Raised
Opacity	Opaque	Opaque
Gram's Nature	Positive	Positive

In Carbon utilization test ACMV1 strain utilized less carbon, ACMV2 strain maltose, starch, glucose, trehalose sugars utilized more carbon and convert to light orange to dark pink colour, ACMV3 strain lactose, starch , glucose, fructose, trehalose sugars utilized more carbon and give a colour change. All biochemical result shown in above figure and table -7,

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Table-7: Result of Carbon utilization test of potent Actinomycetes

Name of the sugars	ACMV1	ACMV2	ACMV3
Cellulose	-	-	-
Adonitol	-	-	-
Maltose	+	+++	++
Raffinose	-	+	+
Xylose	+	+	++
Lactose	+	-	+++
Cellobiose	-	-	-
Starch	-	+++	+++
Sucrose	+	++	++
Galactose	+	+	+
Dextran	-	++	+
Glucose	+	+++	+++
Fructose	+	+	+++
Mannitol	+	+	-
Trehalose	-	+++	+++

Note:- +++=More positive (Dark pink), ++=Moderate positive(Pink), +=Less positive(Light pink), - =Negative

Other biochemical tests like Gelatine hydrolysis test ACMV1 & ACMV2 strain give positive result and shows melanin production, but ACMV3 strain gives negative result. In starch hydrolysis test, catalase and citrate utilization test give positive result for all 3 potent strains.

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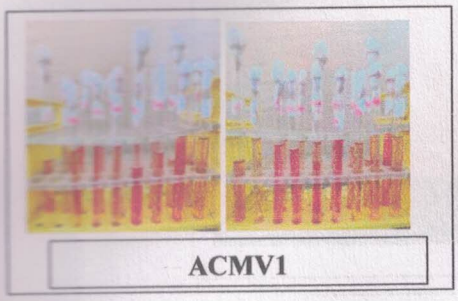
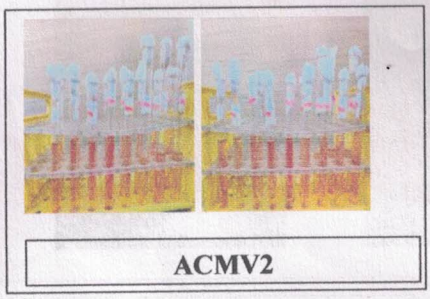
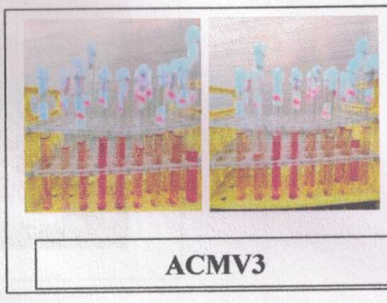


ACMV1

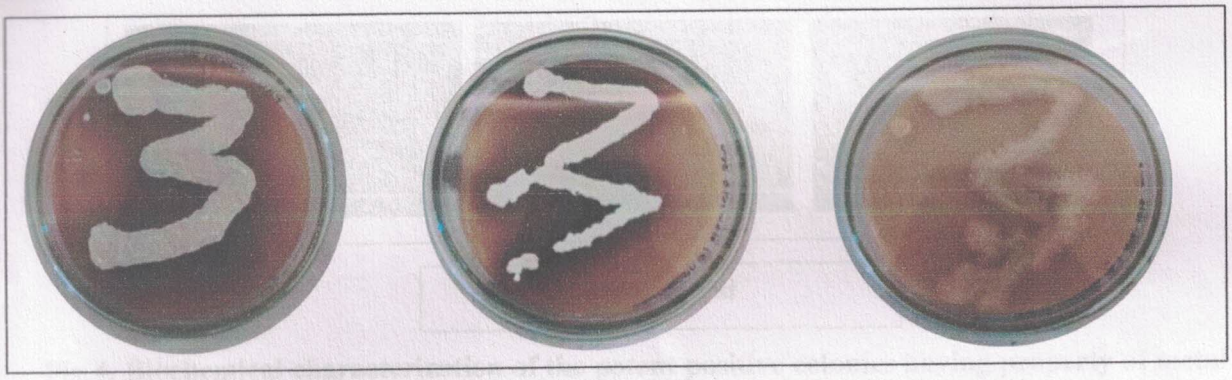


ACMV2



ACMV3

Carbon utilization test



Gelatin hydrolysis

Starch hydrolysis

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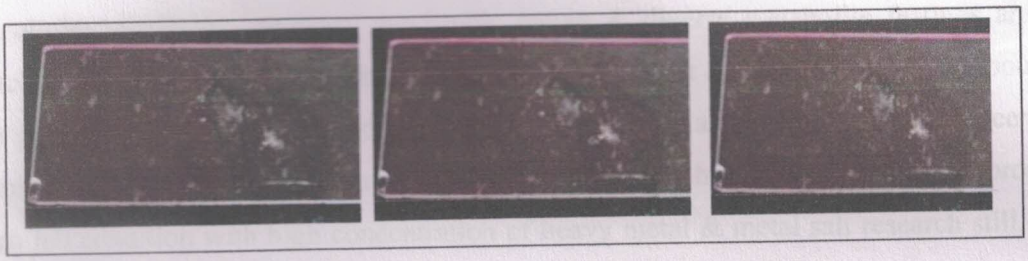
Citrate utilization



Catalase test

Fig 4. Biochemical characterization of the potent positive colonies having property of metal tolerance.

A good number of research reports are found to be recorded with similar type of data. As per the data of Cimermanova et.al.(2021) performed biochemical test for it's 9 isolates and observed low cellulose production, only 1 isolate positive for starch hydrolysis, and observed positive result for amylase production. As per the report of Malaviya et.al.(2012) it observed from 11 isolates, 4 hydrolysed starch, 8 hydrolysed lipid & gelatin, 6 hydrolysed casein, all positive for catalase and isolates utilized arabinose, fructose, galactose, maltose, lactose, trehalose, sucrose, and mannitol.

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CONCLUSIONS:-

In the present study, the bioaccumulation principle very nicely observed employing heavy metal & salts of Zn & Cu respectively. The recent research work has also found to be satisfactory at preliminary level, exploiting Veraval coastal region, Gujarat, actinobacterial isolates ACMV1, ACMV2, ACMV3 tentatively identified as Nocardia sp. Rhodococcus sp. Streptomyces sp. For showing the property of heavy metal tolerance. We are all aware actinobacteria due to them extracellular enzymatic property syntrophic nature & diverse metabolite features are highly adaptable in complex & harsh habitat, like polluted soils with metal and organic compound. The same property has been exploited the further study, with a short attempt to screen potent actinobacterial isolates from Veraval soil sample showing heavy metal tolerance property in invitro lab condition with high concentration pf heavy metal & metal salt research still, a better avenue of research is there, to further explore the bioaccumulation property of the potent isolates ACMV1, ACMV2, ACMV3 in field study, pot culture study employing metal polluted soil sample. Even enumeration of other metals & their interaction can also be studied in the same line of work with advanced protocol.

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ROAD ACCIDENTANALYSIS AND PREDICTION MODEL : A CASE STUDY OF RAJKOT CITY

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A Thesis Submitted to

ATMIYA UNIVERSITY

in Partial Fulfillment of the Requirements for

The Degree of Master of Technology in [Civil – Transportation Engineering]

Month and Year

May 2022

Civil Engineering Department,

Faculty of Engineering & Technology

ATMIYA UNIVERSITY

Yogidham Gurukul, Kalawad Road, Rajkot

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CERTIFICATE

It is certified that the work contained in this dissertation thesis entitled '**ROAD ACCIDENT ANALYSIS AND PREDICTION MODEL : A CASE STUDY OF RAJKOT CITY**' submitted by **MR. CHAUHAN TUSHAR LAXMANBHAI**, **200041003** studying at Civil Engineering Department, Faculty of Engineering & Technology, for the award of M.Tech (Civil Engineering –Transportation Engineering) is absolutely based on his own work carried out under my supervision and that this work/thesis has not been submitted elsewhere for any degree/diploma.

Date: 28/5/2022

Place: CED/AU/RAJKOT

Mayursinh B Jadeja

Signature and Name of internal supervisor

Signature and Name Head of Department

Signature and Name of Head of Institute

Atmiya University Rajkot

COMPLIANCE CERTIFICATE

It is certified that the work contained in this dissertation thesis entitled '**ROAD ACCIDENT ANALYSIS AND PREDICTION MODEL : A CASE STUDY OF RAJKOT CITY**' submitted by **MR. CHAUHAN TUSHAR LAXMANBHAI**, **200041003** studying at Civil Engineering Department, Faculty of Engineering & Technology for partial fulfillment of M.Tech degree to be awarded by ATMIYA University. He has complied the comments of the Dissertation Progress Review-I, Dissertation Part-I as well as Dissertation Progress Review-II with my satisfaction.

Date: 28/5/2022

Place: CED/AU/RAJKOT

Tushar L Chauhan — Signature and Name of Student Signature

Mayursinh B Jadeja — Signature and Name of Internal supervisor

PAPER PUBLICATION CERTIFICATE

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Date: 28/5/2022

Place: CED/AU/RAJKOT

Tushar L Chauhan — Signature and Name of Student Signature

Mayursinh B Jadeja — Signature and Name of Internal supervisor

THESIS APPROVAL CERTIFICATE

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Date: 28/5/2022

Place: CED/AU/RAJKOT

External Examiners' Sign and Name:

1) JAY KIRIT KALARIA

2) _____

Dedicated to,

For every success of my life, for

Being worm and caring, great

Enthusiasm, Inspiration, Support &

Love is Heart of my Achievement.

Thank you.

My Mom, Dad &

My beloved Friends

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Research brings about dramatic changes in the traditional lookout of science & technology. It has widened our vision, opened newer avenues and lightened the dark obscure facts of mysterious universe. Behind every success there are lot many efforts, but efforts are fruitful due to hands making the passage smoother. I express my deep sense of gratitude for hands, people extended to me during my work.

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Place: Atmiya University, Rajkot

- Tushar L Chauhan

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TABLE OF CONTENT

Certificate	**I**
Compliance Certificate	**II**
Paper Publication Certificate	**III**
Thesis Approval Certificate	**IV**
Acknowledgment	**VI**
Table of Content	**VII**
List of Tables	**X**
List of Figures	**XI**
Abstract	**XII**

CHAPTER:1 INTRODUCTION

1.1 Introduction	1
1.2 Need of study	1
1.3 Problem identification	1
1.4 Objective of study	2
1.5 Scope of study	2
1.6 Causes of road accident	2
1.7 Types of injures	3
1.8 Types of collision	3

CHAPTER:2 LITERATURE REVIEW

2.1 Literature Review	4
2.2 Research Work	

CHAPTER:3 STUDY AREA & METHODOLOGY CHART

3.1 Study area	8
3.2 Methodology chart	9

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Rajkot

CHAPTER:4 DATA COLLECTION

4.1 Road Inventory Survey 10

4.2 Traffic Volume Survey 12

4.3 Spot Speed Survey 49

CHAPTER:5 ACCIDENT DATA ANALYSIS

5.1 Fatality rate based on total accident 92

5.2 The accident analysis as per types of injuries 93

5.3 The accident analysis as per months 94

5.4 The accident analysis as per time 100

5.5 The accident analysis as per location wise 106

5.6 The accident analysis as per types of vehicle use 111

5.7 The accident analysis as per drivers age 117

5.8 The accident analysis as per drivers sex wise distribution 122

CHAPTER:6 ACCIDENT PREDICTION MODEL

6.1 Devlopment of prediction model based on driver age group 124

6.2 Devlopment of prediction model based traffic volume (PCU) 125

CHAPTER:7 CONCLUTION 128

CHAPTER:8 IMPORTANT WAYS TO AVOID ACCIDENTS 129

CHAPTER:9 REFRENCES

ARTICLES 130

IRC- CODES 130

WEBSITES 131

ANNEXURE 1 **132**
ANNEXURE 2 **133**
ANNEXURE 3 **134**
ANNEXURE 4 **135**
ANNEXURE 5 **136**
ANNEXURE 6 **137**
ANNEXURE 7 **138**
ANNEXURE 8 **139**
ANNEXURE 9 **140**

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LIST OF TABLES

Table No.	Title	Page No.
Table 1.1.1	Population Of Rajkot city	1
Table 1.1.2	Number of Accident year 2017 to 2021	1
Table 2.1	Literature review	7
Table 4.1	Road Inventory Survey	10
Table 4.2	Traffic Volume Survey	13-48
Table 4.3	Spot Speed Survey	54-89
Table 5.1.1	Fatality Rate Based On Total Accident	92
Table 5.2.1	The Accident Data Analysis as per Types of injuries	93
Table 5.3	The Accident Data Analysis as per Months	93-97
Table 5.4	The Accident Data Analysis as per Time	101-102
Table 5.5	The Accident Data Analysis as per Location wise	106-108
Table 5.6	The Accident Data Analysis as per Types Of Vehicles Use	112-113
Table 5.7	The Accident Data Analysis as per Drivers Age	117-118
Table 5.8.1	The Accident Data Analysis as per Driver Sex Wise Distribution	122
Table 6.1.1	Devlopment Of Prediction Model Based On Driver Age Group	124
Table 6.1.2	Results And Validation Of Liner Regression Model 1 Based on Driver Age Group	125
Table 6.2.1	Devlopment Of Prediction Model Based On Traffic Volume (PCU)	126
Table 6.2.2	Results And Validation Of Liner Regression Model 2 Based on Traffic Volume (PCU)	127

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Rajkot

LIST OF FIGURES

Fig. No.	Title	Page No.
Fig. 3.1.1	Study Area	8
Fig. 4.1.2	Road Inventory Survey	11
Fig. 4.2.1	Traffic Volume Survey	12
Fig. 4.3	Spot Speed Survey	49-53
Fig.5	Accident Data Year From 2017 to 2021	90-91
Fig.5.1.2	Fatality Rate Based On Total Accident	93
Fig.5.2.2	The Accident Data Analysis as per Types of injuries	94
Fig.5.3	The Accident Data Analysis as per Months	98-100
Fig.5.4	The Accident Data Analysis as per Time	103-105
Fig.5.5	The Accident Data Analysis as per Location wise	108-111
Fig.5.6	The Accident Data Analysis as per Types Of Vehicles Use	114-116
Fig.5.7	The Accident Data Analysis as per Drivers Age	119-122
Fig.5.8.2	The Accident Data Analysis as per Driver Sex Wise Distribution	123

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“Road accident analysis and prediction model : A case study Rajkot city”

By

200041003

Mr. Tushar L Chauhan

Atmiya University

ABSTRACT

The main aim of this paper is analyze and study of road traffic accident data. In this paper traffic volume survey and spot speed survey are carried out. The road traffic accident analyzed according to types of injuries, drivers age group , gender wise distribution, months , day and night time, location wise and types of vehicles.

The road accident data analysed in varies types of injuries like fatal , minore , not injured and serious. In fatal accident 2 wheelers are more involved than others.Accident data analyzed as per month, the most of accidents have been occurred in the month of January and June.Minimum or zero number of accident observed in the monsoon month in may and august.Also, accident data analyzed according time in this paper the maximum accident occurred in day time and less and minimum accident are reported in night time.

Further, accident data analyzed according to location wise the number of more accidents have been happened at kankot patiyu and kataria chokdi so observed it as black spot location. As per analyzed the accident data the age group 18 to 30 are more involved than others age group and gender wise distribution the males faces are more involved than female faces.

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To develop road accident prediction model each and every parameter related with the accident is considered and a micro level analysis of road accident is performed. After analysis road accident prediction models is developed based on different parameter like Driver age group and Traffic volume per 6hour (PCU). the models is validate through F test and Chi Square test.

KEYWORDS: Road Accident Analysis, traffic safety, Road Inventory Survey, traffic volume study, spot speed study

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CHAPTER-1 INTRODUCTION

1.1 Introduction

"Road Accident : An accident which occurred on a road open to public traffic resulting in either injury or loss of life, or damage to property, in which at least one moving vehicle was involved". total population of india is 138 crores . 1214 road crashes occur every day in india . two wheelers account for 25 % of total road crash deaths. 20% children under the age of 14 die every day due to road crashes in the india .

RAJKOT CITY	TOTAL	MALE	FEMALE
CITY POPULATION	1286678	674355	612323
CHILDREN	138052	75205	62847

Table No. 1.1.1

YEAR	NO. OF ACCIDENTS
2017	10
2018	13
2019	8
2020	7
2021	9

Table No. 1.1.2

Note : the number of accidents are show in table no 1.1.2 is within study area.

1.2 Need of Study

To identify total number of accidents.

To identify types of accidents.

1.3 Problem Identification

Datasets containing details about previous accident in various location is studied and analysed and model is developed which can be used to predict and prevent road accident .

1.4 Objectives of Study

To study the causes of road traffic accident .

To identify the black spot location.

1.5 Scope of Study

In this study determine accident analysis by traffic volume study and speed study only.

To identify black spot location.

1.6 Causes of Road Accidents

Drivers: Over-speeding, rash driving, violation of rules, failure to understand signs, alcohol.

Pedestrian: Carelessness.

Passengers: Projecting their body outside vehicle, catching a running bus.

Vehicles: Failure of brakes or steering, tyre burst, insufficient headlights, overloading.

Road Conditions: Potholes, damaged road.

Weather conditions : Fog , Snow , Heavy Rainfall , Wind Storms.

1.7 Types of Injuries

Fatal Accident : An accident in which one or more persons were killed.

Minor Injury Accidents : Accidents in which persons received only minor injuries and do not require hospitalization i.e. only first aid is needed.

Grievously Injured Person : A person who has received grievous injuries (in accident) such as fractures, concussions, internal lesions, crushing, severe cuts and lacerations, severe general shock requiring medical treatment and any other serious lesions requiring detention in hospital.

1.8 Types of Collision

VEHICLE ROLLOVER : These particular types of crashes are complex and violent in nature. More than any other type of crash, rollovers reflect the interaction of the driver, road, vehicle, and environmental factors. Although a vehicle's type has a significant role in the accident, so does driver behavior and road and environmental conditions. Other factors include speed, alcohol consumption, and location.

SINGLE CAR ACCIDENT : This is a type of road traffic accident in which only one vehicle is involved. A majority of these types of crashes are run-off-road collisions, collisions with fallen debris, rollovers, and collisions with animals.

REAR-END COLLISION : A traffic accident where a vehicle crashes into the vehicle in front of it. These are usually due to driver inattention or distraction, tailgating, panic stops, and reduced traction due to irregular road conditions caused by weather.

SIDE-IMPACT COLLISION : These accidents, also known as broadside or T-bone collisions, are where the side of one or more vehicles is impacted.

HEAD-ON COLLISION: This type of accident is when the front ends of two vehicles hit each other in opposite directions. Head-on collisions are often fatal road traffic accidents. Being aware of traffic signs, street conditions, and staying in your lane play a critical role in avoiding these types of accidents.

Multiple Vehicle Collision : Another highly vulnerable traffic accident is a multiple vehicle collision — which involves three or more vehicles in a chain of events from a single event.

CHAPTER-2 LITERATURE REVIEW

SR NO.	PAPER NAME	AUTHOR	YEAR	WORK DESCRIPTION	PUBLICATION
1	Road Traffic Accidents in India : Issues and Challenges	Sanjay kumar singh	2016	First he collected accident data from police station and from internet. they done accident analysis of accident data. Then they describes the accident data in graph by as per year , as per age , as per sex , month , and as per time wise. they analyse the accident scenario at state level and city level.	Elsevier , Science Direct
2	Mordern data sources and techniques for analysis and forecast of road accident : a review	Camilo gutierrez - osorio , cesar pedraza	2020	First they collected accident data from public and privet agencies . they enlist of road accident analysis method and shows classification algorithms . they represent the algorithms and methods used on road accident prediction and shows conclusions and future challenges .	Elsevier , Science Direct
3	Road traffic accident mortality analysis based on the occurrence : evidence from kerela ,india	vipin N , Rahul T	2021	first they shows the series regression analysis formula , regression analysis with time series errors formula and performance accuracy measures formula . by use these formula he solve and forecast these problems . (1) summary statistics for NPK due to RTA in kerla during 2005-2018 . (2) summary statistics of NPK concerning each time zones through 2005-2018.	Elsevier , Science Direct

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4	Analysis of traffic accidents in selected period in the zilina region & proposal of security measures	Nina Molovcakova, Veronika advamova, viktor soltes .	2021	First they collected accident data from public and privet agencies .they analysis of traffic accidents in the solvak republic and zilina region .they represented main causes of traffic accident . they represented road traffic analysis on as per time , as per take alcohol and as per Pedestrain . they represented traffic accident in tunnels and railway crossing.	Elsevier , Science Direct
5	Accident Analysis and Highway Safety	Noorliyana Omar , Joewono Prasetijo Basil David Daniel and Mohd Asrul Effendi Abdullah	2017	First they collected accident data from public and privet agencies . and they analysis of which collected datas. they identified the black spot location and they represented the accident data severity by year . they used the regression analysis formulas .	EDP Sciences
6	Factors influencing accident severity : an analysis by road accident type	Laura Eboli ,Carmen Forciniti , Gabriella Mazzulla	2019	First they collected accident data from public and privet agencies . they represented the descriptive statistics of item name as road , external environmental , driver and last is accident . they represented classification and description of independent variable .	Elsevier , Science Direct

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7	Apriori Based Algorithm for Dubai Road Accident Analysis	Maya john , hadil shaiba	2019	First they collected accident data from public and privet agencies . and they analysis and distribute the data by methods as namely , apriori algorithms , data exploration , data Prepossessing and etc. they represented graph as number of accident per time interval ,most common accident patterns during peak accident time and most accident patterns during weekdays.	Elsevier , Science Direct
8	Risk Indicators and Road Accident Analysis for the period 2012-2016	Lucian-Ionel Cioca , Larisa Ivascu	2017	First they collected accident data from public and privet agencies . and they analysis and distribute the data by methods as namely , qualative and semi - qualitive . they represented number of road deaths per million inhabitants in the period 2015-2016 & 2010 - 2016 expressed as a percentage , road catagories in romia and situation of deaths and the number of injuries depending on road configuration .	Sustainability

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9	Traffic Analysis and Road Accidents: A Case Study of Hyderabad using GIS	Akeem A. Audu et al	2014	First they collect data of total vehicle from different location of Hyderabad .Then collect accident data for above location and did analysis of it , they represent the hotspots area of the Hyderabad state.	IOP Publishing Ltd , Earth & Environmental Science
10	Road accident analysis ' a case study of Patna City	Sanjay kumar singh , Ashish misra	2000	First he collected accident data from police station and from internet of Patna City .they done accident analysis of accident data of Patna City . Then they describes the accident data in graph by as per year , as per different types of vehicles .they shows fatalities distribution by age and by location , they shows Black spot locations.	Urban transport journal 2-2 : 60-75

Table 2.1

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CHAPTER-3 STUDY AREA & METHODOLOGY CHART

3.1 Study Area

Location : kararia automobiles pvt ltd - kishan gate number (3) metoda GIDC

Total stretch: 8.2 KM

City: Rajkot city

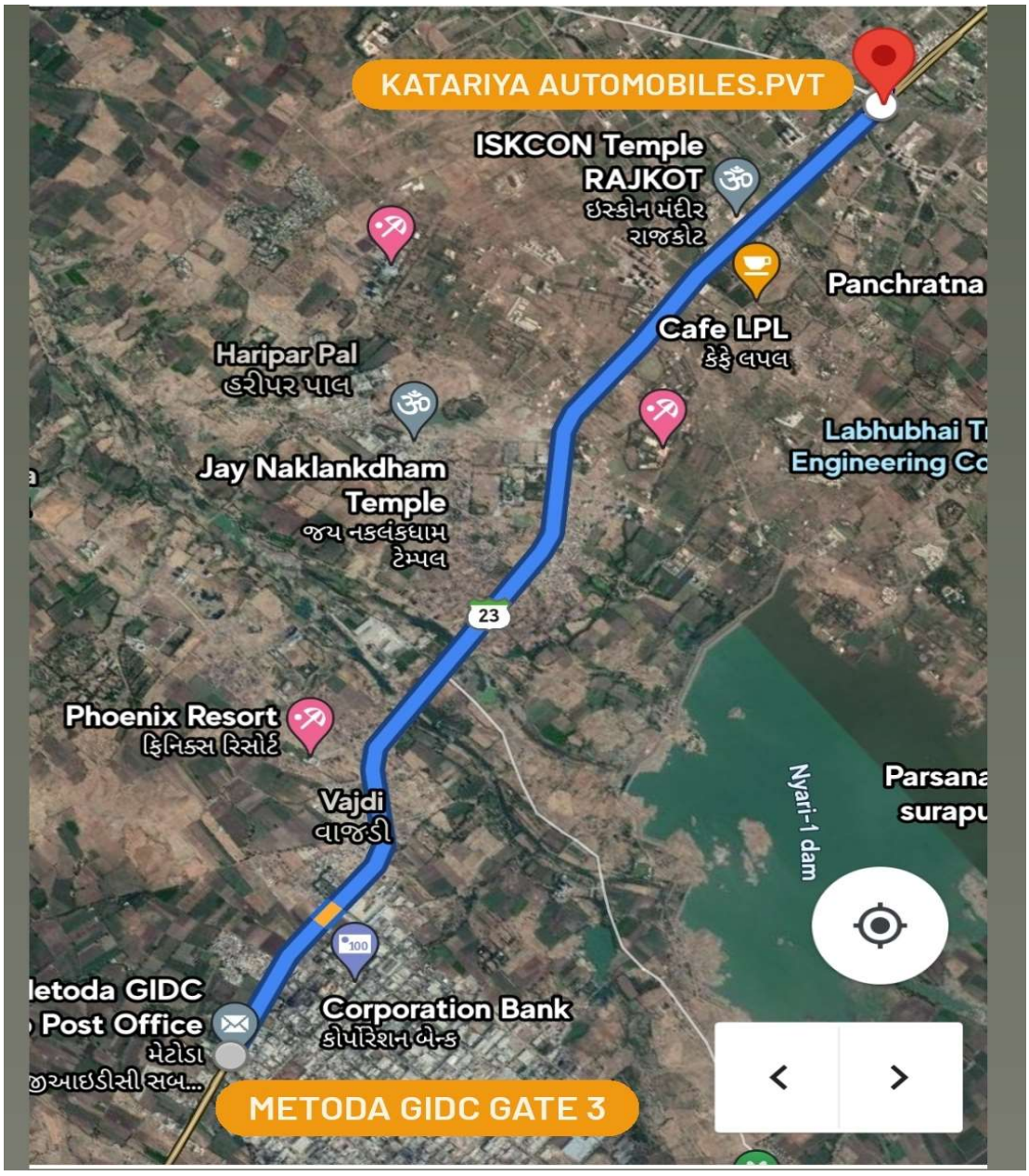

Figure No. 3.1.1

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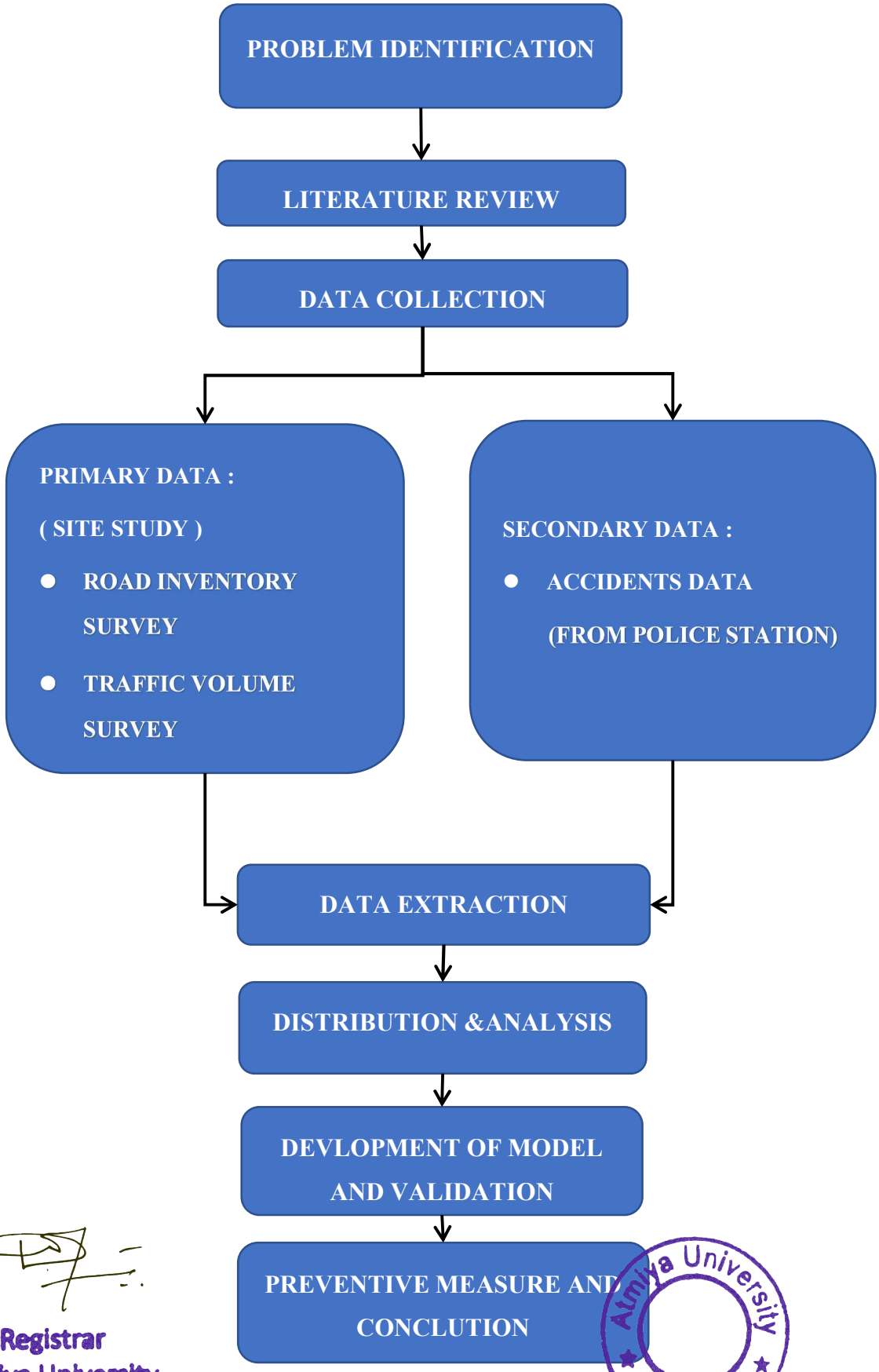
3.2 Methodology chart



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CHAPTER-4 DATA COLLECTION

4.1 Road Inventory Survey

"This is comprehensive survey which can be used to study the profile of the roads in the area of features like road , pavement widths, road pavement types , street lighting , luminosity , drain types , presence of vendors / street furniture , bus stops, bridge ,etc".

Sr no.	Variables	Avaiibility (Yes/no)	Descreption
1	Straight Road length	yes	8.2 km stretch
2	Number of curve	yes	4
3	Street lights	yes	
4	Intersection	yes	
5	Pedestrain way	yes	
6	Bus stop	yes	
7	Road condition	yes	Good road condition
8	Traffic police stand	yes	
9	Signs facilities	yes	
10	Signals facilities	yes	
11	Types of vehicles use the road	yes	Mix traffic
12	Width of road	yes	
13	School near the road	yes	
14	Trees	yes	
15	Bridge	yes	
16	Horizontal curve	yes	
17	Vertical curve	no	
18	Barriers	yes	
19	Drianage facillities	yes	
20	Bicycle facilities	no	
21	Speed limit	yes	Between 30 to 40 kmph
22	Pavement markings	yes	
23	Lane type	yes	Two lane
24	Railroad crossing	no	
25	Mail boxes	no	
26	side walk	yes	
27	Island	yes	

Table No. 4.1.1

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Figure. No. 4.1.2

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4.2 Traffic Volume Survey

The term traffic volume study can be termed as traffic flow survey or simply the traffic survey. It is defined as the procedure to determine mainly volume of traffic moving on the roads at a particular section during a particular time.

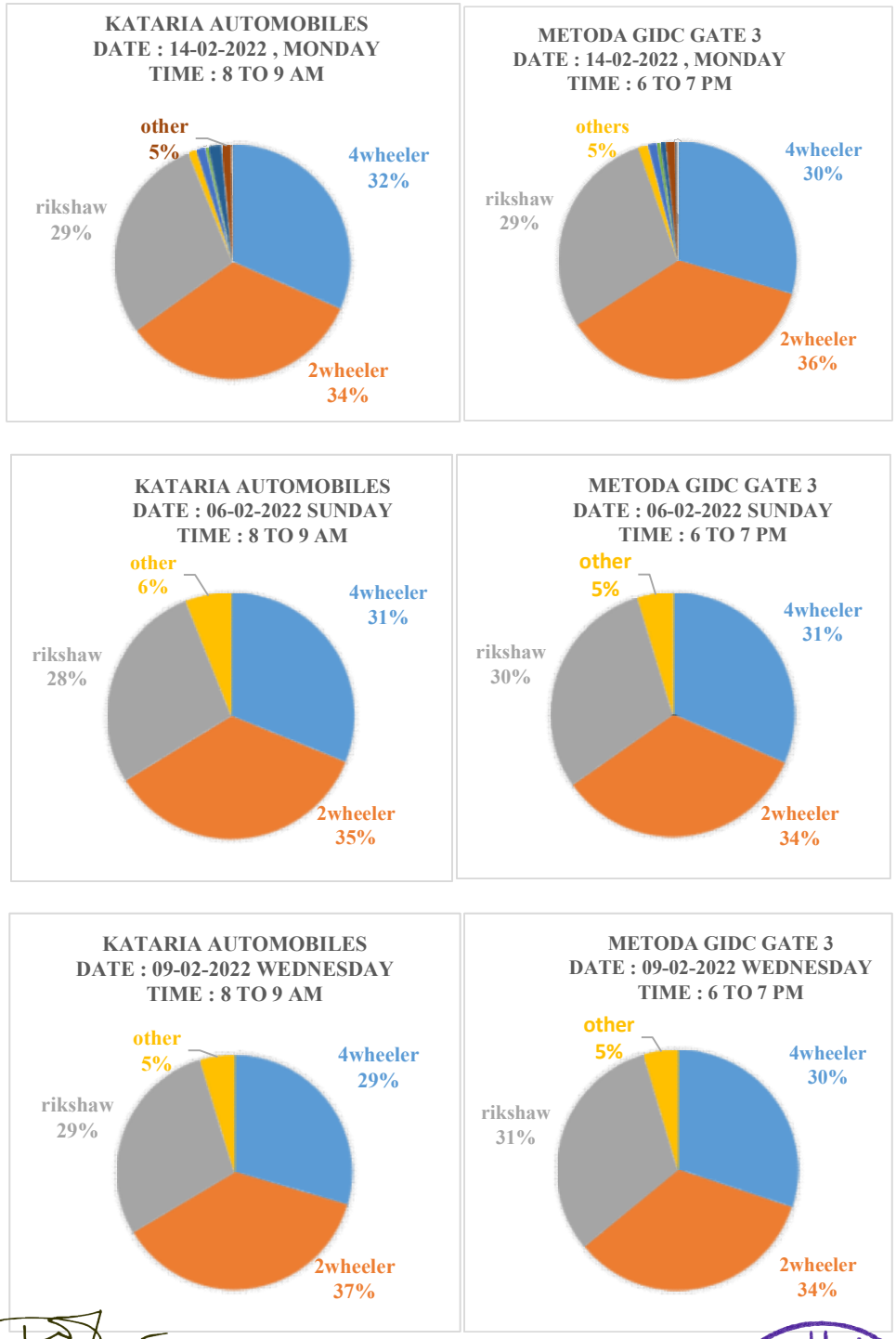

Figure 4.2.1

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 14-02-22 MONDAY TIME : 7 TO 8 AM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	truck	bus	TRACTOR		PCU
1	7	11	6	1	0	0		19.5
2	6	10	8	0	0	0		15
3	7	15	7	1	1	1		29.5
4	9	12	9	2	2	0		34.5
5	7	8	10	1	0	0		20
6	10	9	5	0	0	0		17
7	9	18	11	1	0	1		31.5
8	8	19	6	0	1	1		28
9	6	8	13	1	0	0		20.5
10	4	15	6	1	0	0		18.5
11	9	9	8	1	1	0		25
12	8	10	6	1	0	0		20
13	10	15	12	0	0	0		23.5
14	9	11	8	1	0	0		22.5
15	9	14	7	1	1	0		27
16	12	12	12	1	0	0		28
17	9	9	7	0	0	0		17
18	11	7	7	0	0	1		22
19	9	11	10	0	1	0		23
20	10	8	9	1	1	0		26
21	9	12	7	0	0	0		18.5
22	10	14	9	1	1	0		29
23	9	9	7	0	1	0		20.5
24	7	7	11	0	0	0		16
25	4	12	12	0	1	0		19.5
26	9	13	8	0	1	0		23
27	15	5	9	1	0	0		26
28	7	10	6	0	1	0		18.5
29	9	8	7	0	0	0		16.5
30	12	6	10	0	0	0		20
31	8	9	12	0	0	0		18.5
32	7	15	9	0	0	0		19
33	7	10	8	0	0	1		20
34	8	9	9	0	0	0		17
35	9	7	7	1	0	0		20
36	8	5	9	0	1	0		18.5
37	5	8	8	1	0	0		17
38	9	10	10	0	0	0		19
39	8	6	9	0	0	0		15.5
40	6	4	8	0	1	0		15.5
41	5	5	8	0	1	0		15
42	6	4	9	0	0	0		12.5
43	9	7	6	0	0	0		15.5
44	7	10	7	0	1	1		23
45	10	5	10	0	0	0		17.5
46	6	9	7	0	0	0		14
47	13	12	8	1	0	0		27
48	9	4	9	0	0	0		15.5
49	6	12	9	0	0	0		16.5
50	4	5	7	0	0	0		10
51	8	6	8	0	0	0		15
52	9	9	7	0	1	0		20.5
53	7	10	8	0	0	0		16
54	7	8	7	0	1	0		18
55	6	9	4	1	0	0		16.5
56	9	7	9	1	1	0		24.5
57	4	10	8	0	1	0		16.5
58	5	4	6	1	0	0		14
59	10	8	7	0	0	1		23
60	12	12	8	0	0	0		32
TOTAL	487	570	494	22	21	7	2814	34.5
								1206.5

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 14-02-22 MONDAY TIME : 8 TO 9 AM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	truck	bus	TRACTOR		PCU
1	6	10	7	1	1	0		22
2	9	13	8	0	0	0		19.5
3	10	11	12	1	1	1		33
4	8	8	9	0	2	0		23.5
5	6	11	10	0	0	0		16.5
6	9	12	13	0	0	0		21.5
7	12	11	11	0	0	1		27
8	7	9	15	0	1	1		26.5
9	5	11	13	0	1	0		20.5
10	7	12	12	1	0	0		23
11	8	9	8	0	1	0		20
12	7	9	10	0	0	0		16.5
13	8	11	12	0	0	2		27.5
14	6	7	13	0	0	0		16
15	8	9	7	0	1	0		19.5
16	11	9	12	1	0	0		25.5
17	13	12	13	0	0	0		25.5
18	10	9	7	1	0	1		26
19	9	8	10	0	1	0		21.5
20	12	11	9	0	1	0		25.5
21	8	7	7	0	0	0		15
22	9	9	9	0	1	0		21.5
23	8	12	7	0	1	0		21
24	8	10	11	1	0	0		22.5
25	11	5	12	0	1	0		23
26	8	6	10	1	1	1		27.5
27	17	8	13	0	0	0		27.5
28	9	7	6	1	1	0		23
29	12	7	7	0	0	0		19
30	11	9	10	0	0	0		20.5
31	9	6	12	1	0	0		22
32	10	9	13	0	0	0		21
33	6	12	8	0	1	1		23.5
34	7	13	9	0	0	0		18
35	8	10	7	0	0	0		16.5
36	9	8	11	0	1	0		22
37	6	11	12	1	0	0		21.5
38	8	11	10	0	1	0		22
39	16	9	13	0	0	0		27
40	5	12	8	1	1	0		22.5
41	9	10	8	1	1	0		25.5
42	13	7	9	1	1	0		28.5
43	11	10	6	0	0	0		19
44	6	9	12	0	1	1		24
45	9	8	10	1	2	0		29
46	5	12	7	1	0	0		18.5
47	12	9	8	0	1	0		24
48	8	11	9	1	1	0		25.5
49	11	8	12	0	1	0		24.5
50	9	10	13	0	0	0		20.5
51	7	9	10	1	1	0		24
52	8	10	11	1	0	0		22.5
53	6	8	8	0	0	0		14
54	12	11	7	0	1	0		24.5
55	11	8	4	1	0	0		21
56	10	10	9	0	1	0		23
57	9	13	8	1	1	0		27
58	4	7	6	0	1	0		14
59	12	8	7	2	0	1		31
60	11	15	8	1	0	0		26
TOTAL	539	576	578	23	32	10	2824	33
								1360

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 14-02-22 MONDAY TIME : 9 TO 10 AM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	truck	bus	TRACTOR		PCU
1	5	11	5	1	1	0		20.5
2	12	10	6	0	0	0		20
3	9	15	10	1	1	1		33
4	7	12	7	1	1	0		24
5	5	8	8	0	0	0		13
6	8	9	11	1	0	0		22
7	11	18	9	0	0	1		28.5
8	6	19	13	1	1	0		29.5
9	4	8	11	0	0	0		13.5
10	14	15	10	0	0	0		26.5
11	7	9	6	2	1	2		34
12	6	10	8	0	0	0		15
13	11	15	10	1	0	0		27.5
14	12	11	11	0	0	0		23
15	7	14	5	0	1	0		20
16	10	12	10	1	0	1		29
17	12	9	11	2	0	0		30
18	9	7	5	1	0	0		19
19	13	11	8	0	1	0		26
20	11	8	7	2	0	0		26.5
21	7	12	5	0	0	1		19.5
22	8	14	7	0	1	0		22
23	15	9	5	0	1	0		25.5
24	7	7	9	0	0	0		15
25	10	12	10	0	1	0		24.5
26	11	13	8	1	1	0		29
27	16	5	11	0	0	0		24
28	8	10	4	0	1	0		18.5
29	11	8	5	0	0	0		17.5
30	10	6	8	0	0	1		21
31	8	9	10	1	0	0		21.5
32	9	15	11	0	0	0		22
33	5	10	6	0	1	0		16.5
34	6	9	7	0	0	0		14
35	7	7	5	0	0	0		13
36	13	5	9	0	1	0		23.5
37	9	8	10	1	0	0		22
38	7	10	8	0	1	0		19.5
39	15	6	11	1	0	0		27.5
40	4	4	6	0	1	0		12.5
41	3	5	6	1	1	0		16
42	12	4	7	0	0	0		17.5
43	10	7	4	1	0	0		19.5
44	5	10	10	0	1	1		22.5
45	8	5	8	0	0	0		14.5
46	4	9	5	1	0	0		15
47	11	12	6	0	1	0		23.5
48	7	4	7	0	1	0		16
49	10	12	10	1	0	0		25
50	9	5	11	0	0	0		17
51	6	6	8	0	1	0		16.5
52	7	13	9	1	0	1		26
53	5	10	6	2	0	0		21
54	11	8	5	0	1	0		21
55	4	9	2	0	0	0		9.5
56	9	7	7	0	1	0		19.5
57	8	10	6	1	0	1		24
58	3	4	4	0	1	0		10.5
59	11	8	5	0	0	1		23
60	10	12	6	1	0	0		3
TOTAL	518	570	458	27	24	11	2651	34
								1268

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 14-02-22 MONDAY TIME : 7 TO 8 AM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	truck	bus	TRACTOR		PCU
1	3	7	7	1	1	0		17.5
2	9	8	6	1	0	0		20
3	5	11	8	0	0	0		14.5
4	9	12	6	0	0	0		18
5	8	10	4	0	0	0		15
6	7	11	8	0	0	0		16.5
7	10	9	6	1	0	0		21.5
8	7	9	8	0	0	0		15.5
9	8	6	6	0	0	0		14
10	6	9	7	0	0	0		14
11	6	7	4	1	0	0		15.5
12	5	8	9	0	0	0		13.5
13	7	10	7	0	0	0		15.5
14	9	7	5	0	0	0		15
15	8	11	6	0	0	0		16.5
16	8	9	9	1	1	0		24.5
17	7	6	8	0	0	0		14
18	8	8	5	0	0	0		14.5
19	10	7	9	1	0	0		22
20	7	9	4	0	0	0		13.5
21	7	10	6	0	0	0		15
22	9	8	7	0	0	0		16.5
23	10	9	4	1	0	1		24.5
24	7	7	8	0	0	0		14.5
25	9	9	6	0	0	0		16.5
26	8	11	9	0	0	0		18
27	6	8	6	1	0	0		17
28	7	6	7	0	0	0		13.5
29	8	7	6	0	0	0		14.5
30	7	6	3	0	0	0		11.5
31	10	9	8	0	1	0		22
32	8	9	7	1	0	0		20
33	9	7	5	0	0	0		15
34	5	8	6	1	0	0		16
35	5	8	7	0	0	0		12.5
36	9	7	4	0	0	0		14.5
37	10	10	9	0	0	0		19.5
38	8	6	7	1	0	0		18.5
39	6	9	9	0	0	0		15
40	9	10	4	0	0	0		16
41	6	6	7	0	1	0		16
42	7	6	6	0	0	1		17
43	8	9	3	1	0	0		18
44	7	8	5	0	0	0		13.5
45	8	7	7	0	0	0		15
46	7	9	5	0	0	0		14
47	7	7	6	0	0	0		13.5
48	9	9	4	0	0	0		15.5
49	8	12	6	0	0	0		17
50	11	6	8	0	0	0		18
51	8	7	6	1	0	0		18.5
52	9	7	4	0	0	0		14.5
53	9	10	5	0	0	0		16.5
54	8	6	4	0	0	1		17
55	11	8	4	0	0	0		17
56	12	6	5	1	0	0		21.5
57	9	7	6	0	0	0		15.5
58	9	6	4	0	2	0		21
59	12	9	4	0	1	0		22
60	11	6	5	0	0	0		19.5
TOTAL	480	489	364	14	7	3	2157	24.5
								999

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 14-02-22 MONDAY TIME : 8 TO 9 AM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rickshaw	truck	bus	TRACTOR		PCU
1	3	7	6	0	0	0		9.5
2	9	8	9	1	1	0		25
3	5	11	7	0	0	0		14
4	9	12	5	1	0	0		21.5
5	8	10	3	0	1	0		18
6	9	11	7	2	0	0		26
7	10	9	5	1	0	0		21
8	7	9	7	0	0	0		15
9	8	6	5	0	2	1		24.5
10	6	10	9	0	0	0		15.5
11	10	9	7	0	0	0		18
12	5	10	8	1	0	0		18
13	9	10	6	0	1	0		20.5
14	9	12	4	0	0	0		17
15	4	11	5	0	0	0		12
16	5	9	8	0	0	0		13.5
17	7	6	7	0	1	0		17
18	8	8	4	0	0	0		14
19	10	7	8	0	0	0		17.5
20	7	9	8	1	1	0		23
21	11	10	5	0	0	0		18.5
22	9	8	6	0	0	0		16
23	10	9	7	0	0	1		22
24	11	7	9	0	0	0		19
25	9	10	5	0	0	0		16.5
26	10	11	8	1	0	0		23.5
27	6	8	9	0	0	0		14.5
28	7	6	6	0	0	0		13
29	8	7	5	0	0	0		14
30	9	6	2	0	0	0		13
31	10	9	7	0	0	0		18
32	8	13	6	0	0	0		17.5
33	11	7	4	1	0	0		20.5
34	5	8	5	0	0	0		11.5
35	4	10	6	0	0	1		16
36	10	9	7	0	0	0		18
37	9	10	8	0	0	0		18
38	8	11	6	0	0	0		16.5
39	6	9	8	0	0	0		14.5
40	9	10	9	2	0	0		26.5
41	6	6	6	0	0	0		12
42	7	11	5	0	0	1		19
43	10	9	4	0	0	0		16.5
44	7	10	4	1	0	0		18
45	8	9	6	0	0	0		15.5
46	7	10	4	0	1	0		17.5
47	11	11	5	0	0	0		19
48	10	9	8	0	0	0		18.5
49	8	9	5	0	0	0		15
50	11	6	7	0	0	0		17.5
51	8	9	5	1	0	0		19
52	9	7	9	0	0	0		17
53	11	10	7	0	1	0		23
54	8	8	8	1	0	0		20
55	11	7	3	0	0	0		16
56	10	6	4	0	1	0		18.5
57	11	7	5	1	0	0		21
58	9	6	8	0	0	0		16
59	10	9	7	0	0	0		19
60	11	6	4	0	0	0		16
TOTAL	501	527	370	15	10	4	2233	26.5 1060.5

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 14-02-22 MONDAY TIME : 9 TO 10 AM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	truck	bus	TRACTOR		PCU
1	2	6	5	0	0	0		7.5
2	7	7	7	0	0	0		14
3	5	8	6	1	0	0		16
4	5	7	5	0	1	1		18.5
5	8	9	3	1	0	0		18
6	9	4	7	0	1	0		18
7	6	9	3	1	0	0		16
8	7	9	7	0	0	0		15
9	8	6	5	0	0	0		13.5
10	6	7	3	0	0	0		11
11	7	9	7	0	1	0		18.5
12	5	3	3	0	0	0		8
13	5	7	6	0	0	0		11.5
14	9	6	4	0	0	0		14
15	4	8	5	0	0	0		10.5
16	5	9	5	1	1	0		19.5
17	7	6	7	0	0	0		13.5
18	8	8	4	1	0	0		18
19	3	7	3	0	0	1		12
20	7	9	8	0	0	0		15.5
21	5	7	5	0	0	0		11
22	9	8	6	0	0	0		16
23	6	9	7	1	0	1		22
24	7	7	4	0	0	0		12.5
25	9	9	5	0	1	0		19.5
26	4	11	8	0	0	0		13.5
27	6	8	3	1	0	0		15.5
28	7	6	6	0	0	0		13
29	8	7	5	0	0	0		14
30	9	6	2	0	0	0		13
31	6	9	7	0	0	0		14
32	8	9	6	2	0	0		23.5
33	7	7	4	0	0	0		12.5
34	5	8	5	0	0	0		11.5
35	4	10	6	0	1	0		15.5
36	7	9	7	0	0	0		15
37	9	9	8	0	0	0		17.5
38	8	7	6	0	1	0		18
39	6	9	8	0	0	0		14.5
40	9	8	3	1	0	0		18.5
41	6	6	6	0	0	0		12
42	7	8	5	0	0	1		17.5
43	5	9	4	0	0	0		11.5
44	7	10	5	0	1	0		18
45	8	9	6	0	0	0		15.5
46	7	9	4	0	0	0		13.5
47	7	8	5	0	0	0		13.5
48	4	7	8	0	0	0		11.5
49	8	9	5	1	0	0		19
50	7	6	7	0	0	0		13.5
51	8	9	5	0	1	1		22.5
52	9	7	9	0	0	0		17
53	8	10	7	1	0	0		20.5
54	9	8	8	0	0	0		17
55	6	7	3	0	0	1		15
56	7	6	4	0	1	0		15.5
57	8	7	5	0	0	0		14
58	9	6	8	0	0	0		16
59	8	9	3	0	0	0		17
60	7	6	4	0	0	0		
TOTAL	407	463	325	12	10	6	2029	23.5
								908

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 14-02-22 MONDAY TIME : 5 TO 6 PM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	truck	bus	TRACTOR		PCU
1	9	10	7	1	1	0		25
2	8	9	6	0	0	0		15.5
3	7	9	7	0	0	0		15
4	6	10	5	1	1	0		21
5	7	11	6	0	0	0		15.5
6	10	11	8	0	0	0		19.5
7	9	12	7	0	2	0		25.5
8	8	10	8	1	0	0		21
9	8	13	7	0	0	1		22
10	9	10	8	0	1	0		21.5
11	9	8	5	0	0	0		15.5
12	6	10	8	1	0	0		19
13	7	9	7	0	1	0		18.5
14	9	10	6	0	0	0		17
15	9	9	7	1	0	0		21
16	6	10	4	0	0	0		13
17	9	8	7	0	1	0		20
18	5	9	8	0	0	0		13.5
19	7	11	5	2	0	0		23
20	9	9	6	0	0	0		16.5
21	8	10	7	0	2	0		23.5
22	9	8	9	0	0	0		17.5
23	8	11	8	0	0	0		17.5
24	7	5	8	0	0	0		13.5
25	8	9	9	1	1	0		24.5
26	9	11	6	0	0	0		17.5
27	10	7	5	0	0	0		16
28	7	10	7	0	0	0		15.5
29	7	9	7	0	0	0		15
30	8	11	6	0	1	0		20
31	9	10	9	1	0	0		22.5
32	6	8	8	1	0	0		18
33	9	6	8	0	0	1		20
34	9	9	7	0	0	0		17
35	8	11	6	0	1	0		20
36	7	7	6	1	0	0		17.5
37	9	9	7	0	1	0		20.5
38	6	6	4	0	0	0		11
39	9	9	8	0	0	0		17.5
40	9	8	8	0	0	0		17
41	8	11	5	1	0	0		20
42	6	6	6	0	0	0		12
43	8	10	10	2	1	0		29.5
44	9	9	8	0	0	0		17.5
45	7	5	7	0	0	0		13
46	6	8	9	2	1	0		26
47	9	6	5	0	0	1		18.5
48	8	9	7	0	0	0		16
49	10	9	6	0	0	0		17.5
50	8	11	7	0	0	0		17
51	6	8	4	1	1	0		19.5
52	8	9	7	1	0	0		20
53	7	10	8	0	0	0		16
54	9	8	5	0	0	1		19.5
55	10	11	6	2	1	0		30
56	6	5	7	0	0	0		12
57	9	9	8	0	0	0		17.5
58	6	9	9	0	0	0		15
59	8	8	8	0	1	0		19.5
60	8	9	9	1	0	1		25
TOTAL	475	542	416	21	18	5	2439	1121

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 14-02-22 MONDAY TIME : 6 TO 7 PM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	truck	bus	TRACTOR		PCU
1	10	15	7	1	0	0		25
2	12	11	7	2	0	0		29
3	10	13	8	0	2	0		27.5
4	5	11	6	1	0	0		17.5
5	5	12	7	0	0	1		18.5
6	9	17	11	0	1	0		26.5
7	8	13	8	0	0	0		18.5
8	7	16	9	1	0	0		23.5
9	10	14	12	0	0	1		27
10	13	11	9	0	2	0		30
11	8	9	6	2	0	0		23.5
12	11	13	11	1	0	0		27
13	6	10	8	0	1	0		18.5
14	10	14	7	0	0	0		20.5
15	14	16	8	1	0	0		30
16	5	11	5	0	0	0		13
17	8	9	11	0	2	0		25
18	9	10	9	0	0	1		22.5
19	6	12	6	2	0	0		23
20	8	10	7	2	0	0		24.5
21	11	11	8	0	1	0		24
22	12	9	11	0	0	0		22
23	7	12	9	0	0	0		17.5
24	9	6	9	0	0	0		16.5
25	11	10	10	1	2	0		32
26	11	14	7	0	0	0		21.5
27	9	8	6	0	0	0		16
28	10	11	3	0	0	0		17
29	6	17	8	0	1	0		22
30	7	12	7	0	0	1		20.5
31	8	11	10	1	0	0		22.5
32	5	9	11	1	1	0		22.5
33	4	7	9	0	0	1		16
34	13	10	12	0	1	0		27.5
35	11	12	7	0	0	0		20.5
36	6	8	7	1	0	0		17.5
37	9	6	8	0	2	0		23
38	5	7	5	0	0	0		11
39	12	6	11	0	1	0		24
40	8	9	9	0	0	0		17
41	11	12	6	1	0	0		24
42	10	7	7	0	0	0		17
43	7	11	11	2	2	0		33
44	8	14	9	0	0	0		19.5
45	6	6	5	0	1	0		15
46	10	14	10	2	1	1		37.5
47	5	7	6	0	0	0		11.5
48	10	8	8	0	0	0		18
49	9	15	7	0	0	0		20
50	4	12	8	0	0	0		14
51	5	9	5	1	1	0		19.5
52	7	10	11	0	0	0		17.5
53	10	11	9	0	0	0		20
54	8	9	6	0	0	0		15.5
55	9	12	7	1	2	0		29.5
56	11	6	8	0	0	0		18
57	9	10	11	0	2	0		26.5
58	12	14	10	0	0	0		24
59	11	9	9	0	1	0		23.5
60	10	10	10	1	0	1		28
TOTAL	520	648	492	25	27	7	2690	37.5
								1312.5

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 14-02-22 MONDAY TIME : 7 TO 8 PM				TRAFFIC VOLUME SURVEY				
MIN	4w	2 W	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	8	13	5	1	1	0		24.5
2	10	9	5	0	0	0		17
3	8	11	6	0	0	0		16.5
4	9	9	4	1	0	0		19.5
5	7	10	5	0	0	0		14.5
6	7	15	9	0	0	0		19
7	6	11	6	0	0	0		14.5
8	5	14	7	1	0	0		19.5
9	8	12	10	0	0	1		23
10	11	9	7	0	1	0		22.5
11	6	7	4	0	0	0		11.5
12	9	11	9	1	0	0		23
13	9	8	6	0	0	0		16
14	8	12	5	0	0	0		16.5
15	12	14	6	1	0	0		26
16	10	9	3	0	0	0		16
17	6	7	9	0	1	0		17.5
18	7	8	7	0	0	0		14.5
19	8	10	4	0	0	0		15
20	6	8	5	1	0	0		16.5
21	9	9	6	0	0	0		16.5
22	10	7	9	0	0	0		18
23	5	10	7	0	0	0		13.5
24	7	4	7	0	0	0		12.5
25	9	8	8	1	1	0		24.5
26	9	12	5	0	0	0		17.5
27	7	6	4	0	0	0		12
28	8	9	1	0	0	0		13
29	9	15	6	0	0	0		19.5
30	5	10	5	0	0	0		12.5
31	6	9	8	1	0	0		18.5
32	8	7	9	1	0	0		20
33	9	5	7	0	0	1		19
34	11	8	10	0	0	0		20
35	9	10	5	0	0	0		16.5
36	4	6	5	1	0	0		13.5
37	7	4	6	0	1	0		15.5
38	7	5	3	0	0	0		11
39	10	4	9	0	0	0		16.5
40	6	7	7	0	0	0		13
41	9	10	4	1	0	0		20
42	8	5	5	0	0	0		13
43	5	9	9	0	0	0		14
44	6	12	7	0	0	0		15.5
45	9	4	3	0	0	0		12.5
46	8	12	8	0	1	0		21.5
47	8	5	4	0	0	0		12.5
48	8	6	6	0	0	0		14
49	7	13	5	0	0	0		16
50	9	10	6	0	0	0		17
51	8	7	3	1	0	0		17
52	5	8	9	0	0	0		13.5
53	8	9	7	0	0	0		16
54	6	7	4	0	0	0		11.5
55	7	10	5	0	0	0		14.5
56	9	4	6	0	0	0		14
57	7	8	9	0	0	0		15.5
58	10	12	8	0	0	0		20
59	9	7	7	0	1	0		19
60	8	8	8	1	0	1		24
TOTAL	469	528	372	13	7	3	1413	26
								1007.5

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 14-02-22 MONDAY TIME : 5 TO 6 pm			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	truck	bus	TRACTOR		PCU
1	7	10	8	0	0	0		16
2	6	8	7	1	0	0		17.5
3	7	9	6	0	1	0		18
4	8	8	7	1	0	0		19.5
5	5	11	4	0	0	0		12.5
6	4	10	10	0	0	1		18
7	9	8	8	1	0	0		21
8	8	6	5	0	0	0		13.5
9	6	10	6	0	0	0		14
10	9	9	7	0	0	0		17
11	5	8	8	0	0	0		13
12	9	9	8	0	0	0		17.5
13	8	8	8	1	0	0		20
14	7	9	9	0	0	0		16
15	8	10	6	0	0	0		16
16	7	8	9	0	0	0		15.5
17	8	11	10	0	1	0		22
18	6	9	8	0	0	0		14.5
19	7	7	5	0	0	0		13
20	5	6	6	0	0	0		11
21	4	8	6	1	0	0		15
22	9	9	7	0	1	0		20.5
23	8	7	4	0	0	0		13.5
24	8	8	6	0	0	0		15
25	6	6	8	2	0	0		21
26	9	11	7	0	0	0		18
27	6	7	8	0	0	0		13.5
28	7	9	5	0	1	0		17.5
29	5	6	6	0	0	0		11
30	7	5	7	0	0	0		13
31	8	8	4	0	0	0		14
32	9	11	6	0	1	0		21
33	8	6	8	2	0	0		23
34	7	10	9	0	0	0		16.5
35	8	7	6	0	0	0		14.5
36	4	8	5	0	0	1		14.5
37	6	7	6	1	0	0		16.5
38	7	6	7	0	0	0		13.5
39	5	7	8	0	0	0		12.5
40	7	8	5	1	0	0		17.5
41	4	6	8	0	1	0		14.5
42	4	7	5	0	0	0		10
43	8	11	5	0	0	0		16
44	7	7	7	0	0	0		14
45	8	5	6	0	0	0		13.5
46	6	6	7	0	0	0		12.5
47	9	5	6	1	0	0		18.5
48	6	8	9	0	0	0		14.5
49	7	10	3	0	0	1		17.5
50	5	7	4	0	0	0		10.5
51	7	11	6	0	1	0		19
52	8	10	5	1	0	0		19.5
53	7	8	2	1	0	0		16
54	6	6	4	0	1	0		14.5
55	8	9	6	0	0	0		15.5
56	6	7	4	0	0	0		11.5
57	8	9	5	0	0	0		15
58	7	5	7	0	0	0		13
59	5	6	5	0	0	1		14.5
60	6	10	5	0	0	0		13.5
TOTAL	409	481	382	14	8	4	2157	23
								940.5

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 14-02-22 MONDAY TIME : 6 TO 7 pm			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	truck	bus	TRACTOR		PCU
1	7	11	10	0	0	0		17.5
2	6	9	7	1	0	0		18
3	10	10	6	2	1	0		29.5
4	8	9	7	0	0	0		16
5	5	10	4	1	1	0		19.5
6	4	11	10	0	0	1		18.5
7	9	9	8	1	0	1		25.5
8	8	7	5	0	0	0		14
9	6	6	6	0	0	0		12
10	9	10	7	0	0	0		17.5
11	5	9	10	0	1	0		18
12	9	10	8	0	0	0		18
13	8	9	8	0	0	0		16.5
14	11	10	9	0	0	0		20.5
15	10	11	6	0	0	0		18.5
16	7	9	9	0	1	0		19.5
17	8	12	10	0	0	0		19
18	6	6	8	2	0	0		21
19	7	8	11	0	0	0		16.5
20	5	7	6	0	0	0		11.5
21	4	9	6	1	0	0		15.5
22	9	10	7	0	0	0		17.5
23	10	8	4	0	0	0		16
24	8	6	10	0	0	0		16
25	6	7	8	2	0	1		25.5
26	9	12	10	0	0	0		20
27	6	8	8	0	0	0		14
28	7	6	5	0	1	0		16
29	5	7	6	0	0	0		11.5
30	7	6	7	0	0	0		13.5
31	8	9	10	0	0	0		17.5
32	9	12	11	0	0	1		24.5
33	8	7	8	1	0	0		19.5
34	7	11	9	0	1	0		20.5
35	8	8	6	0	0	0		15
36	4	6	5	0	0	1		13.5
37	6	8	10	1	0	0		19
38	7	7	7	0	0	0		14
39	5	8	8	0	0	0		13
40	10	9	11	0	1	0		23.5
41	9	7	8	0	0	0		16.5
42	4	8	5	0	0	1		14.5
43	8	12	10	0	0	0		19
44	7	8	7	0	1	0		18
45	8	6	6	0	0	0		14
46	6	7	7	0	0	0		13
47	9	6	6	1	0	0		19
48	6	9	9	0	1	0		18.5
49	7	11	3	0	0	0		14
50	5	8	9	0	0	1		17.5
51	7	12	6	0	1	0		19.5
52	8	11	5	2	0	0		24
53	7	9	2	1	0	1		20.5
54	6	7	4	0	0	0		11.5
55	8	10	6	1	0	0		20
56	8	8	4	0	0	0		14
57	8	8	5	0	0	0		14.5
58	7	6	7	0	1	0		17
59	5	7	5	0	0	1		15
60	6	11	5	0	0	0		14
TOTAL	430	518	430	17	11	9	2284	29.5 1046.5

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 14-02-22 MONDAY TIME : 7 TO 8 pm				TRAFFIC VOLUME SURVEY				
MIN	4w	2 W	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	5	9	9	0	0	0		14
2	8	7	6	1	0	0		18.5
3	8	8	5	0	1	0		18
4	6	10	6	0	0	0		14
5	3	8	3	0	0	0		8.5
6	7	9	9	0	0	1		20
7	11	7	7	1	0	0		22
8	9	10	4	0	0	0		16
9	8	4	5	0	0	0		12.5
10	7	8	6	0	0	0		14
11	8	7	9	0	0	0		16
12	10	8	7	0	0	0		17.5
13	6	10	7	0	0	0		14.5
14	9	8	8	0	0	0		17
15	8	9	5	0	0	0		15
16	5	7	8	0	0	0		12.5
17	6	10	9	0	0	0		15.5
18	4	4	7	0	0	0		9.5
19	9	8	10	0	0	0		18
20	7	5	5	0	0	0		12
21	8	8	5	1	0	0		18.5
22	5	8	6	0	0	0		12
23	8	6	3	0	0	0		12.5
24	6	4	9	0	0	0		12.5
25	9	5	7	2	0	0		23
26	7	10	9	0	0	0		16.5
27	4	6	7	0	0	0		10.5
28	5	4	4	0	1	0		12.5
29	9	5	5	0	0	0		14
30	5	4	6	0	0	0		10
31	6	7	9	0	0	0		14
32	5	10	10	0	0	0		15
33	9	5	7	2	0	0		23
34	5	9	8	0	0	0		13.5
35	6	12	5	0	0	0		14.5
36	9	4	4	0	0	1		17
37	4	12	9	1	0	0		18.5
38	5	5	6	0	1	0		14
39	8	6	7	0	0	0		14.5
40	8	13	10	0	0	0		19.5
41	7	5	7	0	0	0		13
42	7	8	4	0	0	0		13
43	4	10	9	0	0	0		13.5
44	5	6	6	0	0	0		11
45	6	4	5	0	0	0		10.5
46	4	5	6	0	0	0		9.5
47	7	4	5	1	0	0		15.5
48	4	7	8	0	0	0		11.5
49	5	9	2	0	0	0		10.5
50	9	15	8	0	0	0		20.5
51	5	10	5	0	1	0		16
52	6	9	4	2	0	1		24.5
53	5	7	1	1	0	0		13
54	9	5	3	0	1	0		16.5
55	4	8	5	0	0	0		10.5
56	6	10	3	0	0	0		12.5
57	9	6	4	0	0	0		14
58	8	4	6	0	0	0		13
59	8	5	4	0	0	1		17
60	4	9	4	0	0	0		0.1
TOTAL	397	445	370	12	5	4	1251	24..
								886

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 09-02-22 WEDNESDAY TIME : 7 TO 8 AM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	TRUCKS	BUS	TRACTOR		PCU
1	6	7	8	1	0	0		17.5
2	7	8	4	0	1	1		20.5
3	6	10	8	0	0	0		15
4	6	7	4	0	0	0		11.5
5	9	8	6	1	0	0		20
6	7	9	5	0	0	0		14
7	5	6	6	0	0	0		11
8	7	9	8	0	0	0		15.5
9	4	8	9	2	0	0		20.5
10	8	6	7	0	0	0		14.5
11	6	9	4	0	0	0		12.5
12	7	9	5	1	0	0		18
13	4	10	9	0	0	0		13.5
14	6	9	6	0	0	0		13.5
15	9	7	8	0	0	0		16.5
16	6	9	5	0	0	1		17
17	9	9	4	1	0	0		19.5
18	6	8	7	0	0	0		13.5
19	5	8	10	1	1	0		21.5
20	9	6	8	1	0	0		20
21	8	9	9	0	0	0		17
22	9	10	7	2	0	0		25.5
23	9	9	5	0	0	0		16
24	4	11	5	0	0	0		12
25	7	8	6	0	0	0		14
26	8	9	8	1	0	0		20.5
27	10	9	9	0	0	0		19
28	6	7	7	0	0	0		13
29	7	8	4	0	0	0		13
30	8	10	5	0	0	1		19.5
31	6	9	9	0	0	0		15
32	9	10	6	1	0	0		21
33	10	8	4	0	0	0		16
34	7	10	8	1	0	0		20
35	7	9	9	0	1	0		19.5
36	8	8	7	0	0	0		15.5
37	6	9	10	0	1	0		19
38	9	9	8	0	0	0		17.5
39	8	9	4	0	1	0		18
40	10	10	7	0	0	0		18.5
41	6	8	9	0	0	0		14.5
42	7	7	7	1	0	0		18
43	9	8	8	0	0	0		17
44	6	8	5	1	0	0		16.5
45	9	9	9	0	0	0		18
46	7	10	7	0	0	0		15.5
47	10	9	3	0	0	1		20
48	6	7	8	0	0	0		13.5
49	9	8	7	0	0	0		16.5
50	8	9	4	0	0	0		14.5
51	5	7	5	0	1	0		14.5
52	9	8	8	0	0	0		17
53	8	8	7	0	0	0		15.5
54	4	10	4	0	0	0		11
55	9	6	5	0	0	0		14.5
56	4	9	6	0	1	0		15
57	7	7	9	1	0	0		19
58	9	8	8	0	0	0		17
59	5	9	4	1	1	0		17
60	6	8	7	0	0	0		14.5
TOTAL	431	506	398	17	8	4	2233	25.5
								993

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 09-02-22 WEDNESDAY TIME : 8 TO 9 AM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	TRUCKS	BUS	TRACTOR		PCU
1	8	11	8	1	0	0		21.5
2	9	9	4	0	1	1		23
3	8	12	9	0	0	0		18.5
4	8	6	5	2	0	0		21.5
5	9	10	7	1	0	0		21.5
6	9	11	6	0	0	0		17.5
7	5	8	7	0	0	0		12.5
8	9	11	4	0	0	0		16.5
9	6	10	10	2	0	0		24
10	5	8	8	0	0	0		13
11	8	11	5	1	0	0		20
12	9	6	6	0	0	0		15
13	6	12	10	1	1	0		24.5
14	8	11	7	0	0	0		17
15	7	9	5	0	0	0		14
16	8	11	6	0	0	1		20.5
17	7	11	5	1	0	0		19
18	8	6	8	0	0	0		15
19	7	10	11	1	1	0		25
20	5	8	9	1	0	0		17.5
21	4	11	10	0	0	0		14.5
22	8	12	8	2	0	0		26
23	9	8	6	0	0	0		16
24	6	8	6	0	0	0		13
25	9	10	7	0	1	0		21
26	5	9	4	1	0	0		15.5
27	7	11	10	1	0	0		21.5
28	8	9	8	0	0	0		16.5
29	5	10	5	0	0	0		12.5
30	4	6	6	1	0	1		18
31	5	7	10	0	0	0		13.5
32	8	12	7	0	0	0		17.5
33	6	10	5	0	0	0		13.5
34	9	8	9	1	0	0		21.5
35	5	6	10	0	1	0		16.5
36	4	10	8	0	0	0		13
37	8	11	11	0	0	0		19
38	9	6	4	0	0	0		14
39	10	11	5	0	1	0		21.5
40	7	9	8	0	0	0		15.5
41	8	10	10	0	0	0		18
42	9	10	8	1	0	0		22
43	6	13	5	0	0	0		15
44	8	10	6	0	0	0		16
45	7	14	10	2	0	0		27
46	5	8	8	0	0	0		13
47	7	11	4	0	0	1		18.5
48	8	9	9	0	0	0		17
49	8	10	8	1	1	0		24.5
50	7	11	5	0	0	0		15
51	9	9	6	0	0	0		16.5
52	5	7	9	0	0	0		13
53	4	10	8	0	0	1		17
54	5	12	5	0	0	0		13.5
55	9	8	6	0	1	0		19.5
56	6	6	7	1	0	0		16.5
57	9	9	10	0	0	0		18.5
58	5	10	9	0	0	0		19.5
59	7	11	5	1	1	0		22
60	8	10	8	0	0	0		24
TOTAL	425	573	433	23	9	5	2339	27 1071.5

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 09-02-22 WEDNESDAY TIME : 9 TO 10 AM				TRAFFIC VOLUME SURVEY				
MIN	4w	2w	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	6	9	7	1	0	0		18
2	7	7	3	0	1	1		19.5
3	6	10	8	0	0	0		15
4	6	4	4	0	0	0		10
5	9	8	6	1	0	0		20
6	7	9	5	0	0	0		14
7	8	6	6	0	0	0		14
8	7	9	3	0	0	0		13
9	4	8	9	2	0	0		20.5
10	8	9	7	0	0	0		16
11	6	9	4	0	0	0		12.5
12	7	8	5	0	0	0		13.5
13	4	10	9	0	0	0		13.5
14	6	9	6	0	0	0		13.5
15	9	7	4	0	0	0		14.5
16	6	9	5	0	0	1		17
17	8	9	4	1	0	0		18.5
18	6	9	7	0	0	0		14
19	5	8	10	1	1	0		21.5
20	8	6	8	1	0	0		19
21	9	9	9	0	0	0		18
22	9	10	7	2	0	0		25.5
23	9	6	5	0	0	0		14.5
24	4	6	5	0	0	0		9.5
25	7	8	6	0	0	0		14
26	8	12	3	1	0	0		19.5
27	10	9	9	0	0	0		19
28	6	7	7	0	0	0		13
29	7	8	4	0	0	0		13
30	9	9	5	0	0	1		20
31	6	5	9	0	0	0		13
32	9	10	6	0	0	0		17
33	4	8	4	0	0	0		10
34	7	6	8	1	0	0		18
35	5	9	9	0	0	0		14
36	8	8	7	0	0	0		15.5
37	6	12	10	0	0	0		17
38	9	9	3	0	0	0		15
39	8	9	4	0	1	0		18
40	5	7	7	0	0	0		12
41	6	8	9	0	0	0		14.5
42	7	8	7	1	0	0		18.5
43	4	11	4	0	0	0		11.5
44	6	8	5	0	0	0		12.5
45	9	12	9	0	0	0		19.5
46	8	6	7	0	1	0		18
47	5	9	3	0	0	1		15
48	6	7	8	0	0	0		13.5
49	9	8	7	0	0	0		16.5
50	8	9	4	1	0	0		18.5
51	5	7	5	0	0	0		11
52	7	5	8	0	0	0		13.5
53	9	8	7	0	1	0		20
54	5	10	4	0	0	0		12
55	9	6	5	0	0	0		14.5
56	4	4	6	0	0	0		9
57	7	7	9	0	0	0		15
58	3	8	8	0	0	0		14
59	5	9	4	1	1	0		19
60	6	8	7	0	0	0		13.5
TOTAL	406	488	373	14	6	4	1323	29.5
								929.5

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 09-02-22 WEDNESDAY TIME : 7 TO 8 AM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	TRUCKS	BUS	TRACTOR		PCU
1	8	10	4	0	0	0		15
2	7	8	5	0	0	0		13.5
3	10	5	5	1	0	0		19
4	9	7	6	0	0	0		15.5
5	6	6	9	0	0	1		17.5
6	7	11	5	0	1	0		18.5
7	5	9	7	0	0	0		13
8	11	8	5	0	0	0		17.5
9	4	4	5	0	0	0		8.5
10	9	10	4	1	0	0		20
11	6	8	7	0	0	0		13.5
12	7	8	6	0	1	0		17.5
13	10	5	6	0	0	0		15.5
14	11	9	9	0	0	0		20
15	16	9	7	0	0	0		24
16	8	7	9	0	0	0		16
17	11	10	7	1	0	1		27.5
18	5	7	9	1	0	0		17
19	4	11	6	0	0	0		12.5
20	6	10	4	0	0	0		13
21	7	8	6	0	0	0		14
22	5	6	5	0	0	0		10.5
23	4	7	8	0	0	0		11.5
24	4	9	6	0	0	0		11.5
25	8	5	8	0	0	0		14.5
26	5	9	9	0	0	1		18
27	6	6	9	1	0	0		17.5
28	10	9	6	0	0	0		17.5
29	9	9	5	0	0	0		16
30	6	7	6	0	0	0		12.5
31	7	5	5	0	0	0		12
32	5	6	8	0	0	0		12
33	10	5	6	1	0	0		19.5
34	4	9	8	0	0	0		12.5
35	3	13	6	0	1	0		16
36	11	4	5	1	0	0		19.5
37	4	10	6	0	1	0		15.5
38	6	8	4	0	0	0		12
39	7	9	6	0	0	0		14.5
40	6	11	4	0	0	0		13.5
41	10	9	8	0	0	0		18.5
42	12	10	9	0	0	1		25.5
43	10	8	7	0	0	0		17.5
44	5	8	4	0	1	0		14.5
45	8	8	6	0	0	0		15
46	4	9	4	0	0	0		10.5
47	5	9	7	0	0	0		13
48	8	9	9	0	0	0		17
49	5	9	6	0	0	0		12.5
50	6	10	3	0	1	0		16
51	4	8	4	0	0	0		10
52	6	9	7	0	0	0		14
53	3	5	8	0	0	0		9.5
54	9	8	5	1	0	0		19.5
55	7	9	4	0	0	0		13.5
56	5	10	9	0	0	0		14.5
57	8	8	7	1	1	0		23
58	5	11	4	0	0	0		17.5
59	6	9	5	0	0	0		17
60	6	6	6	0	0	0		
TOTAL	419	489	373	9	7	4	2116	927.5
								926.5

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 09-02-22 WEDNESDAY TIME : 8 TO 9 AM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	TRUCKS	BUS	TRACTOR		PCU
1	5	7	4	0	0	0		10.5
2	8	9	5	0	0	0		15
3	7	6	6	1	0	0		17
4	6	8	7	0	0	0		13.5
5	7	7	8	0	0	1		18.5
6	8	8	6	0	1	0		18.5
7	6	10	8	1	0	0		19
8	5	9	6	0	0	0		12.5
9	6	5	4	1	0	0		14.5
10	7	11	5	0	0	0		15
11	7	9	8	0	0	0		15.5
12	8	9	7	0	1	0		19.5
13	8	6	4	1	0	0		17
14	9	8	10	0	0	0		18
15	7	10	8	0	0	0		16
16	9	8	10	0	0	0		18
17	7	7	8	0	1	0		18
18	6	8	7	1	0	1		21.5
19	5	7	7	0	0	0		12
20	7	10	5	0	0	0		14.5
21	8	9	7	0	0	0		16
22	6	7	5	0	0	0		12
23	5	8	9	0	0	0		13.5
24	5	10	6	0	0	0		13
25	9	6	9	0	0	0		16.5
26	6	9	10	0	0	1		19.5
27	7	7	7	0	0	0		14
28	8	9	7	1	0	0		20
29	6	10	6	0	0	0		14
30	7	8	7	0	0	0		14.5
31	8	6	6	0	0	0		14
32	6	7	9	0	0	0		14
33	11	6	3	0	0	0		15.5
34	5	10	9	0	0	0		14.5
35	4	8	4	0	1	0		13.5
36	12	5	6	0	0	0		17.5
37	5	11	4	1	0	0		16.5
38	7	9	5	0	0	0		14
39	8	10	7	0	0	0		16.5
40	7	9	5	0	0	0		14
41	11	10	9	0	0	0		20.5
42	8	7	8	1	0	0		19.5
43	11	9	8	0	0	0		19.5
44	6	8	3	0	0	0		11.5
45	9	9	4	0	0	0		15.5
46	5	10	5	1	0	0		16.5
47	6	9	8	0	0	0		14.5
48	9	9	9	0	1	0		21.5
49	6	10	7	1	0	0		18.5
50	7	8	4	0	0	0		13
51	5	9	5	0	0	0		12
52	7	7	8	0	0	0		14.5
53	4	6	9	0	0	0		11.5
54	10	9	6	0	0	0		17.5
55	8	5	5	0	0	0		13
56	6	8	10	0	0	0		15
57	9	9	8	1	1	0		25
58	6	9	5	0	0	0		13
59	7	10	6	0	0	0		15
60	8	7	7	0	0	0		
TOTAL	426	494	398	11	6	3	2159	25
								949

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 09-02-22 WEDNESDAY TIME : 9 TO 10 AM				TRAFFIC VOLUME SURVEY				
MIN	4w	2w	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	7	9	3	0	0	0		13
2	6	7	4	0	0	0		11.5
3	9	4	5	1	0	0		17.5
4	8	6	6	0	0	0		14
5	5	5	9	0	0	0		12
6	6	10	5	0	0	0		13.5
7	8	8	7	0	0	0		15.5
8	10	7	5	0	0	0		16
9	3	3	3	0	0	0		6
10	8	9	4	0	0	0		14.5
11	5	7	7	0	0	0		12
12	6	7	6	0	0	0		12.5
13	9	4	3	0	0	0		12.5
14	10	8	9	0	0	0		18.5
15	9	8	7	0	0	0		16.5
16	7	6	9	0	0	0		14.5
17	10	9	7	0	0	0		18
18	4	6	10	1	0	0		16
19	9	10	6	0	0	0		17
20	5	9	4	0	0	0		11.5
21	6	7	6	0	0	0		12.5
22	4	5	4	0	0	0		8.5
23	9	6	8	0	0	0		16
24	8	8	5	0	0	0		14.5
25	7	4	8	0	0	0		13
26	4	8	9	0	0	1		16.5
27	5	5	9	0	0	0		12
28	9	8	6	0	0	0		16
29	8	8	5	0	0	0		14.5
30	9	6	6	0	0	0		15
31	6	4	5	0	0	0		10.5
32	4	5	8	0	0	0		10.5
33	9	4	2	0	0	0		12
34	9	8	8	0	0	0		17
35	5	12	3	0	1	0		16
36	10	3	5	0	0	0		14
37	3	9	3	0	0	0		9
38	5	7	4	0	0	0		10.5
39	6	8	6	0	0	0		13
40	5	10	4	0	0	0		12
41	9	8	8	0	0	0		17
42	11	9	9	1	1	1		31.5
43	9	7	7	0	0	0		16
44	4	10	2	0	0	0		10
45	7	7	3	1	1	0		19.5
46	8	8	4	0	0	0		14
47	4	10	7	0	0	0		12.5
48	7	8	9	0	0	0		15.5
49	4	8	6	1	0	0		15
50	5	9	3	0	0	0		11
51	9	7	4	0	0	0		14.5
52	5	10	7	0	1	0		17
53	8	4	8	1	0	0		18
54	8	7	5	0	0	0		14
55	6	8	4	0	0	0		12
56	4	9	9	0	0	1		17
57	7	7	7	1	1	0		21.5
58	4	10	4	0	0	0		14
59	5	8	5	0	0	0		13.5
60	5	5	6	0	0	0		10.5
TOTAL	404	436	350	7	5	3	1228	31.5
								654.5

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 09-02-22 WEDNESDAY TIME : 5 TO 6 PM				TRAFFIC VOLUME SURVEY				
MIN	4W	2w	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	8	7	9	0	0	0		16
2	6	5	7	2	1	0		23.5
3	5	8	8	0	0	0		13
4	7	6	8	0	0	0		14
5	8	8	9	0	0	0		16.5
6	5	4	7	0	0	0		10.5
7	9	5	9	0	0	0		16
8	4	9	5	2	0	0		19
9	6	7	7	0	0	0		13
10	5	10	9	0	0	0		14.5
11	6	4	5	0	0	0		10.5
12	8	9	6	0	0	0		15.5
13	8	6	8	0	0	1		19
14	6	5	5	0	0	0		11
15	4	9	9	0	0	0		13
16	3	4	6	0	1	0		11.5
17	9	10	7	1	0	0		21.5
18	7	9	8	0	0	0		15.5
19	8	7	7	1	1	0		22.5
20	3	5	5	2	0	0		16
21	9	8	6	0	0	0		16
22	4	9	4	0	0	0		10.5
23	7	6	8	0	0	0		14
24	9	4	9	0	0	0		15.5
25	10	5	7	1	1	0		23.5
26	6	8	6	0	0	0		13
27	9	7	5	0	0	0		15
28	7	8	5	0	0	0		13.5
29	4	10	6	0	0	0		12
30	7	8	4	0	0	0		13
31	10	8	9	0	0	0		18.5
32	9	9	6	0	0	0		16.5
33	7	7	5	0	0	0		13
34	8	11	6	0	0	0		16.5
35	4	6	8	0	1	0		14.5
36	5	7	9	0	0	1		17
37	6	9	7	0	0	0		14
38	9	7	4	0	0	0		14.5
39	4	11	6	0	1	0		16
40	7	8	7	0	0	0		14.5
41	8	5	5	0	0	0		13
42	10	8	8	0	0	0		18
43	6	5	9	0	0	0		13
44	9	8	6	0	0	0		16
45	8	8	8	0	0	0		16
46	7	6	9	1	0	0		18.5
47	7	9	6	0	1	0		18
48	8	8	8	0	0	0		16
49	8	8	9	0	0	0		16.5
50	6	9	5	0	0	0		13
51	9	8	6	0	0	0		16
52	8	9	8	0	0	0		16.5
53	5	7	9	0	0	0		13
54	6	6	7	0	1	0		16
55	8	5	9	0	0	0		15
56	4	10	6	0	0	0		12
57	5	6	7	0	1	0		15
58	6	9	8	0	0	0		14.5
59	7	5	7	1	0	1		19
60	8	9	4	0	0	0		14.5
TOTAL	409	441	415	11	9	3	1319	23.5
								924.5

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 09-02-22 WEDNESDAY TIME : 6 TO 7 PM			TRAFFIC VOLUME SURVEY					
MIN	4W	2W	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	6	8	7	0	0	0		13.5
2	7	6	8	2	1	0		25.5
3	6	9	2	0	0	0		11.5
4	4	7	9	0	0	0		12
5	7	7	10	1	1	0		23
6	4	5	8	0	0	0		10.5
7	10	6	10	0	0	0		18
8	5	5	6	2	0	0		18.5
9	5	8	8	0	0	0		13
10	6	11	10	1	0	0		20.5
11	7	5	6	0	0	0		12.5
12	4	6	7	0	0	0		10.5
13	9	7	5	1	0	1		23
14	7	6	6	0	0	0		13
15	5	7	10	0	0	0		13.5
16	4	9	7	0	1	0		15.5
17	7	11	8	1	0	0		20.5
18	4	10	3	0	0	0		10.5
19	7	8	8	1	0	0		19
20	4	6	6	2	1	0		21.5
21	10	9	7	0	0	0		18
22	5	8	5	0	0	0		11.5
23	8	7	9	0	0	0		16
24	8	8	10	0	0	1		21
25	11	9	8	1	1	0		27
26	7	9	7	0	0	0		15
27	10	8	6	0	0	0		17
28	8	9	6	1	0	0		19.5
29	5	11	7	0	0	0		14
30	8	9	5	0	0	0		15
31	11	9	10	0	0	0		20.5
32	10	10	7	0	0	0		18.5
33	8	8	6	0	0	0		15
34	9	12	7	0	0	0		18.5
35	5	7	4	0	1	0		14
36	6	8	10	0	0	1		19
37	7	10	8	0	0	0		16
38	10	8	5	0	0	0		16.5
39	5	12	7	1	0	0		18.5
40	8	9	8	0	0	0		16.5
41	6	8	6	0	0	0		13
42	11	9	9	0	1	0		23.5
43	7	7	10	0	0	1		19.5
44	10	9	7	0	0	0		18
45	9	9	9	0	0	0		18
46	5	7	10	1	1	0		21
47	8	6	7	0	0	0		14.5
48	4	9	9	1	0	0		17
49	9	9	10	0	0	0		18.5
50	7	10	6	1	0	0		19
51	10	9	7	0	0	0		18
52	9	10	4	0	1	0		19.5
53	6	8	10	0	0	0		15
54	7	7	8	0	1	0		18
55	9	6	10	0	1	0		20.5
56	5	11	7	0	0	0		14
57	6	7	8	1	0	0		17.5
58	7	5	5	0	1	0		15.5
59	8	6	8	1	0	1		
60	7	7	5	0	0	0		13
TOTAL	427	486	441	19	12	5	2212	27
								1028.5

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 09-02-22 WEDNESDAY TIME : 7 TO 8 PM				TRAFFIC VOLUME SURVEY				
MIN	4W	2w	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	5	7	6	0	0	0		11.5
2	6	5	7	0	1	0		15.5
3	5	8	8	0	0	0		13
4	8	6	8	0	0	0		15
5	9	6	9	1	0	0		20.5
6	7	4	7	0	0	0		12.5
7	9	5	9	0	0	0		16
8	4	4	5	1	0	0		12.5
9	4	7	7	0	0	0		11
10	5	10	9	0	0	0		14.5
11	6	4	5	0	0	0		10.5
12	7	5	6	0	0	0		12.5
13	8	6	9	0	0	1		19.5
14	6	5	5	0	0	0		11
15	4	9	9	0	0	0		13
16	7	4	6	0	1	0		15.5
17	8	10	7	1	0	0		20.5
18	6	9	2	0	0	0		11.5
19	9	7	7	1	0	0		20
20	5	5	5	2	1	0		21.5
21	9	8	6	0	0	0		16
22	4	9	4	0	0	0		10.5
23	7	6	8	0	0	0		14
24	9	7	9	0	0	0		17
25	10	9	7	1	0	0		22
26	6	8	6	0	0	0		13
27	9	7	5	0	0	0		15
28	7	8	9	0	1	0		19
29	4	10	6	0	0	0		12
30	7	8	4	0	0	0		13
31	10	8	9	0	0	0		18.5
32	9	9	6	0	0	0		16.5
33	7	7	5	1	0	0		17
34	8	11	6	0	0	0		16.5
35	9	6	9	0	1	0		20
36	5	7	9	0	0	1		17
37	6	9	7	0	0	0		14
38	5	9	8	0	0	0		13.5
39	4	11	6	0	1	0		16
40	7	8	7	0	0	0		14.5
41	8	5	5	0	0	0		13
42	7	8	8	0	1	0		18.5
43	6	9	9	0	0	0		15
44	9	8	6	0	0	0		16
45	8	8	8	0	0	0		16
46	4	6	9	1	0	0		15.5
47	7	5	6	0	0	0		12.5
48	8	8	8	0	0	0		16
49	8	8	9	0	0	0		16.5
50	6	9	5	0	0	0		13
51	5	8	6	1	0	0		16
52	8	9	8	0	1	0		20
53	5	7	4	0	0	0		10.5
54	6	6	7	0	1	0		16
55	8	5	9	0	0	0		15
56	4	10	6	0	0	0		12
57	5	6	7	0	0	0		11.5
58	6	4	4	0	0	0		10
59	7	5	7	1	0	1		21
60	4	5	4	0	0	0		8.5
TOTAL	399	430	407	11	9	3	1290	905

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 09-02-22 wednesday TIME : 5 TO 6 AM				TRAFFIC VOLUME SURVEY				
MIN	4W	2w	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	5	9	6	0	0	0		12.5
2	5	7	9	0	0	0		13
3	6	4	7	0	0	0		11.5
4	5	5	7	0	0	0		11
5	9	8	8	0	0	0		17
6	4	9	5	0	0	0		11
7	7	6	8	0	0	0		14
8	6	4	9	0	0	0		12.5
9	9	5	7	0	1	0		18.5
10	8	4	10	0	0	0		15
11	10	7	5	0	0	0		16
12	3	6	5	1	0	0		12.5
13	8	9	9	0	0	0		17
14	7	8	5	0	0	0		13.5
15	8	5	7	0	0	0		14
16	5	6	8	0	0	0		12
17	9	9	5	0	0	0		16
18	5	5	4	0	0	0		9.5
19	6	8	1	0	0	0		10.5
20	5	9	3	0	0	0		11
21	9	7	5	0	1	0		18.5
22	8	7	3	0	0	0		13
23	6	9	4	0	0	0		12.5
24	9	8	6	0	0	0		16
25	8	7	4	0	0	0		13.5
26	7	8	6	0	0	0		14
27	8	8	9	0	0	0		16.5
28	8	9	9	0	0	0		17
29	6	7	7	0	0	0		13
30	8	8	8	0	0	0		16
31	7	6	5	0	0	0		12.5
32	4	8	6	1	0	0		15
33	5	6	9	0	1	0		16
34	6	8	7	0	0	1		17.5
35	7	5	7	0	0	0		13
36	9	9	8	1	0	0		21.5
37	8	7	5	0	0	0		14
38	6	8	8	0	0	0		14
39	8	7	9	0	0	0		16
40	6	8	7	1	0	0		17.5
41	4	9	4	0	0	0		10.5
42	6	9	6	1	0	0		17.5
43	8	10	8	0	0	0		17
44	8	8	6	0	0	0		15
45	5	8	8	0	0	0		13
46	6	7	8	0	1	0		17
47	4	8	9	0	0	0		12.5
48	9	8	7	0	0	0		16.5
49	8	8	5	0	0	0		14.5
50	4	5	8	0	0	0		10.5
51	5	4	4	0	0	0		9
52	8	7	7	0	0	0		15
53	8	9	6	0	0	0		15.5
54	7	9	4	0	1	0		17
55	5	8	9	0	0	1		17.5
56	7	9	7	2	0	0		23
57	6	6	5	0	0	0		11.5
58	7	6	6	1	0	0		17
59	8	9	8	0	1	0		20
60	5	6	4	0	0	0		10
TOTAL	401	436	389	8	6	2	1269	23
								874.5

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 09-02-22 wednesday TIME : 6 TO 7 AM			TRAFFIC VOLUME SURVEY					
MIN	4W	2W	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	4	10	7	0	0	0		12.5
2	6	8	10	0	0	0		15
3	7	5	8	0	0	0		13.5
4	6	6	8	1	0	0		17
5	10	9	9	0	0	0		19
6	5	10	6	0	0	1		17
7	4	7	9	1	0	0		16
8	7	5	10	0	0	0		14.5
9	10	6	8	0	0	0		17
10	5	5	11	1	0	0		17
11	11	8	6	0	0	0		18
12	4	7	6	1	0	0		14.5
13	9	4	10	0	0	0		16
14	8	9	6	0	0	0		15.5
15	3	6	8	0	0	0		10
16	6	7	9	0	0	0		14
17	4	10	6	0	0	0		12
18	6	6	5	0	0	0		11.5
19	7	9	2	1	0	0		16.5
20	6	10	4	0	0	0		13
21	10	8	6	0	1	0		20.5
22	9	8	4	0	0	0		15
23	7	5	5	0	0	0		12
24	10	9	7	0	0	0		18
25	9	8	5	1	0	0		19.5
26	8	9	7	0	0	0		16
27	3	5	4	0	0	0		7.5
28	9	10	10	0	0	0		19
29	7	8	8	0	0	0		15
30	5	9	5	0	0	0		12
31	8	7	6	0	0	0		14.5
32	5	3	7	0	1	0		13.5
33	6	7	10	0	0	0		14.5
34	7	5	8	0	0	1		17.5
35	10	6	8	0	0	0		17
36	4	5	9	1	0	0		15
37	3	8	6	0	0	0		10
38	11	9	9	0	0	0		20
39	9	8	10	0	0	0		18
40	7	9	8	0	0	0		15.5
41	5	10	5	0	0	0		12.5
42	7	8	7	0	0	0		14.5
43	3	11	5	0	0	0		11
44	9	5	7	0	0	0		15
45	6	9	5	0	0	0		13
46	7	8	9	0	1	0		19
47	5	9	10	0	0	0		14.5
48	10	4	8	0	0	0		16
49	4	9	6	0	1	0		15
50	3	6	4	0	0	0		8
51	11	5	5	0	0	0		16
52	9	8	8	0	0	0		17
53	2	10	7	0	1	0		14
54	8	10	4	0	0	0		15
55	4	9	10	0	0	1		17.5
56	8	10	8	2	1	0		28.5
57	7	7	6	0	0	0		13.5
58	4	7	7	0	0	0		11
59	9	6	9	0	1	0		20
60	6	7	5	0	0	0		11
TOTAL	402	451	425	9	7	3	2086	28.5
								912.5

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 09-02-22 wednesday TIME : 7 TO 8 AM				TRAFFIC VOLUME SURVEY				
MIN	4W	2w	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	4	9	6	0	0	0		11.5
2	5	7	9	0	0	0		13
3	6	4	7	0	0	0		11.5
4	5	5	7	0	0	0		11
5	9	8	8	0	0	0		17
6	4	9	5	0	0	0		11
7	3	6	8	0	0	0		10
8	6	4	9	0	0	0		12.5
9	9	5	7	0	0	0		15
10	4	4	10	0	0	0		11
11	10	7	5	0	0	0		16
12	4	6	5	1	0	0		13.5
13	8	3	9	0	0	0		14
14	7	8	5	0	0	0		13.5
15	4	5	7	0	0	0		10
16	5	6	8	0	0	0		12
17	3	9	5	0	0	0		10
18	5	5	4	0	0	1		13.5
19	6	8	5	0	0	0		12.5
20	5	9	3	0	0	0		11
21	9	7	5	0	1	0		18.5
22	8	7	3	0	0	0		13
23	6	4	4	0	0	0		10
24	9	8	6	0	0	0		16
25	8	7	4	0	0	0		13.5
26	7	8	6	0	0	0		14
27	4	4	6	0	1	0		12.5
28	8	9	9	0	0	0		17
29	6	7	7	0	0	0		13
30	4	8	4	0	0	0		10
31	7	6	5	0	0	0		12.5
32	8	8	6	0	0	0		15
33	5	6	9	0	0	0		12.5
34	6	4	7	0	0	1		15.5
35	9	5	7	0	0	0		15
36	7	4	8	1	0	0		17
37	4	7	5	0	0	0		10
38	10	8	8	0	0	0		18
39	8	7	9	0	0	0		16
40	6	8	7	0	0	0		13.5
41	9	9	4	1	0	0		19.5
42	6	7	6	0	0	0		12.5
43	4	10	4	0	0	0		11
44	8	4	6	0	0	0		13
45	5	8	4	0	1	0		14.5
46	6	7	8	0	0	0		13.5
47	9	8	9	1	0	0		21.5
48	9	8	7	0	0	0		16.5
49	3	8	5	0	0	0		9.5
50	4	5	3	1	1	0		15.5
51	10	4	4	0	0	0		14
52	8	7	7	0	0	0		15
53	8	4	6	0	0	0		13
54	7	9	3	0	0	0		13
55	3	8	9	0	0	1		15.5
56	7	9	7	2	1	0		26.5
57	6	6	5	0	0	0		11.5
58	4	6	6	0	0	0		11
59	8	5	8	0	1	0		18
60	5	6	4	0	0	0		10
TOTAL	380	397	372	7	6	3	1189	825.5

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 06-02-22 SUNDAY TIME : 7 TO 8 AM				TRAFFIC VOLUME SURVEY				
MIN	4w	2w	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	10	7	11	0	1	0		22.5
2	9	12	10	2	0	0		28
3	8	14	7	0	0	0		18.5
4	6	9	9	1	0	1		23
5	8	10	9	0	0	0		17.5
6	7	8	6	0	0	0		14
7	10	10	5	0	0	0		17.5
8	8	8	6	1	0	0		19
9	12	10	9	0	0	0		21.5
10	10	7	9	0	0	0		18
11	8	10	7	1	0	1		24.5
12	7	9	9	1	0	0		20
13	14	8	5	0	1	0		24
14	6	12	7	2	0	0		23.5
15	9	11	8	0	0	0		18.5
16	10	9	9	1	0	0		23
17	15	12	4	0	0	1		27
18	7	9	9	1	0	0		20
19	10	7	6	0	0	0		16.5
20	8	15	9	1	1	0		27.5
21	8	10	7	0	0	0		16.5
22	12	9	10	0	0	0		21.5
23	9	11	5	1	0	0		21
24	8	13	11	1	0	0		24
25	9	8	6	0	0	0		16
26	10	9	9	2	0	0		27
27	12	7	10	1	0	0		24.5
28	9	10	8	1	0	0		22
29	10	11	9	0	1	0		23.5
30	8	8	4	0	0	0		14
31	7	12	6	0	2	0		23
32	11	14	9	1	0	0		26.5
33	12	9	6	0	1	0		23
34	9	10	8	1	0	0		22
35	7	8	9	0	1	0		19
36	10	10	7	2	0	0		26.5
37	8	13	10	0	0	0		19.5
38	9	9	5	1	0	0		20
39	9	10	8	0	1	1		25.5
40	8	9	9	0	1	0		20.5
41	7	10	7	0	1	0		19
42	12	9	4	1	0	0		22.5
43	7	11	5	0	0	0		15
44	11	13	9	0	1	0		25.5
45	9	11	7	0	0	0		18
46	9	8	9	0	0	0		17.5
47	7	12	8	0	2	0		24
48	8	14	7	1	0	0		22.5
49	11	9	8	1	1	0		27
50	6	15	5	0	0	1		20
51	9	8	6	0	2	0		23
52	7	9	9	0	0	0		16
53	9	8	8	1	1	0		24.5
54	8	12	5	0	0	0		16.5
55	10	7	6	0	0	0		16.5
56	7	10	9	0	2	0		23.5
57	9	9	5	1	0	0		20
58	7	8	9	0	0	0		16
59	10	9	10	0	1	0		24
60	9	8	8	1	0	0		21
TOTAL	539	597	454	28	21	5	1688	28
								1270

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 06-02-22 SUNDAY TIME : 8 TO 9 AM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	TRUCKS	BUS	TRACTOR		PCU
1	8	10	9	0	1	1		25
2	12	9	12	2	0	0		30.5
3	11	8	9	0	2	0		26.5
4	9	11	6	1	0	1		25.5
5	9	12	11	1	1	0		28
6	10	10	8	0	0	0		19
7	8	9	7	0	0	0		16
8	9	10	8	1	2	0		29
9	8	11	5	1	0	0		20
10	13	9	11	0	1	1		30.5
11	9	12	9	1	0	0		23.5
12	10	6	6	1	0	0		20
13	9	8	7	0	1	0		20
14	9	9	9	2	2	0		33
15	8	10	10	1	0	0		22
16	7	11	7	0	0	0		16
17	8	8	6	0	1	1		22.5
18	10	11	3	1	0	0		21
19	9	9	8	0	0	0		17.5
20	11	17	11	1	1	0		32.5
21	9	12	9	0	0	0		19.5
22	10	11	12	1	0	0		25.5
23	9	9	7	1	0	0		21
24	11	8	7	0	0	0		18.5
25	12	10	8	0	0	0		21
26	9	11	5	2	0	0		25
27	8	9	11	1	0	0		22
28	9	12	5	1	0	0		21.5
29	9	13	10	0	1	1		28
30	6	10	6	1	0	0		18
31	10	14	8	0	0	0		21
32	7	16	7	1	0	0		22.5
33	9	11	8	1	0	0		22.5
34	10	9	5	0	0	0		17
35	10	10	11	0	0	0		20.5
36	8	12	9	2	2	0		33.5
37	11	15	6	0	0	0		21.5
38	9	11	7	1	0	0		22
39	8	12	10	0	0	1		23
40	9	11	11	0	1	0		23.5
41	10	12	9	0	1	0		24
42	9	11	6	1	0	0		21.5
43	10	9	7	1	1	0		25.5
44	9	15	11	0	0	0		22
45	12	13	9	0	0	0		23
46	7	10	5	2	0	0		22.5
47	10	7	10	1	1	0		26
48	8	8	9	0	0	0		16.5
49	9	7	6	1	1	0		23
50	9	9	7	0	0	1		21
51	12	10	8	0	0	0		21
52	10	11	11	2	0	0		29
53	8	10	10	1	0	0		22
54	11	9	7	0	0	1		23
55	9	11	8	0	0	0		18.5
56	10	8	6	2	2	0		32
57	12	9	7	0	0	0		20
58	7	10	11	1	0	1		25.5
59	10	9	8	0	1	0		22
60	12	10	6	1	0	0		23
TOTAL	564	624	485	38	23	9	1480	33.5 1387

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 06-02-22 SUNDAY TIME : 9 TO 10 AM				TRAFFIC VOLUME SURVEY				
MIN	4w	2w	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	8	8	7	0	1	0		19
2	9	12	10	2	0	0		28
3	8	14	7	0	0	0		18.5
4	6	9	9	1	1	1		26.5
5	6	10	9	0	0	0		15.5
6	7	8	6	0	1	0		17.5
7	10	10	5	0	0	0		17.5
8	8	8	6	1	2	0		26
9	12	9	7	0	0	0		20
10	10	7	9	0	0	0		18
11	6	10	7	1	0	0		18.5
12	7	4	9	1	1	0		21
13	14	8	5	0	1	0		24
14	6	12	7	2	0	0		23.5
15	9	11	8	0	0	0		18.5
16	10	9	5	0	1	0		20.5
17	15	12	11	0	0	1		30.5
18	8	9	5	1	0	0		19
19	10	7	6	0	0	0		16.5
20	8	15	9	0	1	0		23.5
21	6	10	7	0	1	0		18
22	7	9	10	0	0	0		16.5
23	6	7	5	1	0	0		16
24	8	13	5	0	0	0		17
25	9	8	6	0	0	0		16
26	10	9	8	2	1	0		30
27	5	7	9	0	0	0		13
28	10	10	6	1	0	0		22
29	6	11	8	0	1	0		19
30	9	8	10	0	1	0		21.5
31	7	12	6	0	0	0		16
32	11	14	5	1	0	0		24.5
33	9	9	6	0	0	0		16.5
34	9	7	9	0	0	0		17
35	7	8	9	0	0	0		15.5
36	10	10	7	2	1	0		30
37	8	13	9	0	0	0		19
38	6	9	5	1	0	0		17
39	9	10	8	0	0	1		22
40	8	9	9	0	1	0		20.5
41	7	10	7	0	1	0		19
42	6	9	9	1	0	0		19
43	7	11	5	0	0	0		15
44	11	13	9	0	0	0		22
45	9	11	7	0	1	0		21.5
46	8	8	3	2	0	0		21.5
47	7	12	8	0	0	0		17
48	9	14	7	0	0	0		19.5
49	10	9	8	1	0	0		22.5
50	6	15	5	0	0	1		20
51	9	8	6	0	0	0		16
52	7	9	9	0	0	0		16
53	5	8	8	1	0	0		17
54	8	9	5	0	0	0		15
55	6	7	6	0	1	0		16
56	7	10	8	0	0	0		16
57	9	9	5	0	0	0		16
58	7	8	9	0	0	0		15
59	10	7	6	0	1	0		16
60	9	8	9	1	0	0		1[illegible]
TOTAL	494	580	433	23	19	4	1588	30[illegible] 1175

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 06-02-22 SUNDAY TIME : 7 TO 8 AM				TRAFFIC VOLUME SURVEY				
MIN	4w	2w	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	8	8	5	0	0	0		14.5
2	9	6	6	1	0	0		19
3	6	11	7	0	1	0		18.5
4	10	7	9	0	0	0		18
5	8	9	7	0	0	0		16
6	6	8	9	0	0	0		14.5
7	4	7	7	0	1	0		14.5
8	7	9	4	1	0	0		17.5
9	9	6	6	0	0	0		15
10	5	8	4	1	1	0		18.5
11	9	12	6	0	2	0		25
12	5	8	4	0	0	0		11
13	6	8	8	0	0	0		14
14	5	10	9	0	0	0		14.5
15	9	9	7	0	0	0		17
16	11	7	5	1	0	0		21
17	9	9	9	0	1	0		21.5
18	4	5	4	0	0	0		8.5
19	7	8	7	0	1	0		18
20	8	9	6	0	0	1		19.5
21	10	6	7	0	0	1		20.5
22	6	9	9	1	0	0		19
23	9	5	7	0	0	0		15
24	8	9	8	0	0	0		16.5
25	9	8	5	0	0	0		15.5
26	6	11	6	0	0	0		14.5
27	9	10	9	0	0	0		18.5
28	8	8	9	0	0	0		16.5
29	10	9	7	0	0	0		18
30	9	7	8	0	0	0		16.5
31	8	8	5	1	0	0		18.5
32	8	11	4	0	1	0		19
33	6	9	8	0	0	0		14.5
34	10	7	7	0	0	0		17
35	9	8	9	2	1	0		29
36	7	10	4	0	0	0		14
37	6	11	5	0	0	0		14
38	9	10	6	0	0	1		21
39	9	6	9	0	1	0		20
40	5	13	8	0	0	0		15.5
41	6	10	7	0	0	0		14.5
42	9	8	8	0	0	0		17
43	4	7	6	2	0	0		18.5
44	10	10	9	0	0	0		19.5
45	9	9	8	0	0	0		17.5
46	8	8	9	0	0	0		16.5
47	7	5	7	0	0	0		13
48	9	8	8	1	0	1		25
49	8	8	9	0	0	0		16.5
50	6	6	6	0	0	0		12
51	8	9	9	0	0	0		17
52	7	10	7	0	1	0		19
53	4	6	10	1	0	0		16
54	5	8	9	0	0	0		13.5
55	6	5	8	0	0	1		16.5
56	6	9	4	0	0	0		12.5
57	5	7	6	0	0	0		11.5
58	9	10	5	2	0	0		24.5
59	5	7	8	0	0	0		13
60	6	5	7	0	0	0		12
TOTAL	443	494	419	14	11	5	1420	29
								1014

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 06-02-22 SUNDAY TIME : 8 TO 9 AM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	TRUCKS	BUS	TRACTOR		PCU
1	9	6	7	0	0	0		15.5
2	6	8	8	1	0	0		18
3	9	13	5	0	0	1		22
4	9	9	11	0	0	0		19
5	11	5	9	0	0	0		18
6	9	11	11	0	0	0		20
7	7	9	9	0	0	0		16
8	10	9	6	1	0	0		21.5
9	7	6	8	0	0	0		14
10	8	10	6	1	0	0		20
11	6	14	8	0	0	0		17
12	8	10	6	0	0	0		16
13	9	10	10	0	0	1		23
14	8	12	11	0	0	0		19.5
15	10	11	9	0	0	0		20
16	9	9	7	1	0	0		21
17	8	9	5	0	0	0		15
18	7	7	6	0	0	0		13.5
19	7	10	9	0	1	0		20
20	6	11	8	0	0	1		19.5
21	8	8	5	0	0	0		14.5
22	9	6	11	1	0	0		21.5
23	9	7	9	0	0	0		17
24	7	6	6	0	0	0		13
25	8	9	7	0	0	0		16
26	9	13	8	0	0	0		19.5
27	7	12	11	0	0	0		18.5
28	9	10	6	0	0	0		17
29	6	11	9	0	0	1		20
30	5	9	10	0	0	0		14.5
31	9	10	7	1	0	0		21.5
32	7	6	6	0	0	0		13
33	9	11	3	1	0	0		20
34	8	9	7	0	0	0		16
35	6	10	5	2	1	0		25
36	8	12	6	0	1	0		20.5
37	9	13	7	0	0	0		19
38	8	7	8	1	0	1		23.5
39	7	8	11	0	1	0		20
40	8	15	7	0	0	0		19
41	9	12	9	0	0	0		19.5
42	9	10	10	0	1	0		22.5
43	7	9	8	2	0	1		27.5
44	9	12	6	0	0	0		18
45	6	6	10	0	1	0		17.5
46	7	10	11	0	0	0		17.5
47	10	7	9	0	1	0		21.5
48	5	10	4	1	0	0		16
49	11	10	5	0	0	0		18.5
50	9	8	6	0	1	0		19.5
51	7	7	9	0	0	1		19
52	10	12	3	0	0	0		17.5
53	7	8	5	1	0	0		17.5
54	8	6	7	0	1	0		18
55	8	7	5	0	0	1		18
56	9	6	6	0	0	0		15
57	8	9	8	0	1	0		20
58	9	12	7	2	0	0		26.5
59	8	9	5	0	1	0		18.5
60	9	7	9	0	0	0		15
TOTAL	484	558	450	16	11	8	1165	1122.5

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 06-02-22 SUNDAY TIME : 9 TO 10 AM				TRAFFIC VOLUME SURVEY				
MIN	4w	2w	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	8	8	5	0	0	0		14.5
2	7	6	6	1	0	0		17
3	6	11	9	0	0	0		16
4	10	7	9	0	0	0		18
5	8	8	7	0	0	0		15.5
6	6	9	9	0	0	0		15
7	4	7	7	0	0	0		11
8	7	9	4	1	0	0		17.5
9	8	10	6	0	0	0		16
10	5	8	9	1	1	0		21
11	9	12	6	0	0	0		18
12	5	8	10	0	1	0		17.5
13	6	8	8	0	0	0		14
14	5	10	9	0	0	0		14.5
15	9	9	7	0	0	0		17
16	11	7	5	1	0	0		21
17	9	7	9	0	0	0		17
18	4	5	4	0	0	0		8.5
19	7	8	7	0	1	0		18
20	8	9	6	0	0	1		19.5
21	10	6	6	0	1	0		19.5
22	6	4	9	1	0	0		16.5
23	9	5	7	0	0	0		15
24	8	9	9	0	0	0		17
25	5	7	5	0	0	0		11
26	6	11	6	0	0	0		14.5
27	7	10	6	0	0	0		15
28	9	8	8	0	0	0		17
29	7	9	7	0	0	0		15
30	11	7	8	0	1	0		22
31	10	8	5	1	0	0		20.5
32	8	9	4	0	0	0		14.5
33	6	9	9	0	0	0		15
34	5	7	5	0	0	0		11
35	9	8	6	2	1	0		27.5
36	5	10	9	0	0	0		14.5
37	6	11	5	0	0	0		14
38	5	5	6	0	0	0		10.5
39	9	8	9	0	1	0		21
40	5	13	5	0	0	0		14
41	11	10	7	0	1	0		23
42	9	8	8	0	0	0		17
43	9	7	6	2	0	1		27.5
44	10	10	4	0	0	0		17
45	8	4	8	0	0	0		14
46	8	8	9	0	0	0		16.5
47	7	5	7	0	1	0		16.5
48	6	8	8	0	0	0		14
49	8	8	7	0	0	0		15.5
50	6	6	9	0	0	0		13.5
51	4	5	7	0	0	0		10
52	7	10	4	0	0	0		14
53	8	6	9	1	0	0		19.5
54	9	8	5	0	0	0		15.5
55	5	5	8	0	0	1		15.5
56	6	4	9	0	0	0		12.5
57	5	7	6	0	0	0		11.5
58	9	10	5	1	0	0		20.5
59	5	7	10	0	0	0		19.5
60	9	5	7	0	0	0		15
TOTAL	437	471	419	12	9	3	1386	27.5 973.5

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 06-02-22 SUNDAY TIME : 5 TO 6 PM				TRAFFIC VOLUME SURVEY				
MIN	4w	2w	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	7	10	5	2	0	0		22.5
2	5	4	10	0	0	0		12
3	5	8	8	0	1	0		16.5
4	6	12	6	0	0	0		15
5	9	6	7	1	0	0		19.5
6	8	9	5	0	0	0		15
7	6	12	8	2	1	1		31.5
8	8	6	9	1	0	0		19.5
9	9	9	6	0	0	0		16.5
10	8	11	8	0	0	0		17.5
11	11	8	9	0	0	0		19.5
12	9	12	6	0	0	0		18
13	4	14	4	1	0	0		17
14	9	9	5	0	0	0		16
15	9	7	4	0	2	0		21.5
16	10	8	7	1	0	0		21.5
17	6	9	10	0	1	0		19
18	9	8	8	0	0	0		17
19	8	9	9	2	0	0		25
20	9	7	7	0	1	0		19.5
21	6	5	8	0	0	0		12.5
22	9	8	4	0	0	0		15
23	10	10	9	1	0	0		23.5
24	8	6	8	0	0	0		15
25	9	4	9	0	0	0		15.5
26	10	5	7	1	0	0		20
27	6	4	10	0	0	0		13
28	7	12	9	1	1	0		25
29	10	4	4	0	0	1		18
30	6	12	7	0	0	0		15.5
31	9	5	7	0	0	0		15
32	10	6	10	0	0	0		18
33	9	13	5	0	0	0		18
34	7	10	5	0	0	0		14.5
35	10	8	6	0	0	0		17
36	9	9	9	0	0	0		18
37	7	9	9	1	0	0		20
38	10	7	7	0	0	0		17
39	7	11	4	0	0	0		14.5
40	9	8	5	0	1	0		19
41	8	8	9	1	0	0		20.5
42	7	14	7	2	0	0		25.5
43	8	9	9	0	0	0		17
44	11	9	5	0	0	0		18
45	5	10	6	0	1	0		16.5
46	9	5	9	0	0	0		16
47	12	11	10	0	0	0		22.5
48	8	8	7	0	0	0		15.5
49	10	11	8	0	1	0		23
50	9	8	5	0	0	0		15.5
51	9	8	6	0	0	0		16
52	7	9	8	1	0	0		19.5
53	8	18	9	0	1	0		25
54	10	19	7	0	0	1		27
55	6	8	6	0	1	0		16.5
56	9	15	9	0	0	0		21
57	8	9	6	0	0	0		15.5
58	5	10	4	0	0	0		1[illegible]
59	6	8	8	0	1	0		[illegible]
60	4	5	9	0	0	0		[illegible]
TOTAL	482	536	430	18	13	3	1519	3115
								1094.5

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 06-02-22 SUNDAY TIME : 6 TO 7 PM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	TRUCKS	BUS	TRACTOR		PCU
1	9	8	7	2	0	0		24.5
2	6	6	9	0	0	0		13.5
3	7	9	10	0	1	0		20
4	8	10	8	0	0	0		17
5	9	8	9	1	0	0		21.5
6	10	11	7	0	0	0		19
7	8	9	9	2	0	1		29
8	9	8	11	1	0	0		22.5
9	5	11	8	0	0	0		14.5
10	4	9	9	0	0	0		13
11	10	10	11	0	0	0		20.5
12	11	9	8	0	0	0		19.5
13	6	8	6	1	0	0		17
14	9	11	7	0	0	0		18
15	5	9	6	0	0	0		12.5
16	12	10	7	1	1	0		28
17	8	9	8	0	0	0		16.5
18	11	8	10	0	0	0		20
19	9	11	9	2	0	0		27
20	7	9	9	0	1	0		19.5
21	8	7	10	0	1	0		20
22	6	9	6	0	0	0		13.5
23	9	12	11	1	0	0		24.5
24	10	8	9	0	0	0		18.5
25	9	6	11	0	1	0		21
26	12	7	9	3	0	0		32
27	8	6	8	0	0	0		15
28	9	14	5	0	1	0		22
29	11	6	6	0	0	1		21
30	8	14	9	0	0	0		19.5
31	11	7	9	0	0	0		19
32	9	8	12	0	1	0		22.5
33	8	9	7	0	0	0		16
34	9	12	7	0	0	0		18.5
35	8	10	8	0	2	0		24
36	11	11	5	0	0	0		19
37	9	9	11	1	0	0		23
38	9	9	9	0	1	0		21.5
39	9	9	6	0	0	0		16.5
40	8	10	7	0	0	0		16.5
41	11	9	11	1	0	0		25
42	9	7	9	2	0	0		25
43	10	8	6	0	1	0		20.5
44	6	11	7	0	0	0		15
45	7	9	8	0	1	0		19
46	8	7	11	1	0	0		21
47	9	13	9	0	0	0		20
48	10	5	9	0	2	0		24
49	8	8	10	0	0	0		17
50	11	10	7	0	0	0		19.5
51	6	9	8	0	1	0		18
52	9	11	5	1	0	0		21
53	5	9	11	0	0	0		15
54	12	10	9	0	1	0		25
55	8	8	8	0	0	0		16
56	11	9	6	0	2	0		25.5
57	10	11	8	0	0	1		23.5
58	7	9	6	0	0	0		14.5
59	8	10	9	1	1	0		25
60	6	7	8	0	0	0		13.5
TOTAL	515	546	498	21	19	3	2585	32 1195.5

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DIRECTION : METODA GIDC TO KATARIYA SHOWROM								
DATE : 06-02-22 SUNDAY TIME : 7 TO 8 PM				TRAFFIC VOLUME SURVEY				
MIN	4w	2w	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	10	10	5	1	0	0		21.5
2	4	4	10	0	0	0		11
3	5	8	8	0	0	0		13
4	6	12	6	0	0	0		15
5	12	6	7	1	0	0		22.5
6	8	9	5	0	0	0		15
7	6	12	8	0	0	1		20
8	6	6	9	1	0	0		17.5
9	3	9	6	0	0	0		10.5
10	8	11	8	0	0	0		17.5
11	11	8	9	0	0	0		19.5
12	9	12	6	0	0	0		18
13	4	9	4	1	0	0		14.5
14	7	9	5	0	1	0		17.5
15	4	7	4	0	0	0		9.5
16	10	8	7	1	0	0		21.5
17	6	9	10	0	0	0		15.5
18	9	8	8	0	1	0		20.5
19	8	9	9	2	0	0		25
20	5	7	7	0	1	0		15.5
21	6	5	8	0	0	0		12.5
22	4	8	4	0	0	0		10
23	10	10	9	1	1	0		27
24	8	6	8	0	0	0		15
25	7	7	9	0	0	0		15
26	8	5	7	0	0	0		14
27	6	4	10	0	0	0		13
28	7	10	3	0	0	0		13.5
29	8	4	4	0	0	1		16
30	6	12	7	0	0	0		15.5
31	9	5	7	0	0	0		15
32	10	6	10	0	0	0		18
33	8	8	5	0	1	0		18
34	7	10	5	0	0	0		14.5
35	10	8	6	0	1	0		20.5
36	9	9	9	0	0	0		18
37	7	9	9	1	0	0		20
38	8	7	7	0	0	0		15
39	7	11	4	0	0	0		14.5
40	10	8	5	0	0	0		16.5
41	9	12	9	1	0	0		23.5
42	7	8	7	0	1	0		18
43	8	9	4	0	0	0		14.5
44	4	9	5	0	0	0		11
45	5	10	6	0	1	0		16.5
46	6	5	9	1	0	0		17
47	12	11	10	0	0	0		22.5
48	8	8	7	0	0	0		15.5
49	6	11	8	0	0	0		15.5
50	9	8	5	0	0	0		15.5
51	4	8	6	0	0	0		11
52	7	9	8	0	0	0		15.5
53	3	8	9	0	0	0		11.5
54	8	10	7	0	0	0		16.5
55	6	8	6	0	0	0		13
56	9	9	4	0	0	0		15.5
57	8	9	6	0	0	0		15.5
58	5	9	8	0	0	0		13.5
59	6	8	8	0	1	0		15.5
60	7	5	9	0	0	0		14
TOTAL	433	499	418	11	9	2	1402	27 575

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 06-02-22 SUNDAY TIME : 5 TO 6 AM				TRAFFIC VOLUME SURVEY				
MIN	4w	2w	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	9	8	9	0	1	0		21
2	8	9	7	0	0	0		16
3	4	7	5	1	1	0		17.5
4	9	10	9	0	0	0		18.5
5	6	9	4	0	0	0		12.5
6	12	8	7	0	0	0		19.5
7	8	12	6	0	1	0		20.5
8	6	6	8	0	0	0		13
9	9	10	4	0	1	0		19.5
10	10	12	7	0	0	0		19.5
11	9	8	8	1	0	0		21
12	10	10	5	0	0	0		17.5
13	8	8	4	0	0	0		14
14	6	8	9	0	0	0		14.5
15	4	6	6	0	0	0		10
16	7	11	6	0	0	0		15.5
17	9	5	9	0	0	0		16
18	5	4	5	0	0	0		9.5
19	11	7	7	0	0	0		18
20	5	9	8	0	1	0		17
21	6	9	5	0	0	0		13
22	5	10	4	0	0	0		12
23	9	9	6	0	0	0		16.5
24	11	10	4	1	1	0		25.5
25	6	8	6	0	0	0		13
26	9	9	4	0	0	0		15.5
27	6	7	8	0	0	0		13.5
28	8	10	9	0	0	0		17.5
29	9	9	7	0	0	0		17
30	14	8	9	1	0	0		26.5
31	6	7	8	0	0	0		13.5
32	9	8	4	1	1	0		22.5
33	10	10	7	0	0	0		18.5
34	15	6	9	0	0	0		22.5
35	7	8	5	1	0	0		17.5
36	10	9	6	0	0	0		17.5
37	4	7	9	1	0	0		16
38	9	10	7	0	1	0		21
39	10	6	7	0	0	0		16.5
40	6	9	8	0	0	0		14.5
41	9	8	5	1	0	0		19.5
42	8	8	8	0	0	0		16
43	5	8	9	0	0	0		13.5
44	6	6	5	0	1	0		15
45	9	11	6	0	0	0		17.5
46	9	8	9	0	0	0		17.5
47	6	8	9	2	0	1		26.5
48	7	6	7	0	0	0		13.5
49	7	9	9	0	0	0		16
50	5	5	10	0	1	0		16
51	9	6	7	1	0	0		19.5
52	10	5	8	0	0	1		20.5
53	6	10	5	1	0	0		17.5
54	5	8	9	0	0	0		13.5
55	9	6	9	0	0	0		16.5
56	5	7	6	0	1	0		15
57	6	9	7	0	0	0		14
58	8	8	10	0	1	1		24.5
59	9	10	7	0	0	0		1[illegible]
60	4	8	8	2	0	0		2[illegible]
TOTAL	466	490	418	14	12	3	1433	26.5 1030

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 06-02-22 SUNDAY TIME : 6 TO 7 AM			TRAFFIC VOLUME SURVEY					
MIN	4w	2w	rikshaw	TRUCKS	BUS	TRACTOR		PCU
1	9	10	8	0	0	0		18
2	9	11	9	0	0	0		19
3	6	9	7	1	0	0		18
4	7	12	5	0	0	0		15.5
5	8	6	6	0	1	0		17.5
6	9	10	9	0	0	0		18.5
7	10	9	8	0	0	0		18.5
8	8	8	5	0	1	0		18
9	9	12	6	0	1	0		21.5
10	5	6	9	0	0	0		12.5
11	4	10	6	1	0	0		16
12	9	7	7	0	0	0		16
13	10	10	6	0	1	0		21.5
14	8	9	3	0	0	0		14
15	6	8	8	0	0	0		14
16	9	6	8	0	0	0		16
17	6	7	6	0	0	0		12.5
18	7	6	7	0	0	0		13.5
19	5	9	9	0	0	0		14
20	7	11	10	0	0	0		17.5
21	8	9	7	0	0	1		20
22	7	12	6	0	0	0		16
23	11	11	8	0	0	0		20.5
24	9	12	6	1	0	0		22
25	8	10	8	0	0	0		17
26	11	11	6	0	0	0		19.5
27	8	9	10	1	0	0		21.5
28	10	12	7	0	0	0		19.5
29	11	6	9	0	0	0		18.5
30	9	10	4	1	1	0		23.5
31	8	9	5	1	0	0		19
32	11	10	6	1	1	1		30.5
33	9	12	9	0	0	0		19.5
34	8	10	6	0	0	0		16
35	9	10	7	0	1	0		21
36	12	11	8	0	0	0		21.5
37	6	9	7	1	0	0		18
38	5	12	9	0	0	0		15.5
39	12	6	9	1	0	0		23.5
40	8	10	10	0	0	0		18
41	11	7	7	1	1	0		25.5
42	10	10	7	0	0	0		18.5
43	7	9	11	0	0	0		17
44	8	8	7	1	0	0		19.5
45	6	7	8	0	0	1		17.5
46	11	6	5	0	0	0		16.5
47	5	9	11	2	1	0		26.5
48	9	8	9	0	0	0		17.5
49	6	6	11	0	0	0		14.5
50	7	7	7	0	0	0		14
51	5	8	9	1	0	0		17.5
52	7	7	10	0	1	0		19
53	8	6	7	0	0	0		14.5
54	7	7	6	0	0	0		13.5
55	11	8	7	0	0	0		18.5
56	7	9	8	0	1	0		19
57	8	7	9	0	0	0		16
58	10	7	7	0	0	1		21
59	4	7	9	0	0	0		12
60	6	5	10	2	0	0		24.5
TOTAL	484	525	454	16	11	4	2336	30.5
								1092

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC								
DATE : 06-02-22 SUNDAY TIME : 7 TO 8 AM				TRAFFIC VOLUME SURVEY				
MIN	4w	2w	RIKSHAW	TRUCKS	BUS	TRACTOR		PCU
1	4	8	9	0	0	0		12.5
2	8	9	7	0	0	0		16
3	4	7	5	1	0	0		14
4	5	10	9	0	0	0		14.5
5	8	4	4	0	0	0		12
6	6	8	7	0	0	0		13.5
7	8	12	6	0	0	0		17
8	6	6	7	0	0	0		12.5
9	9	10	9	0	1	0		22
10	4	4	7	0	0	0		9.5
11	8	8	8	1	0	0		20
12	10	5	5	0	0	0		15
13	8	8	4	0	0	0		14
14	6	8	6	0	0	0		13
15	4	6	9	0	0	0		11.5
16	7	4	6	0	0	0		12
17	4	5	9	0	0	0		11
18	5	4	5	0	0	0		9.5
19	9	7	7	0	0	0		16
20	5	9	8	0	0	0		13.5
21	6	8	5	0	0	0		12.5
22	5	10	4	0	0	0		12
23	9	9	6	0	0	0		16.5
24	11	10	8	1	0	0		24
25	6	8	6	1	0	0		17
26	9	9	4	0	0	0		15.5
27	6	7	8	0	0	0		13.5
28	8	10	9	0	0	0		17.5
29	9	4	7	0	0	0		14.5
30	5	8	9	1	0	0		17.5
31	6	7	3	0	0	0		11
32	9	8	9	1	1	0		25
33	6	10	7	0	0	0		14.5
34	8	8	9	0	0	0		16.5
35	7	8	5	0	0	0		13.5
36	6	9	6	0	0	0		13.5
37	4	7	9	1	1	0		19.5
38	3	8	8	0	0	0		11
39	10	9	7	0	0	0		18
40	6	8	8	0	0	0		14
41	9	5	5	1	1	0		21.5
42	8	8	8	0	0	0		16
43	5	8	9	0	0	0		13.5
44	6	6	5	1	1	0		19
45	4	10	6	0	0	0		12
46	8	8	8	0	0	0		16
47	9	8	6	1	1	0		23.5
48	7	6	7	0	0	0		13.5
49	4	9	9	0	0	0		13
50	9	5	6	0	0	0		14.5
51	8	6	7	1	0	0		18.5
52	5	5	8	0	1	0		15
53	6	10	5	0	0	0		13.5
54	5	8	4	0	0	0		11
55	9	6	9	0	0	0		16.5
56	5	7	6	1	1	0		19
57	6	5	7	0	2	0		19
58	8	8	7	0	0	1		19.5
59	9	5	9	0	0	0		16
60	8	9	7	2	0	0		24
TOTAL	405	449	412	14	10	1	1321	25
								930.5

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4.3 Spot Speed Survey

A spot speed is made by measuring the individual speeds of a sample of the vehicle passing a given spot on a street or highway. Spot speed studies are used to determine the speed distribution of a traffic stream at a specific location.

Note: All speed are in (kmph).

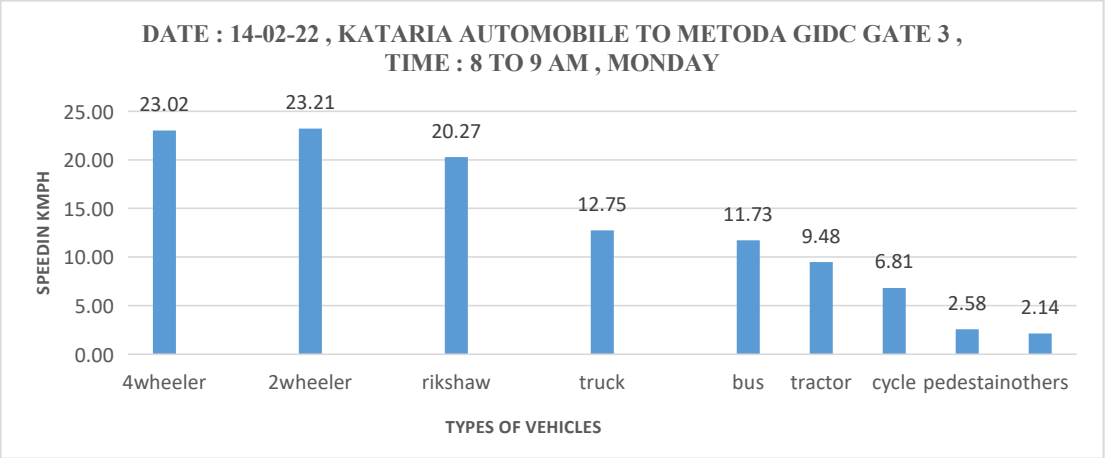

Figure 4.3.1

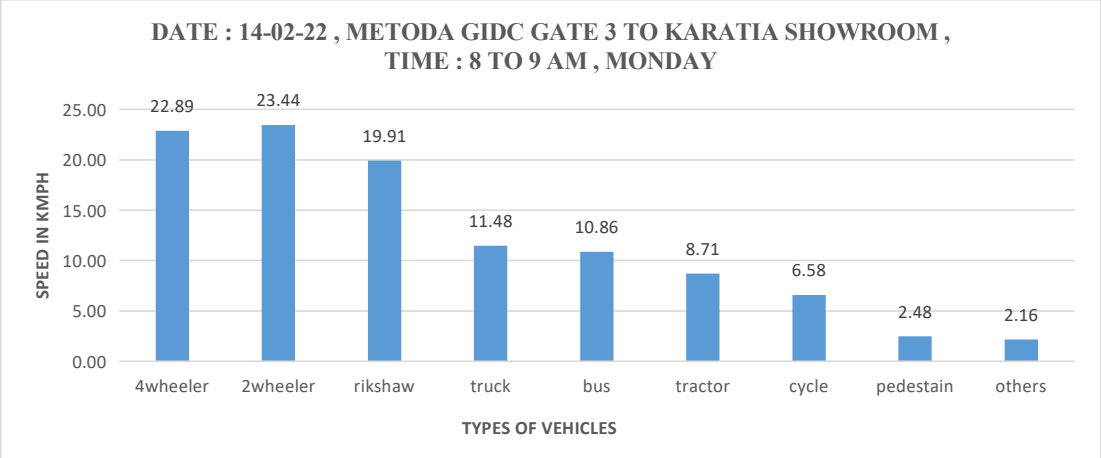

Figure 4.3.2

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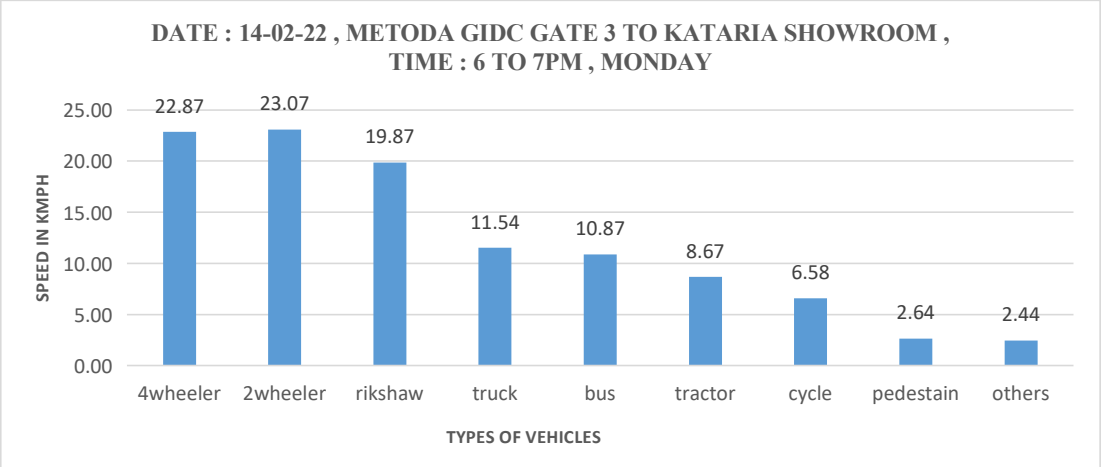

Figure 4.3.3

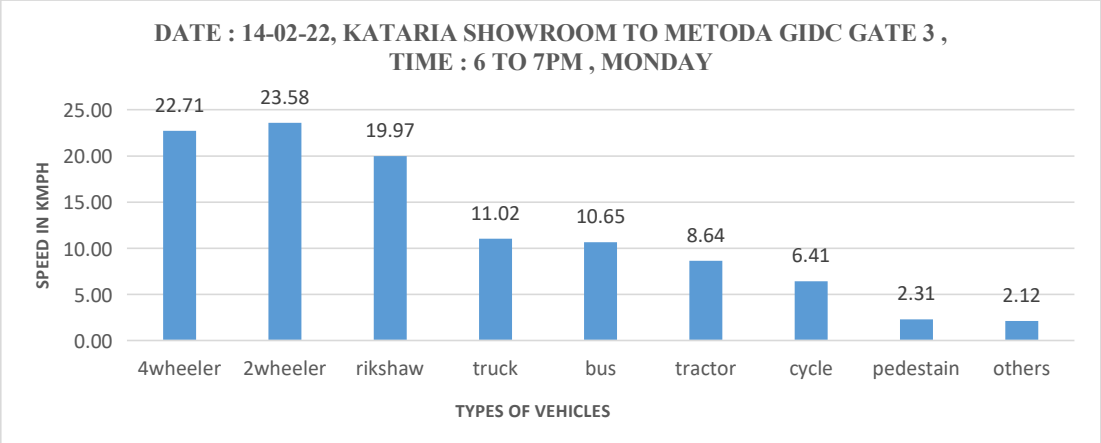

Figure 4.3.4

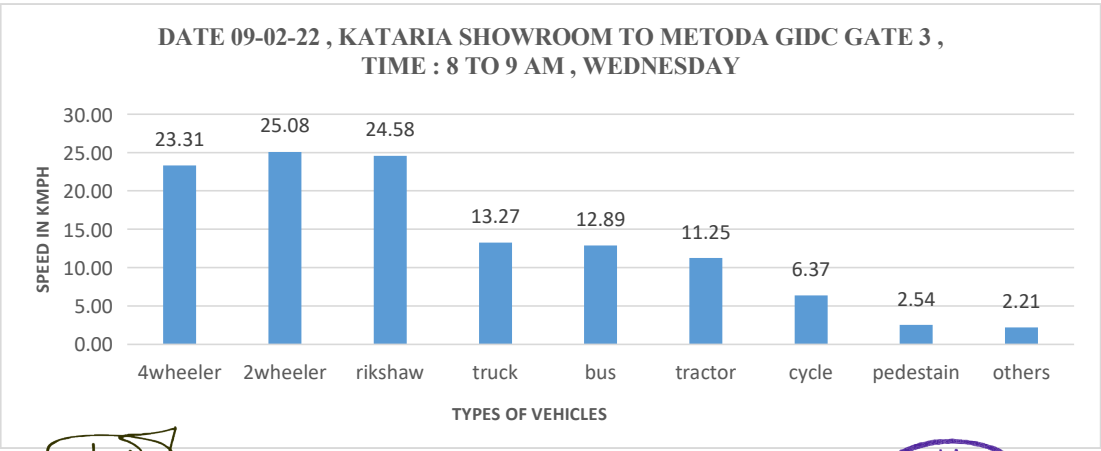

Figure 4.3.5

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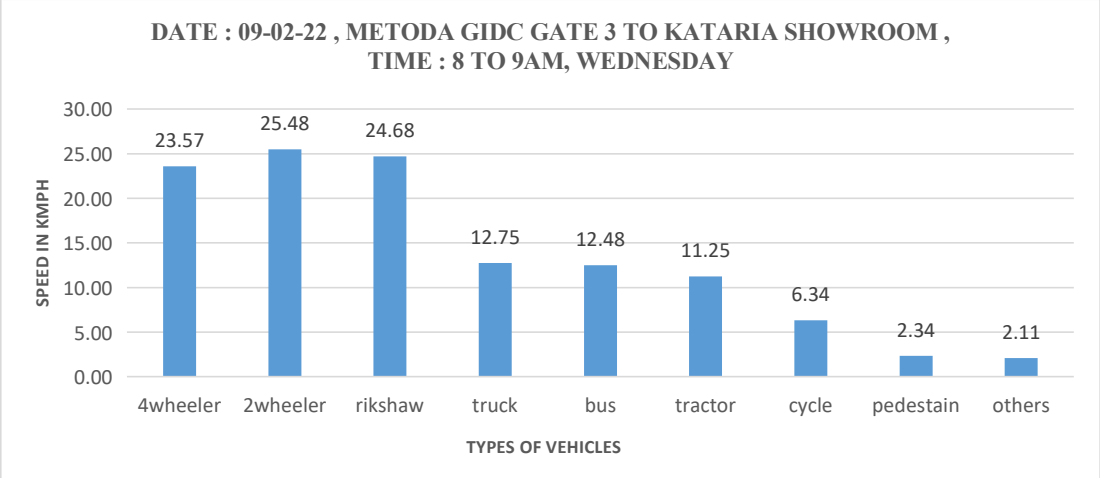

Figure 4.3.6

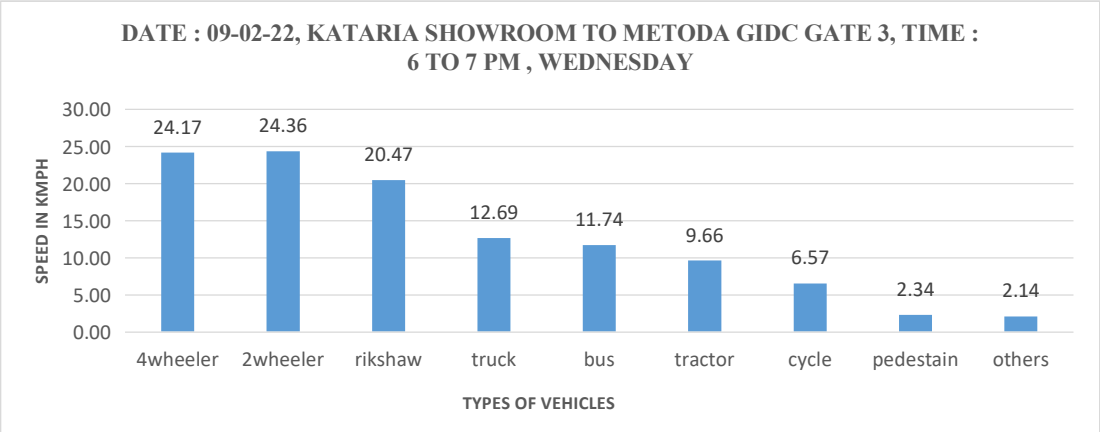

Figure 4.3.7

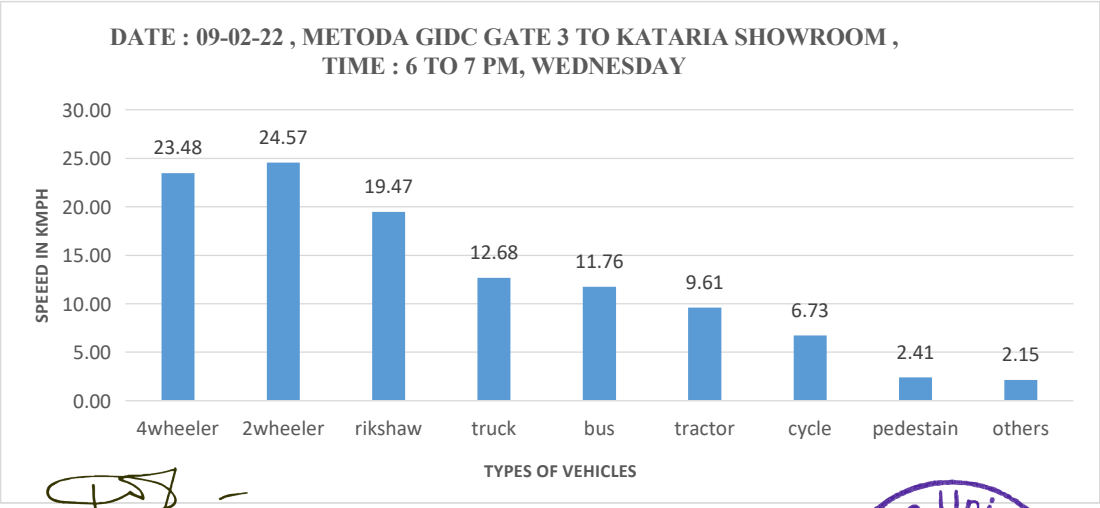

Figure 4.3.8

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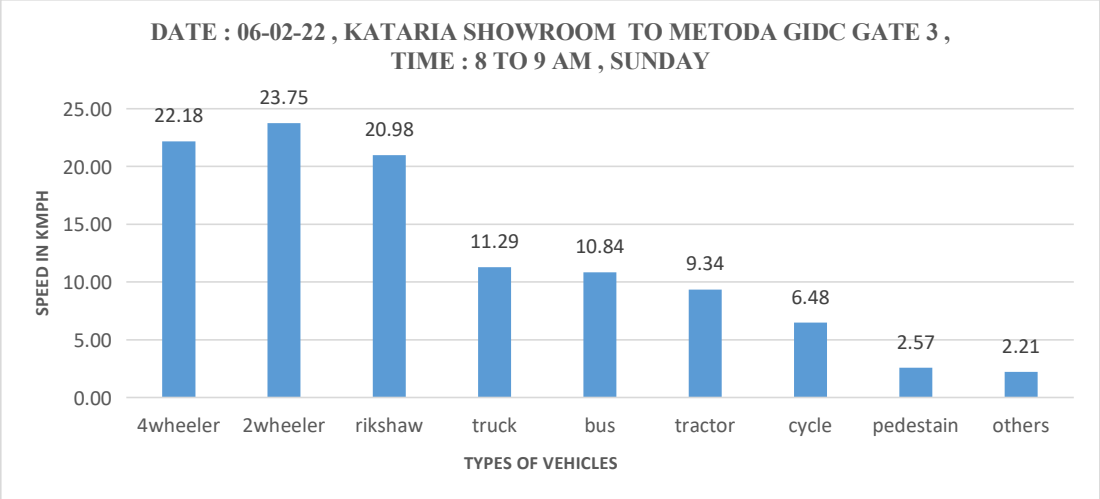

Figure 4.3.9

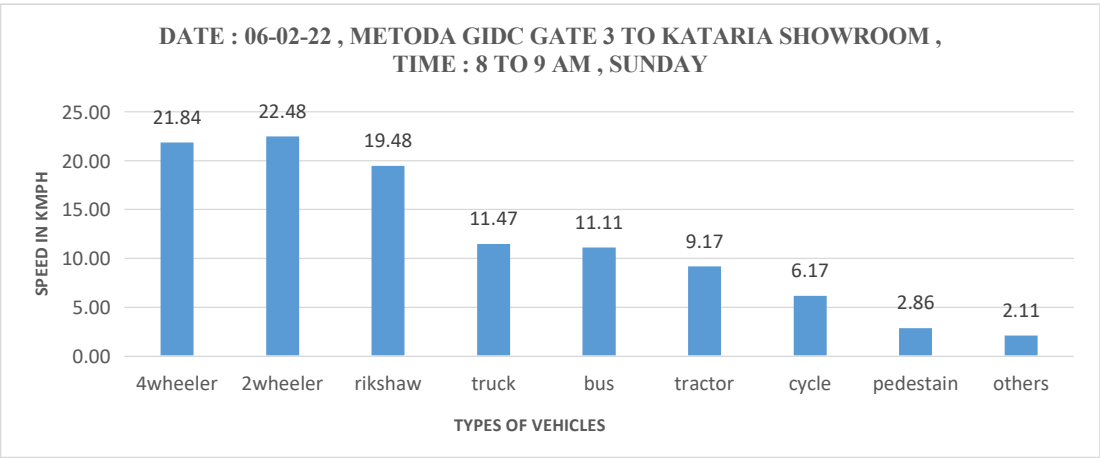

Figure 4.3.10

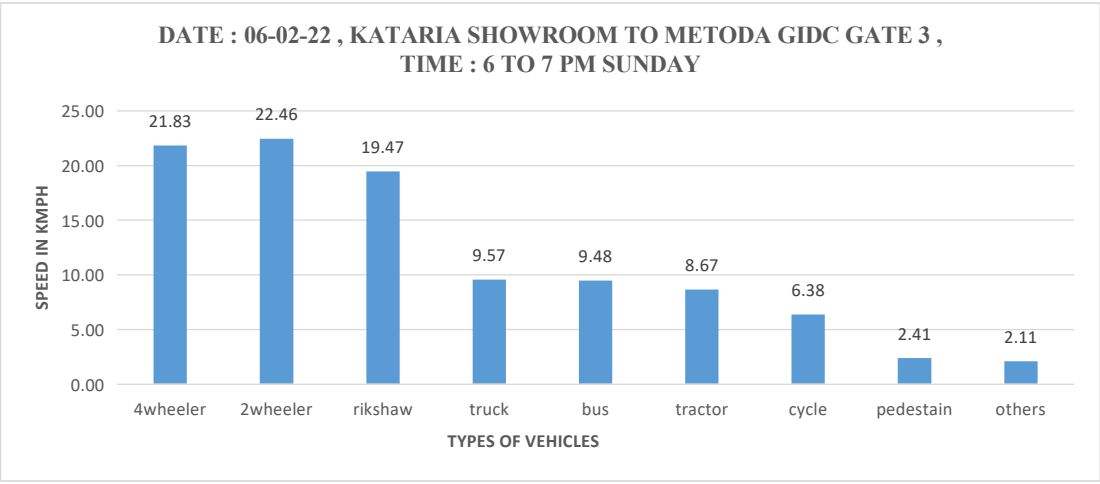

Figure 4.3.11

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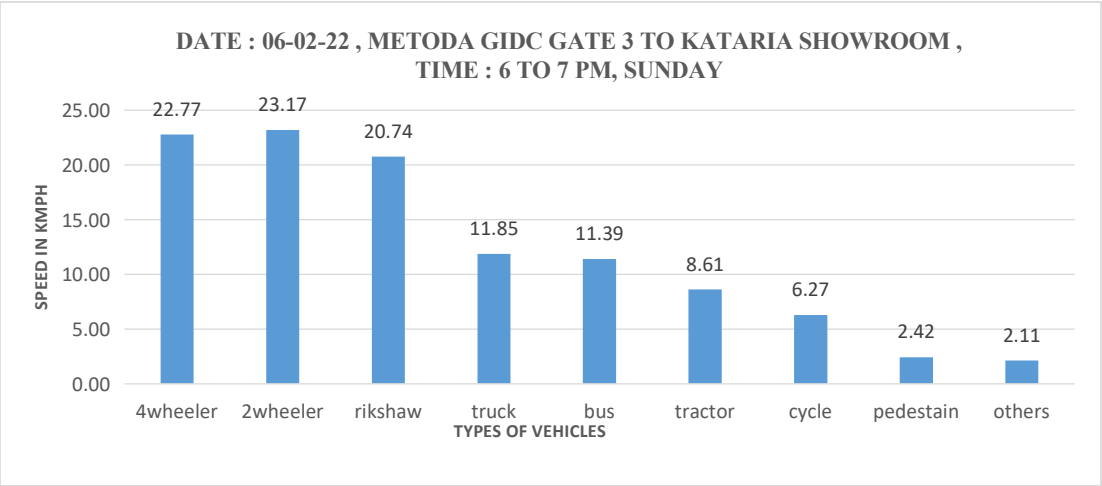

Figure 4.3.12

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 14-02-22 MONDAY TIME : 7 TO 8 AM			SPOT SPEED SURVEY							
MIN	4w	2W	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	26.08	19.78	19.28	12.81	0.00	0.00	0.00	0.00	0.00	
2	15.28	27.28	20.48	0.00	0.00	0.00	0.00	2.18	0.00	
3	22.98	24.18	25.48	11.08	10.29	9.68	5.27	0.00	0.00	
4	22.48	17.38	22.98	0.00	11.69	0.00	6.07	0.00	2.57	
5	28.68	26.48	22.98	12.09	0.00	0.00	5.28	3.08	0.00	
6	23.48	27.48	23.48	0.00	0.00	0.00	0.00	2.58	0.00	
7	15.08	22.98	18.70	12.74	0.00	8.65	6.17	0.00	0.00	
8	14.08	22.48	18.59	0.00	11.86	8.91	0.00	0.00	0.00	
9	18.68	28.68	21.48	10.28	0.00	0.00	0.00	2.99	0.00	
10	21.48	23.48	17.08	11.83	0.00	0.00	0.00	3.07	2.76	
11	17.58	18.28	18.98	10.29	12.93	0.00	5.89	0.00	0.00	
12	15.28	17.08	22.98	11.67	0.00	0.00	0.00	0.00	0.00	
13	26.08	23.48	18.98	0.00	0.00	0.00	0.00	0.00	0.00	
14	23.48	17.98	19.68	13.27	0.00	0.00	6.19	0.00	0.00	
15	18.18	19.48	23.48	12.08	11.08	0.00	0.00	2.07	0.00	
16	19.28	19.98	17.86	12.47	0.00	0.00	0.00	0.00	0.00	
17	16.78	14.88	22.98	0.00	0.00	0.00	6.38	0.00	0.00	
18	19.48	27.58	23.48	0.00	0.00	7.18	5.29	0.00	0.00	
19	19.98	26.48	22.98	0.00	11.83	0.00	0.00	0.00	0.00	
20	19.78	25.28	23.48	10.83	9.67	0.00	0.00	3.07	0.00	
21	27.28	22.48	15.28	0.00	0.00	0.00	0.00	0.00	0.00	
22	16.78	28.68	22.98	11.37	10.28	0.00	5.87	0.00	2.48	
23	17.38	23.48	22.48	0.00	10.96	0.00	0.00	0.00	0.00	
24	26.48	22.58	15.68	0.00	0.00	0.00	6.18	3.11	0.00	
25	27.48	18.28	18.55	0.00	12.57	0.00	0.00	0.00	0.00	
26	23.58	28.68	26.08	0.00	11.83	0.00	0.00	0.00	0.00	
27	19.28	23.48	23.48	11.68	0.00	0.00	6.37	0.00	0.00	
28	20.48	19.48	18.18	0.00	12.73	0.00	0.00	0.00	0.00	
29	25.48	19.48	19.28	0.00	0.00	0.00	0.00	3.08	0.00	
30	28.28	19.98	16.78	0.00	0.00	0.00	0.00	0.00	0.00	
31	22.98	19.78	19.48	0.00	0.00	0.00	0.00	0.00	0.00	
32	23.48	27.28	19.98	0.00	0.00	0.00	0.00	0.00	0.00	
33	19.78	18.28	19.78	0.00	0.00	7.28	6.58	0.00	0.00	
34	22.98	17.38	9.80	0.00	0.00	0.00	0.00	0.00	0.00	
35	22.48	26.48	14.28	11.35	0.00	0.00	0.00	0.00	0.00	
36	28.68	18.88	9.46	0.00	12.07	0.00	0.00	0.00	0.00	
37	23.48	23.58	24.53	10.78	0.00	0.00	0.00	2.47	0.00	
38	24.98	19.28	14.42	0.00	0.00	0.00	0.00	0.00	0.00	
39	17.08	20.48	15.97	0.00	0.00	0.00	0.00	0.00	0.00	
40	17.18	19.28	17.86	0.00	10.91	0.00	0.00	0.00	0.00	
41	27.58	28.68	13.86	0.00	11.29	0.00	0.00	0.00	0.00	
42	25.98	23.48	18.92	0.00	0.00	0.00	0.00	0.00	0.00	
43	21.48	18.98	14.44	0.00	0.00	0.00	0.00	0.00	0.00	
44	18.28	22.48	9.18	0.00	11.68	8.59	0.00	0.00	0.00	
45	26.08	18.68	19.53	0.00	0.00	0.00	0.00	0.00	0.00	
46	23.48	21.48	27.28	0.00	0.00	0.00	0.00	2.69	0.00	
47	18.18	17.08	18.28	12.73	0.00	0.00	0.00	0.00	0.00	
48	19.28	18.98	17.38	0.00	0.00	0.00	0.00	0.00	0.00	
49	26.48	22.98	26.48	0.00	0.00	0.00	7.28	0.00	0.00	
50	19.48	18.98	27.48	0.00	0.00	0.00	0.00	2.85	0.00	
51	19.98	17.88	16.94	0.00	0.00	0.00	0.00	0.00	0.00	
52	19.78	23.48	15.00	0.00	10.58	0.00	0.00	0.00	0.00	
53	14.28	22.98	18.88	0.00	0.00	0.00	0.00	0.00	0.00	
54	26.48	23.48	15.00	0.00	11.69	0.00	0.00	0.00	0.00	
55	25.28	20.48	10.01	13.08	0.00	0.00	0.00	0.00	0.00	
56	26.98	22.98	12.18	12.57	11.73	0.00	0.00	0.00	0.00	
57	19.38	21.98	14.81	0.00	12.09	0.00	0.00	0.00	0.00	
58	23.48	21.48	23.18	11.86	0.00	0.00	0.00	0.00	0.00	
59	24.58	23.48	20.98	0.00	0.00	9.34	0.00	0.00	0.00	
60	27.68	27.28	19.48	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1314.0	570.0	1149.0	236.9	229.8	59.6	78.8	33.2	78	3611.4
Avg	21.90	25.37	22.86	13.08	12.56	10.58	6.87	2.86	2.47	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 14-02-22 MONDAY TIME : 8 TO 9 AM			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	27.20	20.90	20.40	11.23	12.45	0.00	0.00	0.00	0.00	
2	16.40	28.40	21.60	0.00	0.00	0.00	7.84	2.69	0.00	
3	24.10	25.30	26.60	10.26	11.27	9.87	0.00	0.00	0.00	
4	23.60	18.50	24.10	0.00	12.63	0.00	6.24	2.88	2.81	
5	29.80	27.60	24.10	0.00	0.00	0.00	0.00	3.58	0.00	
6	24.60	28.60	24.60	0.00	0.00	0.00	0.00	3.02	0.00	
7	16.20	24.10	19.82	0.00	0.00	9.89	7.01	0.00	0.00	
8	15.20	23.60	19.71	0.00	10.59	11.78	6.11	0.00	0.00	
9	19.80	29.80	22.60	0.00	11.08	0.00	6.29	3.09	2.59	
10	22.60	24.60	18.20	13.58	0.00	0.00	0.00	3.27	0.00	
11	18.70	19.40	20.10	0.00	13.06	0.00	0.00	0.00	0.00	
12	16.40	18.20	24.10	0.00	0.00	0.00	7.28	0.00	0.00	
13	27.20	24.60	20.10	0.00	0.00	10.49	7.99	0.00	0.00	
14	24.60	19.10	20.80	0.00	0.00	0.00	0.00	0.00	0.00	
15	19.30	20.60	24.60	0.00	14.05	0.00	0.00	3.91	0.00	
16	20.40	21.10	18.98	16.27	0.00	0.00	0.00	0.00	0.00	
17	17.90	16.00	24.10	0.00	0.00	0.00	0.00	0.00	2.87	
18	20.60	28.70	24.60	11.22	0.00	9.78	0.00	0.00	0.00	
19	21.10	27.60	24.10	0.00	12.66	0.00	0.00	0.00	0.00	
20	20.90	26.40	24.60	0.00	10.89	0.00	0.00	2.08	0.00	
21	28.40	23.60	16.40	0.00	0.00	0.00	0.00	0.00	0.00	
22	17.90	29.80	24.10	0.00	11.67	0.00	7.18	0.00	2.59	
23	18.50	24.60	23.60	0.00	10.45	0.00	0.00	0.00	0.00	
24	27.60	23.70	16.80	10.36	0.00	0.00	6.28	3.24	0.00	
25	28.60	19.40	19.67	0.00	13.07	0.00	0.00	0.00	0.00	
26	24.70	29.80	27.20	14.21	12.55	11.47	0.00	0.00	0.00	
27	20.40	24.60	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
28	21.60	20.60	19.30	13.06	11.49	0.00	0.00	0.00	0.00	
29	26.60	20.60	20.40	0.00	0.00	0.00	0.00	3.01	0.00	
30	29.40	21.10	17.90	0.00	0.00	0.00	0.00	0.00	0.00	
31	24.10	20.90	20.60	12.88	0.00	0.00	0.00	0.00	0.00	
32	24.60	28.40	21.10	0.00	0.00	0.00	0.00	0.00	0.00	
33	20.90	19.40	20.90	0.00	14.27	10.47	6.51	3.28	0.00	
34	24.10	18.50	10.92	0.00	0.00	0.00	7.21	0.00	0.00	
35	23.60	27.60	15.40	0.00	0.00	0.00	0.00	0.00	0.00	
36	29.80	20.00	10.58	0.00	10.78	0.00	0.00	0.00	0.00	
37	24.60	24.70	25.65	11.56	0.00	0.00	0.00	2.71	0.00	
38	26.10	20.40	15.54	0.00	13.25	0.00	0.00	0.00	0.00	
39	18.20	21.60	17.09	0.00	0.00	0.00	0.00	2.89	0.00	
40	18.30	20.40	18.98	10.26	10.98	0.00	0.00	0.00	0.00	
41	28.70	29.80	14.98	11.89	11.56	0.00	0.00	0.00	0.00	
42	27.10	24.60	20.04	11.05	13.27	0.00	0.00	3.07	0.00	
43	22.60	20.10	15.56	0.00	0.00	0.00	6.39	0.00	0.00	
44	19.40	23.60	10.30	0.00	12.85	9.47	0.00	0.00	0.00	
45	27.20	19.80	20.65	13.71	11.27	0.00	7.58	0.00	0.00	
46	24.60	22.60	28.40	12.04	0.00	0.00	0.00	2.89	0.00	
47	19.30	18.20	19.40	0.00	12.47	0.00	0.00	0.00	0.00	
48	20.40	20.10	18.50	11.09	10.25	0.00	0.00	0.00	0.00	
49	27.60	24.10	27.60	0.00	11.96	0.00	6.78	0.00	0.00	
50	20.60	20.10	28.60	0.00	0.00	0.00	0.00	3.66	0.00	
51	21.10	19.00	18.06	10.56	12.57	0.00	7.19	0.00	0.00	
52	20.90	24.60	16.12	11.08	0.00	0.00	0.00	0.00	0.00	
53	15.40	24.10	20.00	0.00	0.00	0.00	0.00	0.00	0.00	
54	27.60	24.60	16.12	0.00	10.78	0.00	0.00	0.00	0.00	
55	26.40	21.60	11.13	14.28	0.00	0.00	7.18	0.00	0.00	
56	28.10	24.10	13.30	0.00	11.63	0.00	7.48	3.24	0.00	
57	20.50	23.10	15.93	15.29	10.86	0.00	0.00	0.00	0.00	
58	24.60	22.60	24.30	0.00	12.96	0.00	0.00	0.00	0.00	
59	25.70	24.60	22.10	12.87	0.00	10.45	5.28	0.00	0.00	
60	28.80	28.40	20.60	11.02	0.00	0.00	6.88	0.00	0.00	
TOTAL	1381	1393	1216.2	269.8	359.6	93.7	130.7	52.5	10.9	5904.1
Avg	23.02	23.21	20.27	12.75	11.73	9.48	6.81	2.58	2.14	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 14-02-22 MONDAY TIME : 9 TO 10 AM			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	26.78	22.02	21.60	12.28	9.37	0.00	0.00	0.00	0.00	
2	22.88	29.52	22.80	0.00	0.00	0.00	6.27	0.00	0.00	
3	18.58	26.42	27.80	11.24	11.67	9.27	0.00	0.00	0.00	
4	19.78	19.62	25.30	11.08	12.49	0.00	7.49	2.49	0.00	
5	24.78	28.72	25.30	0.00	0.00	0.00	7.55	0.00	0.00	
6	27.58	29.72	25.80	12.39	0.00	0.00	6.89	3.07	0.00	
7	22.28	25.22	21.02	0.00	0.00	8.47	0.00	0.00	0.00	
8	22.78	24.72	20.91	10.28	10.86	0.00	0.00	0.00	0.00	
9	22.28	30.92	23.80	0.00	0.00	0.00	7.36	2.86	0.00	
10	22.78	25.72	19.40	0.00	0.00	9.21	7.48	0.00	0.00	
11	14.58	20.52	21.30	10.85	11.48	8.73	0.00	0.00	0.00	
12	22.28	19.32	25.30	0.00	0.00	0.00	0.00	2.17	0.00	
13	21.78	25.72	21.30	12.76	0.00	0.00	0.00	0.00	0.00	
14	27.98	20.22	22.00	0.00	0.00	0.00	0.00	0.00	0.00	
15	22.78	21.72	25.80	0.00	11.76	0.00	6.34	0.00	0.00	
16	14.38	22.22	20.18	12.64	0.00	9.64	0.00	0.00	0.00	
17	16.38	17.12	25.30	12.48	0.00	0.00	0.00	0.00	0.00	
18	27.98	29.82	25.80	11.86	0.00	0.00	0.00	2.36	0.00	
19	22.78	28.72	25.30	0.00	10.33	0.00	0.00	0.00	0.00	
20	14.38	27.52	25.80	11.86	0.00	0.00	6.88	0.00	0.00	
21	16.38	24.72	17.60	0.00	0.00	10.28	0.00	0.00	0.00	
22	16.48	30.92	25.30	0.00	10.28	0.00	0.00	0.00	2.47	
23	26.88	25.72	24.80	0.00	10.05	0.00	0.00	0.00	0.00	
24	25.28	24.82	18.00	0.00	0.00	0.00	6.52	2.07	0.00	
25	20.78	20.52	20.87	0.00	11.59	0.00	0.00	0.00	0.00	
26	17.58	30.92	28.40	12.76	11.47	0.00	0.00	0.00	0.00	
27	27.98	25.72	25.80	0.00	0.00	0.00	0.00	3.06	0.00	
28	22.78	21.72	20.50	0.00	12.56	0.00	0.00	0.00	0.00	
29	22.78	21.72	21.60	0.00	0.00	0.00	7.51	0.00	0.00	
30	16.38	22.22	19.10	0.00	0.00	9.18	0.00	0.00	0.00	
31	16.48	22.02	21.80	11.39	0.00	0.00	0.00	0.00	0.00	
32	22.28	29.52	22.30	0.00	0.00	0.00	0.00	0.00	0.00	
33	18.28	20.52	22.10	0.00	11.63	0.00	7.28	0.00	0.00	
34	18.98	19.62	12.12	0.00	0.00	0.00	0.00	2.78	0.00	
35	20.78	28.72	16.60	0.00	0.00	0.00	0.00	0.00	0.00	
36	25.78	21.12	11.78	0.00	12.41	0.00	0.00	0.00	0.00	
37	18.98	25.82	26.85	10.86	0.00	0.00	7.58	2.64	0.00	
38	22.48	21.52	16.74	0.00	12.07	0.00	0.00	0.00	0.00	
39	16.08	22.72	18.29	13.27	0.00	0.00	6.48	2.18	0.00	
40	18.78	21.52	20.18	0.00	11.59	0.00	0.00	0.00	0.00	
41	19.28	30.92	16.18	12.09	11.83	0.00	0.00	0.00	0.00	
42	19.08	25.72	21.24	0.00	0.00	0.00	6.39	2.69	0.00	
43	26.58	21.22	16.76	12.76	0.00	0.00	0.00	0.00	0.00	
44	16.08	24.72	11.50	0.00	12.09	9.11	0.00	0.00	0.00	
45	16.68	20.92	21.85	0.00	0.00	0.00	0.00	0.00	0.00	
46	25.78	23.72	29.60	11.08	0.00	0.00	6.84	3.04	0.00	
47	26.78	19.32	20.60	0.00	12.87	0.00	0.00	0.00	0.00	
48	22.88	21.22	19.70	0.00	11.68	0.00	0.00	0.00	0.00	
49	18.58	25.22	28.80	12.39	0.00	0.00	0.00	0.00	0.00	
50	19.78	21.22	29.80	0.00	0.00	0.00	7.24	3.11	0.00	
51	18.58	20.12	19.26	0.00	11.74	0.00	0.00	0.00	0.00	
52	19.78	25.72	17.32	12.08	0.00	9.37	0.00	0.00	0.00	
53	20.28	25.22	21.20	12.47	0.00	0.00	0.00	0.00	0.00	
54	20.28	25.72	17.32	0.00	12.57	0.00	0.00	0.00	0.00	
55	19.08	22.72	12.33	0.00	0.00	0.00	0.00	0.00	0.00	
56	22.88	25.22	14.50	0.00	11.08	0.00	6.27	2.84	0.00	
57	22.28	24.22	17.13	11.87	0.00	8.27	0.00	0.00	0.00	
58	18.78	23.72	25.50	0.00	12.57	0.00	0.00	0.00	0.00	
59	20.47	25.72	23.30	0.00	0.00	10.24	0.00	0.00	0.00	
60	21.07	29.52	21.80	11.96	0.00	0.00	0.00	0.00	0.00	
TOTAL	1263.0	570.0	1288.2	274.7	278.0	101.8	118.4	37.4	0.0	4929
Avg.	25.47	26.39	22.39	13.89	12.76	10.27	6.28	2.87	2.47	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 14-02-22 MONDAY TIME : 8 TO 9 AM			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	26.37	19.40	17.90	12.47	12.08	0.00	0.00	0.00	0.00	
2	27.60	18.50	20.60	1.00	0.00	0.00	6.87	3.07	0.00	
3	28.60	27.60	21.10	0.00	0.00	0.00	0.00	0.00	0.00	
4	24.70	28.60	20.90	0.00	0.00	0.00	0.00	0.00	0.00	
5	20.40	24.70	13.69	0.00	0.00	0.00	0.00	0.00	0.00	
6	21.60	20.40	15.40	0.00	0.00	0.00	7.14	0.00	2.18	
7	26.60	21.60	16.20	13.28	0.00	0.00	0.00	0.00	0.00	
8	29.40	20.40	18.20	0.00	0.00	0.00	0.00	0.00	0.00	
9	24.10	29.80	27.60	0.00	0.00	0.00	0.00	0.00	0.00	
10	24.60	24.60	28.60	0.00	0.00	0.00	0.00	3.83	0.00	
11	24.10	16.20	24.70	10.47	0.00	0.00	0.00	0.00	0.00	
12	24.60	18.20	20.40	0.00	0.00	0.00	6.89	0.00	0.00	
13	16.40	29.80	21.60	0.00	0.00	0.00	0.00	0.00	0.00	
14	24.10	24.60	26.60	0.00	0.00	0.00	0.00	0.00	0.00	
15	23.60	16.20	29.40	0.00	0.00	0.00	6.47	0.00	0.00	
16	29.80	18.20	19.40	12.59	10.28	0.00	0.00	0.00	0.00	
17	24.60	27.60	16.12	0.00	0.00	0.00	7.58	0.00	0.00	
18	16.20	28.60	19.89	0.00	0.00	0.00	0.00	0.00	0.00	
19	18.20	24.70	16.12	13.88	0.00	0.00	0.00	0.00	0.00	
20	29.80	20.40	25.65	0.00	0.00	0.00	7.29	3.27	0.00	
21	24.60	21.60	15.54	0.00	0.00	0.00	0.00	0.00	2.72	
22	16.20	26.60	17.09	0.00	0.00	0.00	0.00	0.00	0.00	
23	18.20	29.40	16.20	12.07	0.00	9.67	6.81	0.00	0.00	
24	18.30	19.40	18.20	0.00	0.00	0.00	0.00	0.00	0.00	
25	28.70	18.50	18.30	0.00	0.00	0.00	0.00	0.00	0.00	
26	27.10	27.60	28.70	0.00	0.00	0.00	0.00	0.00	0.00	
27	22.60	28.60	27.10	11.06	0.00	0.00	6.28	0.00	0.00	
28	19.40	24.70	22.60	0.00	0.00	0.00	0.00	0.00	0.00	
29	29.80	20.40	19.40	0.00	0.00	0.00	0.00	0.00	0.00	
30	24.60	21.60	17.70	0.00	0.00	0.00	7.59	0.00	0.00	
31	24.60	20.40	22.09	0.00	11.63	0.00	7.14	2.18	0.00	
32	18.20	20.40	14.36	13.08	0.00	0.00	6.28	0.00	0.00	
33	18.30	29.80	19.82	0.00	0.00	0.00	0.00	2.59	0.00	
34	24.10	24.60	19.71	12.09	0.00	0.00	0.00	0.00	0.00	
35	20.10	20.10	15.67	0.00	0.00	0.00	0.00	0.00	0.00	
36	20.80	23.60	12.51	0.00	0.00	0.00	6.84	0.00	0.00	
37	22.60	19.80	19.67	0.00	0.00	0.00	0.00	0.00	0.00	
38	27.60	20.10	11.24	11.74	0.00	0.00	0.00	0.00	0.00	
39	20.80	20.80	20.04	0.00	0.00	0.00	0.00	0.00	0.00	
40	24.30	24.60	25.65	0.00	0.00	0.00	6.38	2.87	0.00	
41	17.90	24.10	15.54	0.00	12.09	0.00	0.00	0.00	0.00	
42	20.60	24.60	17.09	0.00	0.00	10.73	0.00	0.00	0.00	
43	21.10	28.60	18.98	10.89	0.00	0.00	0.00	0.00	0.00	
44	20.90	24.10	10.88	0.00	0.00	0.00	0.00	0.00	0.00	
45	28.40	23.60	11.24	0.00	0.00	0.00	0.00	0.00	0.00	
46	17.90	29.80	15.40	0.00	0.00	0.00	0.00	0.00	0.00	
47	18.50	24.60	19.67	0.00	0.00	0.00	0.00	0.00	0.00	
48	27.60	19.40	27.60	0.00	0.00	0.00	0.00	0.00	0.00	
49	28.60	18.20	28.60	0.00	0.00	0.00	0.00	0.00	0.00	
50	24.70	24.60	24.70	0.00	0.00	0.00	0.00	0.00	0.00	
51	20.40	27.60	20.40	11.09	0.00	0.00	0.00	0.00	0.00	
52	21.60	28.60	21.60	0.00	0.00	0.00	0.00	0.00	0.00	
53	20.40	24.10	20.40	0.00	0.00	0.00	0.00	0.00	0.00	
54	21.60	23.60	21.60	0.00	0.00	9.87	0.00	3.84	0.00	
55	22.10	29.80	22.10	0.00	0.00	0.00	0.00	0.00	0.00	
56	22.10	24.60	20.04	13.08	0.00	0.00	0.00	0.00	0.00	
57	20.90	19.40	25.65	0.00	0.00	0.00	0.00	0.00	0.00	
58	24.70	20.10	15.54	0.00	2.00	0.00	0.00	0.00	0.00	
59	24.10	19.60	17.09	0.00	12.73	0.00	0.00	0.00	0.00	
60	20.60	24.60	18.98	0.00	0.00	0.00	0.00	3.27	0.00	
TOTAL	1381	1406	1194.8	158.8	60.8	30.3	89.6	24.9	4.9	2157.0
Avg.	23.89	23.44	19.91	11.48	10.86	8.71	6.58	2.48	2.16	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 14-02-22 MONDAY TIME : 9 TO 10 AM			SPOT SPEED SURVEY							
MIN	4w	2w	rickshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	27.38	20.50	19.00	0.00	0.00	0.00	0.00	0.00	0.00	
2	28.61	19.60	21.70	0.00	0.00	0.00	5.14	2.17	0.00	
3	29.61	28.70	22.20	11.18	0.00	0.00	0.00	0.00	0.00	
4	25.71	29.70	22.00	0.00	12.49	0.00	0.00	0.00	0.00	
5	21.41	25.80	14.79	0.00	0.00	0.00	0.00	0.00	0.00	
6	22.61	21.50	16.50	0.00	0.00	0.00	0.00	0.00	0.00	
7	27.61	22.70	17.30	0.00	0.00	0.00	0.00	0.00	0.00	
8	30.41	21.50	19.30	0.00	10.86	0.00	0.00	0.00	0.00	
9	25.11	30.90	28.70	0.00	0.00	9.34	0.00	0.00	0.00	
10	25.61	25.70	29.70	13.58	0.00	0.00	0.00	3.08	0.00	
11	25.11	17.30	25.80	0.00	0.00	0.00	0.00	0.00	0.00	
12	25.61	19.30	21.50	0.00	0.00	0.00	0.00	0.00	0.00	
13	17.41	30.90	22.70	0.00	0.00	0.00	0.00	0.00	0.00	
14	25.11	25.70	27.70	0.00	0.00	0.00	5.01	0.00	0.00	
15	24.61	17.30	30.50	0.00	11.76	0.00	0.00	0.00	0.00	
16	30.81	19.30	20.50	16.27	0.00	0.00	0.00	0.00	0.00	
17	25.61	28.70	17.22	0.00	0.00	0.00	0.00	0.00	0.00	
18	17.21	29.70	20.99	11.22	0.00	0.00	0.00	0.00	0.00	
19	19.21	25.80	17.22	0.00	10.33	0.00	0.00	0.00	0.00	
20	30.81	21.50	26.75	0.00	0.00	0.00	5.22	3.28	0.00	
21	25.61	22.70	16.64	0.00	0.00	0.00	0.00	0.00	0.00	
22	17.21	27.70	18.19	0.00	10.28	0.00	0.00	0.00	0.00	
23	19.21	30.50	17.30	0.00	0.00	8.24	0.00	0.00	0.00	
24	19.31	20.50	19.30	10.36	0.00	0.00	0.00	0.00	0.00	
25	29.71	19.60	19.40	0.00	11.59	0.00	0.00	0.00	0.00	
26	28.11	28.70	29.80	14.21	0.00	0.00	0.00	0.00	0.00	
27	23.61	29.70	28.20	0.00	0.00	0.00	0.00	0.00	0.00	
28	20.41	25.80	23.70	13.06	12.56	0.00	0.00	0.00	0.00	
29	30.81	21.50	20.50	0.00	0.00	0.00	0.00	0.00	2.47	
30	25.61	22.70	18.80	0.00	0.00	0.00	0.00	0.00	0.00	
31	25.61	21.50	23.19	12.88	0.00	0.00	6.04	2.87	0.00	
32	19.21	21.50	15.46	0.00	0.00	0.00	0.00	0.00	0.00	
33	19.31	30.90	20.92	0.00	11.63	0.00	0.00	2.74	0.00	
34	25.11	25.70	20.81	0.00	0.00	0.00	0.00	0.00	0.00	
35	21.11	21.20	16.77	0.00	0.00	7.24	0.00	2.83	0.00	
36	21.81	24.70	13.61	0.00	12.41	0.00	0.00	0.00	0.00	
37	23.61	20.90	20.77	11.56	0.00	0.00	0.00	0.00	0.00	
38	28.61	21.20	12.34	0.00	12.07	0.00	0.00	0.00	0.00	
39	21.81	21.90	21.14	0.00	0.00	0.00	7.05	0.00	2.36	
40	25.31	25.70	26.75	10.26	11.59	0.00	6.37	0.00	0.00	
41	18.91	25.20	16.64	11.89	11.83	0.00	0.00	0.00	0.00	
42	21.61	25.70	18.19	11.05	0.00	9.58	0.00	0.00	0.00	
43	22.11	29.70	20.08	0.00	0.00	0.00	7.08	0.00	0.00	
44	21.91	25.20	11.98	0.00	12.09	0.00	0.00	3.09	0.00	
45	29.41	24.70	12.34	13.71	0.00	0.00	0.00	0.00	0.00	
46	18.91	30.90	16.50	12.04	0.00	0.00	0.00	3.11	0.00	
47	19.51	25.70	20.77	0.00	12.87	0.00	0.00	0.00	0.00	
48	28.61	20.50	28.70	11.09	11.68	0.00	6.87	0.00	0.00	
49	29.61	19.30	29.70	0.00	0.00	0.00	0.00	0.00	0.00	
50	25.71	25.70	25.80	0.00	0.00	0.00	0.00	0.00	0.00	
51	21.41	28.70	21.50	10.56	11.74	0.00	0.00	0.00	0.00	
52	22.61	29.70	22.70	11.08	0.00	0.00	6.28	0.00	2.14	
53	21.41	25.20	21.50	0.00	0.00	0.00	0.00	0.00	0.00	
54	22.61	24.70	22.70	0.00	12.57	0.00	0.00	2.46	0.00	
55	23.11	30.90	23.20	14.28	0.00	0.00	6.24	0.00	0.00	
56	23.11	25.70	21.14	0.00	11.08	0.00	0.00	0.00	0.00	
57	21.91	20.50	26.75	15.29	0.00	0.00	0.00	0.00	0.00	
58	25.71	21.20	16.64	0.00	12.57	0.00	0.00	0.00	0.00	
59	25.11	20.70	18.19	12.87	0.00	0.00	7.14	2.13	0.00	
60	21.61	25.70	20.08	11.02	0.00	0.00	0.00	2.88	0.00	
TOTAL	1441.6	1472	1260.8	259.5	224.0	34.4	68.4	30.6	6.97	2233
Avg	23.47	25.76	21.07	12.96	13.28	9.67	6.34	2.84	2.41	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 14-02-22 MONDAY TIME : 7 TO 8 AM			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	28.48	21.60	20.10	0.00	0.00	0.00	0.00	0.00	0.00	
2	29.71	20.70	22.80	0.00	0.00	0.00	6.39	2.47	0.00	
3	30.71	29.80	23.30	14.24	0.00	0.00	0.00	0.00	0.00	
4	26.81	30.80	23.10	0.00	11.46	9.67	0.00	3.28	0.00	
5	22.51	26.90	15.89	13.29	0.00	0.00	0.00	0.00	0.00	
6	23.71	22.60	17.60	0.00	12.47	0.00	0.00	0.00	0.00	
7	28.71	23.80	18.40	13.66	0.00	0.00	0.00	0.00	0.00	
8	31.51	22.60	20.40	0.00	0.00	0.00	0.00	0.00	0.00	
9	26.21	32.00	29.80	0.00	0.00	0.00	0.00	0.00	0.00	
10	26.71	26.80	30.80	0.00	0.00	0.00	0.00	3.09	0.00	
11	26.21	18.40	26.90	0.00	13.87	0.00	0.00	0.00	0.00	
12	26.71	20.40	22.60	0.00	0.00	0.00	0.00	0.00	0.00	
13	18.51	32.00	23.80	0.00	0.00	0.00	0.00	0.00	0.00	
14	26.21	26.80	28.80	0.00	0.00	0.00	0.00	0.00	0.00	
15	25.71	18.40	31.60	0.00	0.00	0.00	5.69	0.00	0.00	
16	31.91	20.40	21.60	12.47	15.36	0.00	0.00	0.00	0.00	
17	26.71	29.80	18.32	0.00	0.00	0.00	0.00	0.00	0.00	
18	18.31	30.80	22.09	13.58	0.00	0.00	0.00	0.00	0.00	
19	20.31	26.90	18.32	0.00	0.00	10.48	0.00	0.00	0.00	
20	31.91	22.60	27.85	0.00	0.00	0.00	5.81	3.21	0.00	
21	26.71	23.80	17.74	0.00	0.00	0.00	0.00	0.00	0.00	
22	18.31	28.80	19.29	0.00	0.00	0.00	0.00	0.00	0.00	
23	20.31	31.60	18.40	12.33	0.00	11.28	0.00	0.00	2.14	
24	20.41	21.60	20.40	0.00	0.00	0.00	0.00	0.00	0.00	
25	30.81	20.70	20.50	0.00	14.27	0.00	0.00	0.00	0.00	
26	29.21	29.80	30.90	0.00	0.00	0.00	0.00	0.00	0.00	
27	24.71	30.80	29.30	14.87	0.00	0.00	0.00	0.00	0.00	
28	21.51	26.90	24.80	0.00	0.00	0.00	0.00	0.00	0.00	
29	31.91	22.60	21.60	0.00	0.00	0.00	0.00	0.00	0.00	
30	26.71	23.80	19.90	0.00	0.00	0.00	0.00	0.00	0.00	
31	26.71	22.60	24.29	0.00	0.00	0.00	6.38	2.78	2.16	
32	20.31	22.60	16.56	13.69	0.00	0.00	0.00	0.00	0.00	
33	20.41	32.00	22.02	0.00	0.00	0.00	5.21	2.16	0.00	
34	26.21	26.80	21.91	0.00	0.00	0.00	0.00	0.00	0.00	
35	22.21	22.30	17.87	0.00	13.86	0.00	0.00	0.00	0.00	
36	22.91	25.80	14.71	0.00	0.00	0.00	0.00	2.49	0.00	
37	24.71	22.00	21.87	0.00	0.00	0.00	0.00	0.00	0.00	
38	29.71	22.30	13.44	0.00	11.44	0.00	0.00	0.00	2.44	
39	22.91	23.00	22.24	0.00	0.00	0.00	0.00	0.00	0.00	
40	26.41	26.80	27.85	11.08	0.00	0.00	6.39	3.04	0.00	
41	20.01	26.30	17.74	0.00	0.00	0.00	6.11	0.00	0.00	
42	22.71	26.80	19.29	0.00	0.00	10.28	0.00	0.00	0.00	
43	23.21	30.80	21.18	0.00	0.00	0.00	5.28	0.00	0.00	
44	23.01	26.30	13.08	0.00	12.04	0.00	0.00	0.00	0.00	
45	30.51	25.80	13.44	0.00	0.00	0.00	0.00	0.00	0.00	
46	20.01	32.00	17.60	0.00	0.00	0.00	0.00	0.00	2.07	
47	20.61	26.80	21.87	0.00	0.00	0.00	0.00	0.00	0.00	
48	29.71	21.60	29.80	0.00	0.00	0.00	0.00	0.00	0.00	
49	30.71	20.40	30.80	12.55	0.00	0.00	0.00	2.77	0.00	
50	26.81	26.80	26.90	0.00	0.00	0.00	0.00	0.00	0.00	
51	22.51	29.80	22.60	0.00	13.33	10.83	0.00	0.00	0.00	
52	23.71	30.80	23.80	0.00	0.00	0.00	0.00	0.00	0.00	
53	22.51	26.30	22.60	13.08	0.00	0.00	7.41	0.00	0.00	
54	23.71	25.80	23.80	0.00	0.00	0.00	0.00	2.08	0.00	
55	24.21	32.00	24.30	0.00	0.00	12.08	0.00	0.00	0.00	
56	24.21	26.80	22.24	0.00	12.47	0.00	0.00	0.00	2.99	
57	23.01	21.60	27.85	0.00	0.00	0.00	0.00	0.00	0.00	
58	26.81	22.30	17.74	0.00	0.00	0.00	6.32	0.00	0.00	
59	26.21	21.80	19.29	0.00	0.00	0.00	0.00	0.00	0.00	
60	22.71	26.80	21.18	0.00	0.00	0.00	0.00	2.06	0.00	
TOTAL	1508	1538	1326.8	144.8	130.6	64.62	60.99	29.43	11.80	2029.0
Avg	24.15	25.36	22.07	12.75	11.24	10.86	6.34	2.87	2.43	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 14-02-22 MONDAY TIME : 5 TO 6 PM			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	25.70	25.70	22.30	0.00	0.00	0.00	0.00	2.14	0.00	
2	17.30	21.20	22.10	0.00	0.00	0.00	0.00	0.00	0.00	
3	19.30	24.70	20.18	11.18	0.00	0.00	6.87	0.00	0.00	
4	19.40	20.90	16.60	0.00	12.49	0.00	0.00	0.00	0.00	
5	29.80	21.20	27.67	0.00	0.00	0.00	0.00	0.00	0.00	
6	28.20	21.90	15.26	0.00	0.00	0.00	0.00	0.00	0.00	
7	23.70	25.70	20.87	0.00	0.00	0.00	0.00	0.00	0.00	
8	20.50	25.20	17.84	0.00	10.86	0.00	0.00	0.00	0.00	
9	30.90	25.70	20.87	0.00	0.00	8.64	0.00	0.00	0.00	
10	25.70	29.70	17.84	13.58	0.00	0.00	0.00	0.00	2.14	
11	25.70	25.20	19.26	0.00	0.00	0.00	0.00	0.00	0.00	
12	19.30	24.70	17.32	0.00	0.00	0.00	0.00	0.00	0.00	
13	19.40	29.70	21.09	0.00	0.00	0.00	0.00	0.00	0.00	
14	25.20	25.80	17.32	0.00	0.00	0.00	0.00	0.00	0.00	
15	21.20	21.50	21.02	0.00	11.76	0.00	6.11	0.00	0.00	
16	25.20	22.70	18.29	16.27	0.00	0.00	0.00	0.00	2.36	
17	24.70	21.50	25.98	0.00	0.00	0.00	0.00	0.00	0.00	
18	30.90	30.90	27.44	11.22	0.00	0.00	0.00	0.00	0.00	
19	25.70	25.70	21.18	0.00	10.33	0.00	0.00	0.00	0.00	
20	27.20	17.30	23.29	0.00	0.00	0.00	0.00	0.00	0.00	
21	19.30	19.30	26.46	0.00	0.00	0.00	0.00	3.05	0.00	
22	19.40	30.90	21.02	0.00	10.28	0.00	0.00	0.00	0.00	
23	29.80	25.70	23.21	0.00	0.00	0.00	0.00	0.00	0.00	
24	28.20	17.30	20.18	10.36	0.00	0.00	0.00	0.00	0.00	
25	23.70	22.70	29.84	0.00	11.59	0.00	0.00	0.00	0.00	
26	20.50	21.50	20.87	14.21	0.00	0.00	0.00	0.00	0.00	
27	28.30	30.90	29.61	0.00	0.00	0.00	0.00	0.00	0.00	
28	25.70	25.70	25.36	13.06	12.56	0.00	0.00	2.36	0.00	
29	28.30	21.20	17.01	0.00	0.00	0.00	0.00	0.00	0.00	
30	25.70	24.70	24.77	0.00	0.00	0.00	0.00	0.00	0.00	
31	20.40	20.90	21.24	12.88	0.00	0.00	6.35	0.00	0.00	
32	21.50	23.70	26.85	0.00	0.00	0.00	0.00	2.15	0.00	
33	28.70	19.30	16.74	0.00	11.63	7.47	0.00	0.00	0.00	
34	21.70	21.20	18.29	0.00	0.00	0.00	0.00	0.00	0.00	
35	22.20	25.20	20.18	0.00	0.00	0.00	0.00	0.00	0.00	
36	22.00	21.20	23.59	0.00	12.41	0.00	0.00	2.36	0.00	
37	21.24	20.10	21.24	11.56	0.00	0.00	0.00	0.00	0.00	
38	28.70	25.70	16.76	0.00	12.07	0.00	0.00	0.00	0.00	
39	27.50	19.30	21.20	0.00	0.00	0.00	0.00	0.00	0.00	
40	22.70	25.70	14.35	10.26	11.59	0.00	0.00	2.63	0.00	
41	21.50	20.20	23.21	11.89	11.83	0.00	0.00	0.00	0.00	
42	22.70	21.70	26.85	11.05	0.00	0.00	0.00	0.00	0.00	
43	23.20	22.20	20.87	0.00	0.00	0.00	0.00	2.85	0.00	
44	25.14	30.78	17.84	0.00	12.09	0.00	0.00	0.00	0.00	
45	22.00	29.80	19.26	13.71	0.00	0.00	0.00	0.00	2.13	
46	24.78	19.60	17.32	12.04	0.00	0.00	0.00	3.06	0.00	
47	25.20	28.70	20.68	0.00	12.87	6.34	0.00	0.00	0.00	
48	25.20	29.70	24.61	11.09	11.68	0.00	0.00	0.00	0.00	
49	25.70	25.80	26.85	0.00	0.00	0.00	0.00	2.61	0.00	
50	24.51	21.50	16.74	0.00	0.00	0.00	0.00	0.00	0.00	
51	21.64	22.70	18.29	10.56	11.74	0.00	0.00	2.84	0.00	
52	17.50	21.50	26.85	11.08	0.00	0.00	0.00	0.00	0.00	
53	25.20	22.57	19.65	0.00	0.00	0.00	7.14	0.00	0.00	
54	24.70	27.61	18.29	0.00	12.57	7.15	0.00	0.00	0.00	
55	20.31	28.71	20.18	14.28	0.00	0.00	1.00	0.00	2.51	
56	24.74	21.24	16.18	0.00	11.08	0.00	0.00	0.00	0.00	
57	21.99	28.66	21.24	15.29	0.00	0.00	0.00	0.00	0.00	
58	21.24	24.55	16.60	0.00	12.57	0.00	6.27	2.14	0.00	
59	25.66	28.71	15.39	12.87	0.00	0.00	0.00	0.00	0.00	
60	24.58	24.99	25.87	11.02	0.00	8.27	0.00	0.00	0.00	
TOTAL	1438	1450.3	1265.3	259.5	224.0	37.87	33.74	28.19	9.14	2439.0
Avg	23.41	25.43	20.76	12.36	12.74	9.63	6.89	2.86	2.41	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 14-02-22 MONDAY TIME : 6 TO 7 PM			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	24.60	24.60	21.10	9.31	11.43	0.00	0.00	2.14	0.00	
2	16.20	20.10	20.90	12.86	0.00	0.00	0.00	0.00	0.00	
3	18.20	23.60	18.98	0.00	0.00	0.00	5.63	0.00	0.00	
4	18.30	19.80	15.40	11.42	0.00	0.00	0.00	0.00	0.00	
5	28.70	20.10	26.47	0.00	0.00	7.42	0.00	0.00	0.00	
6	27.10	20.80	14.06	0.00	0.00	0.00	0.00	0.00	0.00	
7	22.60	24.60	19.67	0.00	0.00	0.00	0.00	0.00	0.00	
8	19.40	24.10	16.64	14.98	0.00	0.00	0.00	0.00	2.11	
9	29.80	24.60	19.67	0.00	0.00	7.33	0.00	0.00	0.00	
10	24.60	28.60	16.64	0.00	13.24	0.00	0.00	0.00	0.00	
11	24.60	24.10	18.06	12.05	0.00	0.00	0.00	0.00	0.00	
12	18.20	23.60	16.12	10.59	0.00	0.00	0.00	0.00	0.00	
13	18.30	28.60	19.89	0.00	0.00	0.00	0.00	0.00	0.00	
14	24.10	24.70	16.12	0.00	0.00	0.00	0.00	3.06	0.00	
15	20.10	20.40	19.82	11.40	0.00	0.00	5.62	0.00	0.00	
16	24.10	21.60	17.09	0.00	0.00	0.00	0.00	0.00	0.00	
17	23.60	20.40	24.78	0.00	8.78	0.00	0.00	0.00	0.00	
18	29.80	29.80	26.24	0.00	0.00	8.14	5.68	0.00	0.00	
19	24.60	24.60	19.98	12.50	0.00	0.00	0.00	0.00	0.00	
20	26.10	16.20	22.09	10.09	0.00	0.00	0.00	0.00	0.00	
21	18.20	18.20	25.26	0.00	0.00	0.00	0.00	0.00	2.18	
22	18.30	29.80	19.82	0.00	0.00	0.00	0.00	0.00	0.00	
23	28.70	24.60	22.01	0.00	0.00	0.00	0.00	0.00	0.00	
24	27.10	16.20	18.98	0.00	0.00	0.00	0.00	0.00	0.00	
25	22.60	21.60	28.64	14.57	10.92	0.00	0.00	0.00	0.00	
26	19.40	20.40	19.67	0.00	0.00	0.00	0.00	0.00	0.00	
27	27.20	29.80	28.41	0.00	0.00	0.00	0.00	0.00	2.01	
28	24.60	24.60	24.16	0.00	0.00	0.00	0.00	2.16	0.00	
29	27.20	20.10	15.81	0.00	0.00	0.00	0.00	0.00	0.00	
30	24.60	23.60	23.57	0.00	0.00	8.61	0.00	0.00	0.00	
31	19.30	19.80	20.04	11.73	0.00	0.00	4.12	0.00	0.00	
32	20.40	22.60	25.65	12.43	0.00	0.00	0.00	2.48	0.00	
33	27.60	18.20	15.54	0.00	0.00	9.37	0.00	0.00	0.00	
34	20.60	20.10	17.09	0.00	0.00	0.00	0.00	0.00	0.00	
35	21.10	24.10	18.98	0.00	0.00	0.00	0.00	0.00	0.00	
36	20.90	20.10	22.39	12.54	0.00	0.00	5.36	2.36	0.00	
37	20.14	19.00	20.04	0.00	10.21	0.00	0.00	0.00	0.00	
38	27.60	24.60	15.56	0.00	0.00	0.00	0.00	0.00	0.00	
39	26.40	18.20	20.00	0.00	0.00	0.00	0.00	0.00	2.36	
40	21.60	24.60	13.15	0.00	0.00	0.00	0.00	2.75	0.00	
41	20.40	19.10	22.01	13.65	0.00	0.00	0.00	0.00	0.00	
42	21.60	20.60	25.65	0.00	0.00	0.00	0.00	0.00	0.00	
43	22.10	21.10	19.67	11.87	0.00	0.00	0.00	2.11	2.08	
44	24.04	29.68	16.64	0.00	0.00	0.00	0.00	0.00	0.00	
45	20.90	28.70	18.06	0.00	0.00	0.00	0.00	0.00	0.00	
46	23.68	18.50	16.12	9.47	9.47	9.63	0.00	3.01	0.00	
47	24.10	27.60	19.48	0.00	0.00	0.00	0.00	0.00	0.00	
48	24.10	28.60	23.41	0.00	0.00	0.00	0.00	0.00	2.01	
49	24.60	24.70	25.65	0.00	0.00	0.00	0.00	2.88	0.00	
50	23.41	20.40	15.54	0.00	0.00	0.00	6.18	0.00	0.00	
51	20.54	21.60	17.09	10.19	0.00	0.00	0.00	2.41	0.00	
52	16.40	20.40	25.65	0.00	0.00	0.00	0.00	2.39	0.00	
53	24.10	21.47	18.45	0.00	0.00	0.00	0.00	0.00	0.00	
54	23.60	26.51	17.09	0.00	0.00	0.00	0.00	0.00	0.00	
55	19.21	27.61	18.98	12.13	0.00	0.00	6.17	0.00	0.00	
56	23.64	20.14	14.98	0.00	0.00	0.00	0.00	0.00	0.00	
57	20.89	27.56	20.04	0.00	0.00	0.00	0.00	0.00	0.00	
58	20.14	23.45	15.40	0.00	0.00	0.00	0.00	2.37	2.33	
59	24.56	27.61	14.19	0.00	9.31	0.00	0.00	0.00	0.00	
60	23.48	23.89	24.67	10.33	0.00	7.88	0.00	0.00	0.00	
TOTAL	1372.0	1384.3	1193.3	224.1	73.36	58.38	38.76	30.12	15.08	2690.0
AVG	22.87	23.07	19.87	11.54	10.87	8.67	6.58	2.64	2.44	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 14-02-22 MONDAY TIME : 7 TO 8 PM				SPOT SPEED SURVEY						
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	26.81	26.82	23.42	0.00	0.00	0.00	0.00	2.51	0.00	
2	18.41	22.32	23.22	0.00	0.00	0.00	0.00	0.00	0.00	
3	20.41	25.82	21.30	14.23	0.00	0.00	7.08	0.00	0.00	
4	20.51	22.02	17.72	0.00	12.36	0.00	0.00	0.00	0.00	
5	30.91	22.32	28.79	0.00	0.00	0.00	0.00	0.00	0.00	
6	29.31	23.02	16.38	0.00	0.00	0.00	0.00	0.00	0.00	
7	24.81	26.82	21.99	13.66	0.00	0.00	0.00	0.00	0.00	
8	21.61	26.32	18.96	0.00	0.00	0.00	0.00	0.00	0.00	
9	32.01	26.82	21.99	0.00	0.00	9.34	0.00	0.00	0.00	
10	26.81	30.82	18.96	0.00	0.00	0.00	0.00	0.00	0.00	
11	26.81	26.32	20.38	0.00	13.87	0.00	0.00	0.00	0.00	
12	20.41	25.82	18.44	0.00	0.00	0.00	0.00	0.00	0.00	
13	20.51	30.82	22.21	0.00	0.00	0.00	0.00	0.00	0.00	
14	26.31	26.92	18.44	0.00	0.00	0.00	0.00	2.63	0.00	
15	22.31	22.62	22.14	0.00	0.00	0.00	7.39	0.00	0.00	
16	26.31	23.82	19.41	11.28	15.36	0.00	0.00	0.00	0.00	
17	25.81	22.62	27.10	0.00	0.00	0.00	0.00	0.00	0.00	
18	32.01	32.02	28.56	13.58	0.00	0.00	0.00	0.00	0.00	
19	26.81	26.82	22.30	0.00	0.00	0.00	0.00	0.00	0.00	
20	28.31	18.42	24.41	0.00	0.00	0.00	0.00	0.00	0.00	
21	20.41	20.42	27.58	0.00	0.00	0.00	0.00	0.00	0.00	
22	20.51	32.02	22.14	0.00	0.00	0.00	0.00	0.00	0.00	
23	30.91	26.82	24.33	12.33	0.00	0.00	0.00	0.00	0.00	
24	29.31	18.42	21.30	0.00	0.00	0.00	0.00	0.00	0.00	
25	24.81	23.82	30.96	0.00	14.27	0.00	0.00	0.00	0.00	
26	21.61	22.62	21.99	0.00	0.00	0.00	0.00	0.00	0.00	
27	29.41	32.02	30.73	14.87	0.00	0.00	0.00	0.00	0.00	
28	26.81	26.82	26.48	0.00	0.00	0.00	0.00	2.55	0.00	
29	29.41	22.32	18.13	0.00	0.00	0.00	0.00	0.00	0.00	
30	26.81	25.82	25.89	0.00	0.00	0.00	0.00	0.00	0.00	
31	21.51	22.02	22.36	0.00	0.00	0.00	6.53	0.00	0.00	
32	22.61	24.82	27.97	13.69	0.00	0.00	0.00	2.63	2.01	
33	29.81	20.42	17.86	0.00	0.00	9.74	0.00	0.00	0.00	
34	22.81	22.32	19.41	0.00	0.00	0.00	0.00	0.00	0.00	
35	23.31	26.32	21.30	0.00	13.86	0.00	0.00	0.00	0.00	
36	23.11	22.32	24.71	0.00	0.00	0.00	0.00	2.66	2.31	
37	22.35	21.22	22.36	0.00	0.00	0.00	0.00	0.00	0.00	
38	29.81	26.82	17.88	0.00	11.44	0.00	0.00	0.00	2.08	
39	28.61	20.42	22.32	0.00	0.00	0.00	0.00	0.00	0.00	
40	23.81	26.82	15.47	11.08	0.00	0.00	0.00	0.00	0.00	
41	22.61	21.32	24.33	0.00	0.00	0.00	0.00	0.00	0.00	
42	23.81	22.82	27.97	0.00	0.00	0.00	0.00	0.00	0.00	
43	24.31	23.32	21.99	0.00	0.00	0.00	0.00	0.00	0.00	
44	26.25	31.90	18.96	0.00	12.04	0.00	0.00	0.00	0.00	
45	23.11	30.92	20.38	0.00	0.00	0.00	0.00	0.00	0.00	
46	25.89	20.72	18.44	0.00	0.00	0.00	0.00	0.00	0.00	
47	26.31	29.82	21.80	0.00	0.00	0.00	0.00	0.00	0.00	
48	26.31	30.82	25.73	0.00	0.00	0.00	0.00	0.00	0.00	
49	26.81	26.92	27.97	12.55	0.00	0.00	0.00	0.00	0.00	
50	25.62	22.62	17.86	0.00	0.00	0.00	0.00	0.00	0.00	
51	22.75	23.82	19.41	0.00	13.33	0.00	0.00	2.14	0.00	
52	18.61	22.62	27.97	0.00	0.00	0.00	0.00	0.00	0.00	
53	26.31	23.69	20.77	13.08	0.00	0.00	0.00	0.00	0.00	
54	25.81	28.73	19.41	0.00	0.00	0.00	0.00	0.00	0.00	
55	21.42	29.83	21.30	0.00	0.00	0.00	6.34	0.00	0.00	
56	25.85	22.36	17.30	0.00	12.47	0.00	0.00	0.00	0.00	
57	23.10	29.78	22.36	0.00	0.00	0.00	0.00	0.00	0.00	
58	22.35	25.67	17.72	0.00	0.00	0.00	0.00	3.08	0.00	
59	26.77	29.83	16.51	0.00	0.00	0.00	0.00	0.00	0.00	
60	25.69	26.11	26.99	0.00	0.00	8.52	0.00	0.00	0.00	
TOTAL	1504.6	528.00	372.00	130.35	7.00	27.60	27.34	18.20	5.40	1413.0
AVG	25.52	26.38	22.14	12.47	12.89	9.69	6.54	2.84	2.16	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 14-02-22 MONDAY TIME : 5 TO 6 pm			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	23.21	25.72	25.72	0.00	0.00	0.00	0.00	2.14	0.00	
2	25.15	19.32	19.32	0.00	0.00	0.00	0.00	0.00	0.00	
3	22.01	25.72	25.72	11.08	0.00	0.00	0.00	2.95	0.00	
4	24.79	20.22	20.22	0.00	11.69	0.00	5.28	0.00	0.00	
5	25.21	21.72	21.72	12.09	0.00	0.00	0.00	0.00	0.00	
6	25.21	22.22	22.22	0.00	0.00	9.68	0.00	0.00	0.00	
7	25.71	30.80	30.80	12.74	0.00	0.00	6.31	0.00	0.00	
8	24.52	29.82	29.82	0.00	11.86	0.00	0.00	2.68	0.00	
9	21.65	19.62	19.62	10.28	0.00	0.00	0.00	0.00	0.00	
10	17.51	28.72	28.72	0.00	0.00	0.00	0.00	0.00	0.00	
11	25.21	29.72	29.72	0.00	12.93	0.00	5.96	0.00	0.00	
12	24.71	25.82	25.82	11.67	0.00	0.00	0.00	0.00	0.00	
13	20.32	30.92	30.92	0.00	12.07	0.00	0.00	0.00	0.00	
14	25.71	25.72	25.72	0.00	0.00	0.00	0.00	0.00	0.00	
15	25.71	21.22	21.22	12.08	11.08	0.00	0.00	0.00	0.00	
16	19.31	24.72	24.72	0.00	0.00	0.00	0.00	0.00	0.00	
17	19.41	20.92	20.92	0.00	0.00	0.00	0.00	3.08	0.00	
18	25.21	21.22	21.22	0.00	0.00	0.00	0.00	0.00	0.00	
19	21.21	21.92	21.92	0.00	11.83	0.00	0.00	2.84	0.00	
20	25.21	25.72	25.72	10.83	0.00	0.00	0.00	0.00	0.00	
21	24.71	25.22	25.22	0.00	0.00	0.00	5.28	0.00	0.00	
22	30.91	25.72	25.72	11.37	0.00	0.00	0.00	0.00	0.00	
23	25.71	29.72	29.72	0.00	10.96	0.00	0.00	0.00	0.00	
24	27.21	25.22	25.22	0.00	0.00	0.00	0.00	0.00	0.00	
25	19.31	24.72	24.72	0.00	0.00	0.00	0.00	0.00	0.00	
26	19.41	30.92	30.92	0.00	11.83	0.00	0.00	0.00	0.00	
27	25.21	25.72	25.72	11.68	0.00	0.00	0.00	0.00	0.00	
28	21.21	30.92	30.92	0.00	12.73	0.00	0.00	0.00	0.00	
29	21.91	25.72	25.72	0.00	0.00	0.00	0.00	0.00	0.00	
30	23.71	21.22	21.22	0.00	0.00	0.00	0.00	2.97	0.00	
31	28.71	24.72	24.72	0.00	0.00	0.00	0.00	0.00	0.00	
32	21.91	20.92	20.92	10.58	0.00	0.00	0.00	0.00	0.00	
33	25.41	23.72	23.72	0.00	0.00	0.00	0.00	0.00	0.00	
34	19.01	19.32	19.32	0.00	0.00	0.00	0.00	0.00	0.00	
35	21.71	21.22	21.22	12.98	0.00	0.00	0.00	0.00	0.00	
36	22.21	25.22	25.22	0.00	12.07	9.57	0.00	2.37	0.00	
37	21.51	21.22	21.22	10.78	0.00	0.00	0.00	0.00	0.00	
38	22.71	20.12	20.12	0.00	0.00	0.00	0.00	0.00	2.11	
39	23.21	25.72	25.72	0.00	0.00	0.00	6.25	2.57	0.00	
40	25.15	25.22	25.22	13.05	0.00	0.00	0.00	0.00	0.00	
41	22.01	24.72	24.72	0.00	11.29	0.00	0.00	0.00	0.00	
42	24.79	29.72	29.72	0.00	0.00	0.00	7.14	0.00	2.36	
43	25.21	25.82	25.82	0.00	0.00	0.00	6.87	2.07	0.00	
44	20.51	21.52	21.52	0.00	11.68	0.00	0.00	0.00	0.00	
45	28.31	22.72	22.72	0.00	0.00	0.00	0.00	0.00	0.00	
46	25.71	21.52	21.52	0.00	0.00	0.00	0.00	2.58	0.00	
47	28.31	30.92	30.92	12.73	0.00	0.00	0.00	0.00	0.00	
48	25.71	25.72	25.72	0.00	0.00	0.00	0.00	0.00	0.00	
49	20.41	17.32	17.32	0.00	12.08	9.65	0.00	0.00	0.00	
50	21.51	19.32	19.32	0.00	0.00	0.00	0.00	0.00	0.00	
51	29.81	30.92	30.92	0.00	0.00	0.00	0.00	0.00	0.00	
52	28.21	25.72	25.72	0.00	10.58	0.00	7.14	0.00	0.00	
53	23.71	17.32	17.32	0.00	0.00	0.00	0.00	0.00	2.36	
54	20.51	22.38	22.38	0.00	0.00	0.00	0.00	0.00	0.00	
55	28.31	24.71	24.71	13.08	0.00	0.00	0.00	0.00	0.00	
56	25.71	25.27	25.27	0.00	11.73	0.00	6.34	3.08	0.00	
57	20.41	24.57	24.57	0.00	0.00	0.00	0.00	0.00	0.00	
58	21.51	21.70	21.70	11.86	0.00	0.00	0.00	0.00	0.00	
59	28.71	28.76	28.76	0.00	0.00	9.57	0.00	0.00	0.00	
60	21.71	25.27	25.27	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1429	1470.2	1470.2	188.9	176.4	38.47	56.6	29.33	6.83	2157
Avg	23.04	24.26	20.84	11.85	11.47	8.98	7.48	2.42	2.13	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 14-02-22 MONDAY TIME : 6 TO 7 pm			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	22.10	24.60	24.60	0.00	0.00	0.00	0.00	2.78	0.00	
2	24.04	18.20	18.20	0.00	0.00	0.00	0.00	0.00	0.00	
3	20.90	24.60	24.60	10.26	11.27	0.00	7.08	2.69	0.00	
4	23.68	19.10	19.10	0.00	12.63	0.00	0.00	0.00	0.00	
5	24.10	20.60	20.60	0.00	0.00	0.00	0.00	2.34	0.00	
6	24.10	21.10	21.10	0.00	0.00	8.47	0.00	0.00	0.00	
7	24.60	29.68	29.68	0.00	0.00	8.89	6.38	0.00	0.00	
8	23.41	28.70	28.70	0.00	10.59	0.00	0.00	2.84	0.00	
9	20.54	18.50	18.50	0.00	0.00	0.00	0.00	0.00	0.00	
10	16.40	27.60	27.60	13.58	0.00	0.00	0.00	2.66	0.00	
11	24.10	28.60	28.60	0.00	13.06	0.00	0.00	0.00	0.00	
12	23.60	24.70	24.70	0.00	0.00	0.00	0.00	0.00	0.00	
13	19.21	29.80	29.80	0.00	0.00	0.00	6.91	0.00	0.00	
14	24.60	24.60	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
15	24.60	20.10	20.10	0.00	0.00	0.00	0.00	0.00	0.00	
16	18.20	23.60	23.60	0.00	0.00	0.00	0.00	3.02	0.00	
17	18.30	19.80	19.80	0.00	0.00	0.00	0.00	2.89	0.00	
18	24.10	20.10	20.10	11.22	0.00	0.00	0.00	0.00	0.00	
19	20.10	20.80	20.80	0.00	0.00	0.00	0.00	2.07	0.00	
20	24.10	24.60	24.60	0.00	10.89	0.00	0.00	0.00	0.00	
21	23.60	24.10	24.10	0.00	0.00	0.00	0.00	0.00	0.00	
22	29.80	24.60	24.60	0.00	11.67	0.00	0.00	0.00	0.00	
23	24.60	28.60	28.60	0.00	0.00	0.00	6.38	0.00	0.00	
24	26.10	24.10	24.10	10.36	0.00	0.00	0.00	2.84	0.00	
25	18.20	23.60	23.60	0.00	13.07	9.37	0.00	0.00	0.00	
26	18.30	29.80	29.80	0.00	0.00	0.00	0.00	0.00	2.36	
27	24.10	24.60	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
28	20.10	29.80	29.80	13.06	11.49	0.00	0.00	0.00	0.00	
29	20.80	24.60	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
30	22.60	20.10	20.10	0.00	0.00	0.00	0.00	2.08	0.00	
31	27.60	23.60	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
32	20.80	19.80	19.80	0.00	0.00	9.04	0.00	2.69	0.00	
33	24.30	22.60	22.60	0.00	14.27	0.00	7.36	0.00	2.16	
34	17.90	18.20	18.20	0.00	0.00	0.00	0.00	0.00	0.00	
35	20.60	20.10	20.10	0.00	0.00	0.00	0.00	0.00	0.00	
36	21.10	24.10	24.10	0.00	10.78	8.34	0.00	2.08	0.00	
37	20.40	20.10	20.10	11.56	0.00	0.00	0.00	2.57	0.00	
38	21.60	19.00	19.00	0.00	0.00	0.00	0.00	0.00	0.00	
39	22.10	24.60	24.60	0.00	0.00	0.00	7.08	0.00	0.00	
40	24.04	24.10	24.10	10.26	10.98	0.00	0.00	0.00	0.00	
41	20.90	23.60	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
42	23.68	28.60	28.60	0.00	0.00	8.63	6.34	0.00	0.00	
43	24.10	24.70	24.70	0.00	0.00	0.00	0.00	0.00	0.00	
44	19.40	20.40	20.40	0.00	0.00	0.00	0.00	0.00	2.15	
45	27.20	21.60	21.60	13.71	11.27	0.00	0.00	0.00	0.00	
46	24.60	20.40	20.40	0.00	0.00	0.00	7.11	2.36	0.00	
47	27.20	29.80	29.80	0.00	12.47	0.00	0.00	0.00	0.00	
48	24.60	24.60	24.60	11.09	0.00	0.00	0.00	0.00	2.17	
49	19.30	16.20	16.20	0.00	0.00	0.00	0.00	0.00	0.00	
50	20.40	18.20	18.20	0.00	0.00	9.34	0.00	0.00	0.00	
51	28.70	29.80	29.80	0.00	0.00	0.00	6.74	2.61	0.00	
52	27.10	24.60	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
53	22.60	16.20	16.20	0.00	0.00	9.31	0.00	0.00	0.00	
54	19.40	21.26	21.26	0.00	10.78	0.00	0.00	0.00	0.00	
55	27.20	23.59	23.59	0.00	0.00	0.00	0.00	0.00	0.00	
56	24.60	24.15	24.15	0.00	0.00	0.00	6.33	0.00	2.11	
57	19.30	23.45	23.45	0.00	0.00	0.00	0.00	0.00	0.00	
58	20.40	20.58	20.58	0.00	12.96	0.00	0.00	0.00	0.00	
59	27.60	27.64	27.64	12.87	0.00	8.62	6.24	0.00	0.00	
60	20.60	24.15	24.15	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1362.3	1403.0	1403.0	118.0	178.2	80.01	73.95	38.52	10.95	2284.0
AVG	22.71	23.58	19.97	11.02	10.65	8.64	6.41	2.31	2.12	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 14-02-22 MONDAY TIME : 7 TO 8 pm				SPOT SPEED SURVEY						
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	24.33	26.73	26.83	0.00	9.37	0.00	0.00	2.25	0.00	
2	26.27	20.33	20.43	0.00	0.00	0.00	0.00	0.00	0.00	
3	23.13	26.73	26.83	11.24	0.00	0.00	0.00	2.34	0.00	
4	25.91	21.23	21.33	0.00	0.00	0.00	0.00	0.00	0.00	
5	26.33	22.73	22.83	0.00	0.00	0.00	0.00	0.00	0.00	
6	26.33	23.23	23.33	12.39	0.00	9.14	0.00	0.00	0.00	
7	26.83	31.81	31.91	0.00	0.00	0.00	7.08	0.00	0.00	
8	25.64	30.83	30.93	10.28	10.86	0.00	0.00	2.98	2.14	
9	22.77	20.63	20.73	0.00	0.00	0.00	0.00	0.00	0.00	
10	18.63	29.73	29.83	0.00	0.00	0.00	0.00	0.00	0.00	
11	26.33	30.73	30.83	0.00	0.00	0.00	0.00	0.00	0.00	
12	25.83	26.83	26.93	0.00	0.00	0.00	0.00	0.00	0.00	
13	21.44	31.93	32.03	12.76	0.00	0.00	0.00	0.00	0.00	
14	26.83	26.73	26.83	0.00	0.00	0.00	0.00	0.00	0.00	
15	26.83	22.23	22.33	0.00	11.76	0.00	0.00	0.00	0.00	
16	20.43	25.73	25.83	12.64	0.00	0.00	0.00	0.00	0.00	
17	20.53	21.93	22.03	0.00	0.00	0.00	0.00	2.36	0.00	
18	26.33	22.23	22.33	13.28	0.00	0.00	0.00	0.00	0.00	
19	22.33	22.93	23.03	0.00	0.00	0.00	0.00	2.98	0.00	
20	26.33	26.73	26.83	11.86	0.00	0.00	0.00	0.00	0.00	
21	25.83	26.23	26.33	0.00	0.00	0.00	0.00	0.00	2.31	
22	32.03	26.73	26.83	0.00	10.28	0.00	0.00	0.00	0.00	
23	26.83	30.73	30.83	0.00	0.00	0.00	0.00	0.00	0.00	
24	28.33	26.23	26.33	13.07	0.00	0.00	0.00	0.00	0.00	
25	20.43	25.73	25.83	0.00	0.00	0.00	0.00	0.00	0.00	
26	20.53	31.93	32.03	0.00	11.47	0.00	0.00	0.00	0.00	
27	26.33	26.73	26.83	0.00	0.00	0.00	0.00	0.00	0.00	
28	22.33	31.93	32.03	0.00	12.56	0.00	0.00	0.00	0.00	
29	23.03	26.73	26.83	0.00	0.00	0.00	0.00	0.00	0.00	
30	24.83	22.23	22.33	0.00	0.00	0.00	0.00	2.86	0.00	
31	29.83	25.73	25.83	11.39	0.00	0.00	0.00	0.00	0.00	
32	23.03	21.93	22.03	0.00	0.00	0.00	0.00	0.00	0.00	
33	26.53	24.73	24.83	0.00	11.63	0.00	0.00	0.00	0.00	
34	20.13	20.33	20.43	0.00	0.00	0.00	0.00	0.00	0.00	
35	22.83	22.23	22.33	0.00	0.00	0.00	0.00	0.00	0.00	
36	23.33	26.23	26.33	0.00	0.00	10.25	0.00	2.76	0.00	
37	22.63	22.23	22.33	10.86	0.00	0.00	0.00	0.00	0.00	
38	23.83	21.13	21.23	0.00	12.07	0.00	0.00	0.00	0.00	
39	24.33	26.73	26.83	0.00	0.00	0.00	0.00	0.00	0.00	
40	26.27	26.23	26.33	0.00	11.59	0.00	0.00	0.00	0.00	
41	23.13	25.73	25.83	12.09	0.00	0.00	0.00	0.00	0.00	
42	25.91	30.73	30.83	0.00	0.00	0.00	0.00	0.00	0.00	
43	26.33	26.83	26.93	0.00	0.00	0.00	6.53	0.00	0.00	
44	21.63	22.53	22.63	0.00	12.09	0.00	0.00	0.00	0.00	
45	29.43	23.73	23.83	0.00	0.00	0.00	0.00	0.00	0.00	
46	26.83	22.53	22.63	11.08	0.00	0.00	0.00	2.68	0.00	
47	29.43	31.93	32.03	0.00	0.00	0.00	0.00	0.00	0.00	
48	26.83	26.73	26.83	0.00	11.68	0.00	0.00	0.00	0.00	
49	21.53	18.33	18.43	0.00	0.00	0.00	0.00	0.00	0.00	
50	22.63	20.33	20.43	0.00	0.00	0.00	0.00	0.00	0.00	
51	30.93	31.93	32.03	0.00	11.74	0.00	0.00	0.00	0.00	
52	29.33	26.73	26.83	12.08	0.00	11.04	0.00	0.00	0.00	
53	24.83	18.33	18.43	0.00	0.00	0.00	0.00	0.00	0.00	
54	21.63	23.39	23.49	0.00	13.08	0.00	0.00	0.00	0.00	
55	29.43	25.72	25.82	0.00	0.00	0.00	0.00	0.00	0.00	
56	26.83	26.28	26.38	0.00	0.00	0.00	7.14	3.01	0.00	
57	21.53	25.58	25.68	11.87	0.00	0.00	0.00	0.00	0.00	
58	22.63	22.71	22.81	0.00	12.57	0.00	0.00	0.00	0.00	
59	29.83	29.77	29.87	0.00	0.00	10.54	0.00	0.00	0.00	
60	22.83	26.28	26.38	0.00	0.00	0.00	0.00	0.00	0.00	
[illegible]	1496.1	445.00	1536.80	12.00	162.8	40.97	3.00	24.22	1.45	1251.00
[illegible]	24.17	25.30	23.47	12.08	11.07	10.27	7.85	2.56	2.16	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 09-02-22 WEDNESDAY TIME : 7 TO 8 AM			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	31.68	33.51	25.20	12.58	0.00	0.00	0.00	0.00	0.00	
2	25.70	30.90	24.70	0.00	12.48	12.68	0.00	2.41	0.00	
3	23.66	25.70	30.96	0.00	0.00	0.00	6.34	0.00	0.00	
4	21.50	24.80	25.20	0.00	0.00	0.00	0.00	0.00	0.00	
5	30.57	31.38	24.70	13.47	0.00	0.00	0.00	0.00	0.00	
6	21.70	30.90	20.31	0.00	0.00	0.00	0.00	0.00	2.14	
7	22.20	25.70	24.74	0.00	0.00	0.00	0.00	0.00	0.00	
8	22.00	33.69	26.75	0.00	0.00	0.00	0.00	0.00	0.00	
9	29.50	32.15	25.20	14.25	0.00	0.00	0.00	0.00	0.00	
10	31.39	30.90	24.70	0.00	0.00	0.00	0.00	0.00	0.00	
11	23.70	25.70	25.20	0.00	0.00	0.00	0.00	2.93	0.00	
12	32.18	25.70	21.20	12.36	0.00	0.00	0.00	0.00	0.00	
13	30.90	33.69	25.70	0.00	0.00	0.00	7.48	0.00	0.00	
14	25.70	29.74	24.70	0.00	0.00	0.00	6.17	0.00	0.00	
15	25.70	25.20	23.15	0.00	0.00	0.00	0.00	0.00	0.00	
16	21.63	21.20	24.74	0.00	0.00	11.64	0.00	0.00	0.00	
17	19.40	25.70	28.46	12.84	0.00	0.00	0.00	0.00	0.00	
18	22.20	24.70	21.90	0.00	0.00	0.00	0.00	0.00	0.00	
19	31.15	33.14	25.70	12.87	13.28	0.00	0.00	0.00	0.00	
20	22.55	24.74	22.24	0.00	0.00	0.00	0.00	0.00	0.00	
21	28.70	28.46	27.38	0.00	0.00	0.00	0.00	0.00	0.00	
22	27.50	21.24	25.20	13.04	0.00	0.00	0.00	0.00	0.00	
23	29.20	25.20	24.70	0.00	0.00	0.00	0.00	2.47	0.00	
24	21.60	21.20	28.71	0.00	0.00	0.00	0.00	0.00	0.00	
25	25.40	32.91	28.70	0.00	0.00	0.00	0.00	2.86	2.34	
26	24.74	25.70	27.50	14.25	0.00	0.00	0.00	0.00	0.00	
27	29.46	32.18	22.70	0.00	0.00	0.00	0.00	0.00	0.00	
28	22.20	25.70	21.50	0.00	0.00	0.00	0.00	0.00	0.00	
29	22.00	31.15	22.70	0.00	0.00	0.00	0.00	0.00	0.00	
30	29.50	25.20	23.20	0.00	0.00	10.47	0.00	0.00	0.00	
31	25.70	22.75	25.14	0.00	0.00	0.00	0.00	0.00	0.00	
32	27.20	30.90	21.70	12.36	0.00	0.00	0.00	0.00	0.00	
33	27.85	25.70	22.20	0.00	0.00	0.00	6.37	2.57	0.00	
34	33.14	25.70	25.70	13.48	0.00	0.00	0.00	0.00	0.00	
35	25.66	31.39	25.20	0.00	14.68	0.00	0.00	2.36	0.00	
36	28.20	27.38	25.70	0.00	0.00	0.00	0.00	0.00	0.00	
37	23.70	25.20	22.69	0.00	12.29	0.00	0.00	3.01	0.00	
38	25.70	24.70	26.78	0.00	0.00	0.00	0.00	0.00	0.00	
39	25.70	28.71	32.16	0.00	11.97	0.00	6.85	2.36	0.00	
40	29.84	23.70	29.56	0.00	0.00	0.00	0.00	2.52	0.00	
41	25.22	31.39	24.70	0.00	0.00	0.00	0.00	0.00	0.00	
42	24.30	21.20	30.90	10.89	0.00	0.00	0.00	0.00	0.00	
43	31.36	25.20	25.70	0.00	0.00	0.00	0.00	2.69	0.00	
44	25.20	21.20	24.80	11.07	0.00	0.00	0.00	0.00	0.00	
45	24.70	25.66	31.38	0.00	0.00	0.00	0.00	0.00	2.31	
46	30.96	25.70	30.90	0.00	0.00	0.00	6.85	0.00	0.00	
47	25.20	21.20	23.70	0.00	0.00	11.65	0.00	0.00	0.00	
48	24.70	24.70	32.18	0.00	0.00	0.00	0.00	0.00	0.00	
49	20.31	26.36	30.90	0.00	0.00	0.00	7.61	2.47	0.00	
50	24.74	21.20	25.70	0.00	0.00	0.00	0.00	0.00	0.00	
51	28.46	21.90	25.70	0.00	11.67	0.00	0.00	0.00	0.00	
52	21.24	31.62	21.63	0.00	0.00	0.00	6.34	0.00	0.00	
53	25.66	25.20	19.40	0.00	0.00	0.00	0.00	2.67	0.00	
54	24.58	33.68	26.26	0.00	0.00	0.00	0.00	0.00	0.00	
55	21.50	22.69	28.69	0.00	0.00	0.00	0.00	0.00	0.00	
56	30.55	26.78	23.36	0.00	11.48	0.00	6.89	0.00	0.00	
57	23.20	32.16	30.74	12.58	0.00	0.00	0.00	2.54	2.16	
58	25.74	29.56	23.34	0.00	0.00	0.00	0.00	0.00	0.00	
59	24.58	30.55	28.74	13.68	12.47	0.00	0.00	0.00	0.00	
60	32.30	33.18	23.34	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1562	1635	1536.6	179.7	100.3	46.4	60.9	33.9	9.0	2233.0
AVG	24.65	26.87	24.87	13.98	13.87	9.64	6.54	2.43	2.22	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 09-02-22 WEDNESDAY TIME : 8 TO 9 AM			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	30.58	32.41	24.10	12.49	0.00	0.00	0.00	0.00	0.00	
2	24.60	29.80	23.60	0.00	11.05	9.68	0.00	2.94	0.00	
3	22.56	24.60	29.86	0.00	0.00	0.00	7.54	0.00	0.00	
4	20.40	23.70	24.10	0.00	0.00	0.00	0.00	0.00	0.00	
5	29.47	30.28	23.60	11.24	0.00	0.00	0.00	0.00	0.00	
6	20.60	29.80	19.21	0.00	0.00	0.00	0.00	0.00	2.41	
7	21.10	24.60	23.64	0.00	12.48	0.00	0.00	0.00	0.00	
8	20.90	32.59	25.65	0.00	0.00	0.00	0.00	2.84	0.00	
9	28.40	31.05	24.10	14.56	0.00	0.00	0.00	0.00	0.00	
10	30.29	29.80	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
11	22.60	24.60	24.10	0.00	0.00	0.00	0.00	2.71	0.00	
12	31.08	24.60	20.10	0.00	0.00	0.00	0.00	0.00	0.00	
13	29.80	32.59	24.60	0.00	0.00	0.00	7.18	0.00	0.00	
14	24.60	28.64	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
15	24.60	24.10	22.05	0.00	0.00	0.00	0.00	0.00	0.00	
16	20.53	20.10	23.64	0.00	0.00	11.47	5.39	2.86	0.00	
17	18.30	24.60	27.36	15.94	12.69	0.00	0.00	0.00	0.00	
18	21.10	23.60	20.80	0.00	0.00	0.00	0.00	0.00	0.00	
19	30.05	32.04	24.60	14.26	11.84	0.00	0.00	0.00	0.00	
20	21.45	23.64	21.14	13.27	0.00	0.00	0.00	0.00	0.00	
21	27.60	27.36	26.28	0.00	0.00	0.00	0.00	2.84	0.00	
22	26.40	20.14	24.10	14.87	0.00	0.00	0.00	0.00	0.00	
23	28.10	24.10	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
24	20.50	20.10	27.61	0.00	0.00	0.00	0.00	0.00	0.00	
25	24.30	31.81	27.60	0.00	0.00	0.00	0.00	2.74	2.41	
26	23.64	24.60	26.40	13.25	0.00	0.00	6.83	0.00	0.00	
27	28.36	31.08	21.60	0.00	0.00	0.00	0.00	0.00	0.00	
28	21.10	24.60	20.40	0.00	0.00	0.00	0.00	0.00	0.00	
29	20.90	30.05	21.60	0.00	0.00	0.00	0.00	0.00	0.00	
30	28.40	24.10	22.10	0.00	0.00	12.87	0.00	0.00	0.00	
31	24.60	21.65	24.04	0.00	0.00	0.00	0.00	0.00	0.00	
32	26.10	29.80	20.60	0.00	0.00	0.00	0.00	0.00	0.00	
33	26.75	24.60	21.10	0.00	0.00	0.00	6.94	2.34	0.00	
34	32.04	24.60	24.60	14.92	0.00	0.00	0.00	0.00	0.00	
35	24.56	30.29	24.10	0.00	0.00	0.00	0.00	2.14	0.00	
36	27.10	26.28	24.60	0.00	13.47	0.00	0.00	0.00	0.00	
37	22.60	24.10	21.59	0.00	0.00	0.00	0.00	0.00	0.00	
38	24.60	23.60	25.68	0.00	0.00	0.00	0.00	0.00	0.00	
39	24.60	27.61	31.06	0.00	13.28	0.00	7.14	0.00	0.00	
40	28.74	22.60	28.46	0.00	0.00	0.00	0.00	2.64	0.00	
41	24.12	30.29	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
42	23.20	20.10	29.80	13.54	0.00	0.00	0.00	0.00	0.00	
43	30.26	24.10	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
44	24.10	20.10	23.70	0.00	0.00	0.00	0.00	0.00	0.00	
45	23.60	24.56	30.28	0.00	0.00	0.00	0.00	0.00	0.00	
46	29.86	24.60	29.80	0.00	0.00	0.00	0.00	0.00	0.00	
47	24.10	20.10	22.60	0.00	0.00	10.24	7.12	0.00	0.00	
48	23.60	23.60	31.08	0.00	0.00	0.00	0.00	2.14	0.00	
49	19.21	25.26	29.80	0.00	0.00	0.00	0.00	0.00	0.00	
50	23.64	20.10	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
51	27.36	20.80	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
52	20.14	30.52	20.53	0.00	0.00	0.00	6.18	0.00	2.24	
53	24.56	24.10	18.30	0.00	0.00	12.36	0.00	2.61	0.00	
54	23.48	32.58	25.16	0.00	0.00	0.00	0.00	0.00	0.00	
55	20.40	21.59	27.59	0.00	0.00	0.00	0.00	0.00	0.00	
56	29.45	25.68	22.26	0.00	0.00	0.00	7.69	0.00	0.00	
57	22.10	31.06	29.64	0.00	0.00	0.00	0.00	0.00	0.00	
58	24.04	28.46	22.24	0.00	0.00	0.00	0.00	2.68	0.00	
59	23.48	29.45	27.64	16.24	12.47	0.00	0.00	0.00	0.00	
60	31.20	32.08	22.24	0.00	0.00	0.00	6.34	0.00	0.00	
TOTAL	1495.9	1569	1470.63	154.58	87.28	56.62	68.35	31.48	7.06	2339.0
AVG	24.93	26.15	24.51	2.58	1.45	0.94	1.14	0.52	0.12	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 09-02-22 WEDNESDAY TIME : 9 TO 10 AM				SPOT SPEED SURVEY						
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	24.74	28.46	27.38	0.00	0.00	0.00	0.00	0.00	0.00	
2	29.46	21.24	25.20	14.25	12.95	9.77	0.00	2.71	0.00	
3	22.20	25.20	24.70	0.00	0.00	0.00	6.74	0.00	0.00	
4	22.00	21.20	28.71	0.00	0.00	0.00	0.00	0.00	0.00	
5	29.50	32.91	28.70	0.00	0.00	0.00	0.00	0.00	0.00	
6	25.70	25.70	27.50	0.00	0.00	0.00	0.00	0.00	2.31	
7	27.20	32.18	22.70	0.00	0.00	0.00	0.00	0.00	0.00	
8	27.85	25.70	21.50	12.36	0.00	0.00	0.00	0.00	0.00	
9	33.14	31.15	22.70	0.00	0.00	0.00	0.00	0.00	0.00	
10	25.66	25.20	23.20	13.48	0.00	0.00	0.00	2.61	0.00	
11	28.20	22.75	25.14	0.00	0.00	0.00	0.00	2.63	0.00	
12	23.70	30.90	21.70	0.00	0.00	0.00	0.00	0.00	0.00	
13	25.70	25.70	22.20	0.00	0.00	0.00	6.84	0.00	0.00	
14	25.70	25.70	25.70	0.00	0.00	0.00	0.00	0.00	0.00	
15	29.84	31.39	25.20	0.00	0.00	0.00	0.00	0.00	0.00	
16	25.22	27.38	25.70	0.00	0.00	8.49	0.00	0.00	0.00	
17	24.30	25.20	22.69	0.00	0.00	0.00	0.00	0.00	0.00	
18	31.36	24.70	26.78	10.89	0.00	0.00	0.00	0.00	0.00	
19	25.20	28.71	32.16	0.00	11.24	0.00	0.00	0.00	0.00	
20	24.70	23.70	29.56	11.07	0.00	0.00	0.00	2.84	0.00	
21	30.96	31.39	24.70	0.00	0.00	0.00	0.00	0.00	0.00	
22	25.20	21.20	30.90	0.00	0.00	0.00	0.00	0.00	0.00	
23	24.70	25.20	25.70	0.00	0.00	0.00	0.00	0.00	0.00	
24	20.31	21.20	24.80	0.00	0.00	0.00	0.00	0.00	0.00	
25	24.74	25.66	31.38	0.00	0.00	0.00	0.00	2.64	2.11	
26	28.46	25.70	30.90	0.00	0.00	0.00	0.00	0.00	0.00	
27	21.24	21.20	23.70	0.00	0.00	0.00	0.00	0.00	0.00	
28	25.66	24.70	32.18	0.00	0.00	0.00	0.00	0.00	0.00	
29	24.58	26.36	30.90	0.00	0.00	0.00	0.00	0.00	0.00	
30	21.50	21.20	25.70	0.00	0.00	10.87	0.00	0.00	0.00	
31	30.55	21.90	25.70	0.00	0.00	0.00	0.00	0.00	0.00	
32	23.20	31.62	21.63	0.00	0.00	0.00	0.00	0.00	0.00	
33	25.14	25.20	19.40	12.58	0.00	0.00	6.98	2.74	0.00	
34	24.58	33.68	26.26	0.00	0.00	0.00	0.00	0.00	0.00	
35	32.30	22.69	28.69	13.68	0.00	0.00	0.00	0.00	0.00	
36	31.68	26.78	23.36	0.00	0.00	0.00	0.00	0.00	0.00	
37	25.70	32.16	30.74	0.00	0.00	0.00	0.00	0.00	0.00	
38	23.66	29.56	23.34	0.00	0.00	0.00	0.00	0.00	0.00	
39	21.50	30.55	28.74	0.00	13.54	0.00	5.28	0.00	0.00	
40	30.57	33.18	23.34	13.47	0.00	0.00	0.00	2.64	0.00	
41	21.70	33.51	25.20	0.00	0.00	0.00	0.00	0.00	0.00	
42	22.20	30.90	24.70	0.00	0.00	0.00	0.00	0.00	0.00	
43	22.00	25.70	30.96	0.00	0.00	0.00	7.16	0.00	0.00	
44	29.50	24.80	25.20	14.25	0.00	0.00	0.00	0.00	0.00	
45	31.39	31.38	24.70	0.00	0.00	0.00	7.18	0.00	0.00	
46	23.70	30.90	20.31	0.00	13.59	0.00	0.00	0.00	0.00	
47	32.18	25.70	24.74	12.36	0.00	12.48	0.00	0.00	0.00	
48	30.90	33.69	26.75	0.00	0.00	0.00	0.00	0.00	0.00	
49	25.70	32.15	25.20	0.00	0.00	0.00	0.00	2.42	0.00	
50	25.70	30.90	24.70	0.00	0.00	0.00	0.00	0.00	0.00	
51	21.63	25.70	25.20	0.00	0.00	0.00	0.00	0.00	0.00	
52	19.40	25.70	21.20	12.84	0.00	0.00	0.00	0.00	0.00	
53	22.20	33.69	25.70	0.00	11.74	0.00	0.00	2.41	0.00	
54	31.15	29.74	24.70	12.87	0.00	0.00	0.00	0.00	0.00	
55	22.55	25.20	23.15	0.00	0.00	0.00	0.00	0.00	0.00	
56	28.70	21.20	24.74	0.00	0.00	0.00	6.27	0.00	0.00	
57	27.50	25.70	28.46	13.04	0.00	0.00	0.00	2.51	0.00	
58	29.20	24.70	21.90	0.00	0.00	0.00	0.00	0.00	0.00	
59	21.60	33.14	25.70	0.00	12.54	0.00	0.00	0.00	0.00	
60	25.40	24.74	22.24	0.00	0.00	0.00	0.00	0.00	0.00	
[illegible]	1561.9	1635.3	373.00	167.14	75.60	41.61	46.45	26.15	4.42	1323.0
[illegible]	25.78	27.64	25.65	12.24	12.58	11.28	6.57	2.52	2.23	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 09-02-22 WEDNESDAY TIME : 7 TO 8 AM			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	22.70	24.60	24.10	0.00	0.00	0.00	0.00	0.00	0.00	
2	21.50	23.60	23.60	0.00	0.00	0.00	6.34	0.00	0.00	
3	22.70	30.24	27.61	12.64	0.00	0.00	0.00	0.00	0.00	
4	23.20	23.64	27.60	0.00	0.00	0.00	0.00	0.00	0.00	
5	25.14	27.36	26.40	0.00	0.00	12.42	0.00	0.00	0.00	
6	21.70	29.45	21.60	0.00	13.26	0.00	0.00	0.00	0.00	
7	22.20	32.08	20.40	0.00	0.00	0.00	0.00	0.00	0.00	
8	22.00	24.04	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
9	29.50	23.48	23.70	0.00	0.00	0.00	0.00	0.00	0.00	
10	29.36	22.21	29.86	11.09	0.00	0.00	0.00	0.00	0.00	
11	23.70	24.60	24.10	0.00	0.00	0.00	0.00	0.00	0.00	
12	24.78	20.10	23.60	0.00	12.87	0.00	0.00	0.00	0.00	
13	25.20	23.60	24.10	0.00	0.00	0.00	0.00	0.00	0.00	
14	25.20	25.26	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
15	25.70	20.10	19.21	0.00	0.00	0.00	0.00	0.00	0.00	
16	24.51	20.80	20.60	0.00	0.00	0.00	0.00	0.00	0.00	
17	21.64	24.60	21.10	0.00	0.00	12.47	0.00	0.00	0.00	
18	20.55	21.14	24.60	12.45	0.00	0.00	0.00	0.00	0.00	
19	25.20	26.28	20.60	0.00	0.00	0.00	0.00	0.00	0.00	
20	24.70	24.10	31.05	0.00	0.00	0.00	6.78	2.42	0.00	
21	20.31	23.60	29.80	0.00	0.00	0.00	0.00	0.00	0.00	
22	28.20	27.61	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
23	23.70	22.60	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
24	20.50	24.26	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
25	30.90	25.20	29.80	0.00	0.00	0.00	0.00	0.00	0.00	
26	25.70	21.20	24.60	0.00	0.00	10.28	0.00	0.00	0.00	
27	25.70	25.66	23.70	13.08	0.00	0.00	0.00	0.00	0.00	
28	19.30	25.70	30.28	0.00	0.00	0.00	0.00	2.52	0.00	
29	20.40	21.20	29.80	0.00	0.00	0.00	0.00	0.00	0.00	
30	21.60	24.70	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
31	22.10	26.36	20.60	0.00	0.00	0.00	7.41	0.00	0.00	
32	24.04	33.83	31.05	0.00	0.00	0.00	0.00	2.62	0.00	
33	20.60	21.90	29.80	10.53	0.00	0.00	0.00	0.00	0.00	
34	21.10	25.70	18.30	0.00	0.00	0.00	7.14	0.00	2.42	
35	20.90	29.84	25.16	0.00	11.08	0.00	0.00	2.31	0.00	
36	28.40	25.22	27.59	13.67	0.00	0.00	0.00	0.00	0.00	
37	28.26	24.30	22.26	0.00	12.58	0.00	6.85	0.00	0.00	
38	22.60	31.36	29.64	0.00	0.00	0.00	0.00	0.00	0.00	
39	23.68	25.20	22.24	0.00	0.00	0.00	0.00	0.00	0.00	
40	24.10	24.70	20.31	0.00	0.00	0.00	6.15	0.00	0.00	
41	24.10	25.20	21.70	0.00	0.00	0.00	0.00	2.71	0.00	
42	24.60	21.20	22.20	0.00	0.00	9.17	0.00	0.00	0.00	
43	23.41	25.70	25.70	0.00	0.00	0.00	6.91	0.00	0.00	
44	20.54	24.70	21.70	0.00	13.39	0.00	0.00	0.00	0.00	
45	19.45	31.34	32.15	0.00	0.00	0.00	0.00	0.00	0.00	
46	24.10	24.74	30.90	0.00	0.00	0.00	0.00	0.00	0.00	
47	23.60	28.46	25.70	0.00	0.00	0.00	0.00	3.05	0.00	
48	18.20	30.55	25.70	0.00	0.00	0.00	0.00	0.00	0.00	
49	19.99	33.18	24.70	0.00	0.00	0.00	0.00	0.00	0.00	
50	24.10	25.14	30.90	0.00	12.58	0.00	5.46	2.17	0.00	
51	20.10	24.58	32.15	0.00	0.00	0.00	0.00	0.00	0.00	
52	24.60	23.31	30.90	0.00	0.00	0.00	0.00	0.00	0.00	
53	26.10	20.60	19.40	0.00	0.00	0.00	0.00	0.00	2.01	
54	26.75	31.05	26.26	13.29	0.00	0.00	0.00	2.34	0.00	
55	28.18	29.80	28.69	0.00	0.00	0.00	0.00	0.00	0.00	
56	24.56	24.60	23.36	0.00	0.00	0.00	0.00	0.00	0.00	
57	27.10	24.60	30.74	12.64	11.42	0.00	0.00	0.00	0.00	
58	29.40	28.94	23.34	0.00	0.00	0.00	0.00	2.74	0.00	
59	24.10	29.54	28.74	0.00	0.00	0.00	0.00	0.00	0.00	
60	22.36	32.09	28.70	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1429	1541	1527.99	99.39	87.18	44.34	53.04	22.88	4.43	2116.0
AVG	24.36	26.75	25.35	12.87	12.86	9.67	6.75	2.61	2.14	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 09-02-22 WEDNESDAY TIME : 8 TO 9 AM			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	24.10	22.60	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
2	23.60	30.29	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
3	24.65	20.10	20.53	13.24	0.00	0.00	5.18	0.00	0.00	
4	24.10	24.10	18.30	0.00	0.00	0.00	0.00	0.00	0.00	
5	23.60	20.10	25.16	0.00	0.00	10.26	0.00	2.42	0.00	
6	19.21	24.56	27.59	0.00	13.81	0.00	0.00	0.00	0.00	
7	20.60	24.60	22.26	12.63	0.00	0.00	0.00	0.00	0.00	
8	21.10	20.10	19.67	0.00	0.00	0.00	0.00	0.00	0.00	
9	20.90	23.60	21.14	11.02	0.00	0.00	0.00	0.00	0.00	
10	20.14	25.26	26.28	0.00	0.00	0.00	5.26	0.00	0.00	
11	27.60	32.73	24.10	0.00	0.00	0.00	0.00	0.00	0.00	
12	26.40	20.80	23.60	0.00	12.68	0.00	0.00	0.00	0.00	
13	21.60	24.60	27.61	10.26	0.00	0.00	6.84	0.00	0.00	
14	20.40	28.74	27.60	0.00	0.00	0.00	0.00	0.00	0.00	
15	21.60	24.12	26.40	0.00	0.00	0.00	0.00	2.98	0.00	
16	22.10	23.20	21.60	0.00	0.00	0.00	0.00	0.00	0.00	
17	24.04	30.26	20.40	0.00	12.48	0.00	0.00	0.00	0.00	
18	20.60	24.10	24.60	12.68	0.00	11.65	0.00	2.86	0.00	
19	21.10	23.60	23.70	0.00	0.00	0.00	0.00	0.00	2.31	
20	20.90	24.10	29.86	0.00	0.00	0.00	6.82	2.46	0.00	
21	28.40	20.10	24.10	0.00	0.00	0.00	0.00	0.00	0.00	
22	28.26	24.60	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
23	22.60	23.60	24.10	0.00	0.00	0.00	0.00	0.00	0.00	
24	23.68	30.24	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
25	24.10	23.64	19.21	0.00	0.00	0.00	0.00	0.00	0.00	
26	24.10	27.36	20.60	0.00	0.00	12.65	0.00	0.00	0.00	
27	24.60	29.45	21.10	0.00	0.00	0.00	0.00	0.00	0.00	
28	23.41	32.08	24.60	13.24	0.00	0.00	6.18	2.63	0.00	
29	20.54	24.04	20.60	0.00	0.00	0.00	0.00	0.00	0.00	
30	19.45	23.48	31.05	0.00	0.00	0.00	0.00	0.00	0.00	
31	24.10	22.21	29.80	0.00	0.00	0.00	6.38	2.74	0.00	
32	23.60	24.60	24.60	0.00	0.00	0.00	0.00	2.36	0.00	
33	19.21	20.10	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
34	27.10	23.60	23.60	0.00	0.00	0.00	0.00	0.00	2.11	
35	22.60	25.26	29.80	0.00	12.65	0.00	0.00	0.00	0.00	
36	19.40	20.10	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
37	29.80	20.80	23.70	12.58	0.00	0.00	0.00	3.01	0.00	
38	24.60	24.60	30.28	0.00	0.00	0.00	0.00	0.00	0.00	
39	24.60	21.14	29.80	0.00	0.00	0.00	0.00	0.00	0.00	
40	18.20	26.28	24.60	0.00	0.00	0.00	7.61	0.00	0.00	
41	19.99	24.10	20.60	0.00	0.00	0.00	0.00	0.00	0.00	
42	24.10	23.60	31.05	11.87	0.00	0.00	0.00	0.00	0.00	
43	20.10	27.61	29.80	0.00	0.00	0.00	7.14	0.00	0.00	
44	24.60	22.60	18.30	0.00	0.00	0.00	0.00	3.26	0.00	
45	26.10	24.26	25.16	0.00	0.00	0.00	0.00	0.00	0.00	
46	26.75	24.60	27.59	12.64	0.00	0.00	0.00	0.00	0.00	
47	28.18	20.60	22.26	0.00	0.00	0.00	0.00	2.87	0.00	
48	24.56	31.05	29.64	0.00	13.25	0.00	0.00	0.00	0.00	
49	27.10	29.80	22.24	11.25	0.00	0.00	0.00	0.00	0.00	
50	29.40	24.60	27.64	0.00	0.00	0.00	0.00	0.00	0.00	
51	24.10	24.60	27.60	0.00	0.00	0.00	0.00	0.00	0.00	
52	24.60	28.94	26.40	0.00	0.00	0.00	0.00	0.00	0.00	
53	24.10	29.54	21.60	0.00	0.00	0.00	6.24	0.00	0.00	
54	24.60	32.09	20.40	0.00	0.00	0.00	0.00	0.00	0.00	
55	16.40	24.56	21.60	0.00	0.00	0.00	0.00	2.54	0.00	
56	24.10	26.25	22.10	0.00	0.00	0.00	0.00	0.00	0.00	
57	28.46	26.21	24.68	10.74	11.06	0.00	0.00	0.00	0.00	
58	21.16	27.29	23.51	0.00	0.00	0.00	0.00	2.31	0.00	
59	19.56	29.61	20.32	0.00	0.00	0.00	0.00	0.00	0.00	
60	20.22	24.28	27.59	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1398.9	1505	1467.62	132.15	75.93	34.56	57.65	32.44	4.42	2159.0
AVG	23.57	25.48	24.68	12.75	12.48	11.25	6.34	2.34	2.11	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 09-02-22 WEDNESDAY TIME : 9 TO 10 AM				SPOT SPEED SURVEY						
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	25.20	23.70	25.70	0.00	12.48	0.00	0.00	0.00	0.00	
2	24.70	31.39	25.70	0.00	0.00	0.00	6.74	0.00	0.00	
3	25.75	21.20	21.63	0.00	0.00	0.00	0.00	0.00	0.00	
4	25.20	25.20	19.40	0.00	0.00	0.00	0.00	0.00	0.00	
5	24.70	21.20	26.26	12.68	0.00	0.00	0.00	0.00	0.00	
6	20.31	25.66	28.69	0.00	0.00	0.00	0.00	0.00	0.00	
7	21.70	25.70	23.36	0.00	0.00	0.00	0.00	0.00	0.00	
8	22.20	21.20	20.77	0.00	0.00	0.00	7.64	0.00	0.00	
9	22.00	24.70	22.24	0.00	0.00	0.00	0.00	0.00	0.00	
10	21.24	26.36	27.38	0.00	0.00	0.00	0.00	0.00	0.00	
11	28.70	33.83	25.20	0.00	0.00	0.00	0.00	0.00	0.00	
12	27.50	21.90	24.70	0.00	0.00	0.00	0.00	0.00	0.00	
13	22.70	25.70	28.71	0.00	0.00	0.00	0.00	0.00	0.00	
14	21.50	29.84	28.70	0.00	0.00	0.00	0.00	0.00	0.00	
15	22.70	25.22	27.50	13.24	0.00	0.00	0.00	0.00	0.00	
16	23.20	24.30	22.70	0.00	0.00	0.00	0.00	0.00	0.00	
17	25.14	31.36	21.50	0.00	0.00	0.00	0.00	0.00	0.00	
18	21.70	25.20	25.70	0.00	0.00	0.00	0.00	0.00	0.00	
19	22.20	24.70	24.80	0.00	12.65	0.00	0.00	0.00	0.00	
20	22.00	25.20	30.96	0.00	0.00	0.00	6.84	2.47	0.00	
21	29.50	21.20	25.20	0.00	0.00	0.00	0.00	0.00	0.00	
22	29.36	25.70	24.70	0.00	0.00	0.00	0.00	0.00	0.00	
23	23.70	24.70	25.20	0.00	0.00	0.00	0.00	0.00	0.00	
24	24.78	31.34	24.70	12.58	0.00	0.00	0.00	0.00	0.00	
25	25.20	24.74	20.31	0.00	0.00	0.00	0.00	0.00	0.00	
26	25.20	28.46	21.70	0.00	0.00	11.84	0.00	0.00	0.00	
27	25.70	30.55	22.20	0.00	0.00	0.00	0.00	0.00	0.00	
28	24.51	33.18	25.70	0.00	0.00	0.00	0.00	2.84	0.00	
29	21.64	25.14	21.70	11.87	0.00	0.00	0.00	0.00	0.00	
30	20.55	24.58	32.15	0.00	0.00	0.00	0.00	0.00	0.00	
31	25.20	23.31	30.90	0.00	0.00	0.00	6.72	0.00	0.00	
32	24.70	25.70	25.70	0.00	13.57	0.00	0.00	2.61	0.00	
33	20.31	21.20	25.70	12.64	0.00	0.00	0.00	0.00	0.00	
34	28.20	24.70	24.70	0.00	0.00	0.00	0.00	0.00	2.14	
35	23.70	26.36	30.90	0.00	0.00	0.00	0.00	0.00	0.00	
36	20.50	21.20	25.70	11.25	0.00	0.00	0.00	0.00	0.00	
37	30.90	21.90	24.80	0.00	0.00	0.00	0.00	2.57	0.00	
38	25.70	25.70	31.38	0.00	13.25	0.00	0.00	0.00	0.00	
39	25.70	22.24	30.90	0.00	0.00	0.00	0.00	0.00	0.00	
40	19.30	27.38	25.70	0.00	0.00	0.00	6.31	0.00	0.00	
41	21.09	25.20	21.70	10.55	0.00	0.00	0.00	0.00	0.00	
42	25.20	24.70	32.15	0.00	0.00	12.58	0.00	0.00	0.00	
43	21.20	28.71	30.90	0.00	0.00	0.00	0.00	0.00	0.00	
44	25.70	23.70	19.40	0.00	0.00	0.00	6.42	0.00	0.00	
45	27.20	25.36	26.26	0.00	0.00	0.00	0.00	0.00	2.44	
46	27.85	25.70	28.69	0.00	0.00	0.00	0.00	0.00	0.00	
47	29.28	21.70	23.36	13.24	13.81	0.00	0.00	3.04	0.00	
48	25.66	32.15	30.74	0.00	0.00	0.00	7.42	0.00	0.00	
49	28.20	30.90	23.34	0.00	0.00	0.00	0.00	0.00	0.00	
50	30.50	25.70	28.74	0.00	0.00	0.00	0.00	0.00	0.00	
51	25.20	25.70	28.70	0.00	0.00	0.00	0.00	0.00	0.00	
52	25.70	30.04	27.50	0.00	0.00	0.00	0.00	0.00	0.00	
53	25.20	30.64	22.70	11.02	12.68	0.00	6.53	0.00	0.00	
54	25.70	33.19	21.50	0.00	0.00	0.00	0.00	0.00	0.00	
55	17.50	25.66	22.70	0.00	0.00	0.00	0.00	0.00	0.00	
56	25.20	27.35	23.20	0.00	0.00	9.47	0.00	2.48	0.00	
57	29.56	27.31	25.78	10.26	13.24	0.00	0.00	0.00	0.00	
58	22.26	28.39	24.61	0.00	0.00	0.00	0.00	2.61	0.00	
59	20.66	30.71	21.42	0.00	0.00	0.00	6.86	0.00	0.00	
60	21.32	25.38	28.69	0.00	0.00	0.00	0.00	0.00	0.00	
[illegible]	1464.9	436.0	1533.6	119.33	91.68	33.89	61.48	18.62	4.58	1228.0
[illegible]	25.47	27.86	25.68	12.68	13.74	11.68	6.27	2.81	2.31	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 09-02-22 WEDNESDAY TIME : 5 TO 6 PM				SPOT SPEED SURVEY						
MIN	4W	2W	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	19.30	24.04	19.21	0.00	0.00	0.00	0.00	0.00	0.00	
2	20.40	23.48	20.60	10.95	10.27	0.00	0.00	0.00	2.14	
3	21.60	22.21	21.10	0.00	0.00	0.00	0.00	2.41	0.00	
4	22.10	24.60	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
5	24.04	20.10	20.60	0.00	0.00	0.00	0.00	0.00	0.00	
6	20.60	23.60	31.05	0.00	0.00	0.00	5.48	0.00	0.00	
7	21.10	25.26	29.80	0.00	0.00	0.00	0.00	0.00	0.00	
8	20.90	20.10	24.60	11.08	0.00	0.00	0.00	2.37	0.00	
9	28.40	20.80	24.60	0.00	0.00	0.00	0.00	0.00	2.13	
10	28.26	24.60	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
11	22.60	21.14	29.80	0.00	0.00	0.00	0.00	0.00	0.00	
12	23.68	26.28	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
13	24.10	24.10	23.70	0.00	0.00	8.67	0.00	0.00	0.00	
14	24.10	23.60	30.28	0.00	0.00	0.00	0.00	0.00	0.00	
15	24.60	27.61	29.80	0.00	0.00	0.00	0.00	2.51	0.00	
16	23.41	22.60	24.60	0.00	11.08	0.00	0.00	0.00	0.00	
17	20.54	24.26	20.60	12.05	0.00	0.00	0.00	0.00	0.00	
18	19.45	25.20	31.05	0.00	0.00	0.00	0.00	0.00	0.00	
19	24.10	21.20	29.80	0.00	12.69	0.00	5.67	0.00	0.00	
20	23.60	25.66	18.30	10.69	0.00	0.00	0.00	0.00	0.00	
21	18.20	25.70	25.16	0.00	0.00	0.00	0.00	0.00	0.00	
22	19.99	21.20	27.59	0.00	0.00	12.39	0.00	0.00	2.11	
23	24.10	24.70	22.26	0.00	0.00	0.00	0.00	0.00	0.00	
24	20.10	26.36	29.64	0.00	0.00	0.00	0.00	0.00	0.00	
25	24.60	33.83	22.24	11.90	12.37	0.00	0.00	0.00	0.00	
26	26.10	21.90	20.31	0.00	0.00	0.00	0.00	0.00	0.00	
27	26.75	25.70	21.70	0.00	0.00	0.00	0.00	2.34	0.00	
28	28.18	29.84	22.20	0.00	0.00	0.00	0.00	0.00	0.00	
29	21.63	25.22	25.70	0.00	0.00	0.00	0.00	0.00	0.00	
30	19.40	24.30	21.70	0.00	0.00	0.00	0.00	0.00	0.00	
31	22.20	31.36	28.46	0.00	0.00	0.00	0.00	0.00	0.00	
32	31.15	25.20	21.90	0.00	0.00	0.00	0.00	0.00	0.00	
33	22.55	24.70	25.70	0.00	0.00	0.00	0.00	0.00	0.00	
34	28.70	32.15	22.24	0.00	0.00	0.00	0.00	0.00	0.00	
35	27.50	30.90	27.38	0.00	13.47	0.00	0.00	0.00	0.00	
36	29.20	25.70	25.20	0.00	0.00	10.29	0.00	0.00	0.00	
37	21.60	25.70	24.70	0.00	0.00	0.00	5.47	0.00	0.00	
38	25.40	33.69	28.71	0.00	0.00	0.00	0.00	0.00	0.00	
39	24.74	29.74	28.70	0.00	13.67	0.00	0.00	0.00	0.00	
40	29.46	25.20	27.50	0.00	0.00	0.00	6.58	0.00	0.00	
41	22.20	21.20	22.70	0.00	0.00	0.00	0.00	0.00	0.00	
42	22.00	25.70	21.50	0.00	0.00	0.00	0.00	0.00	0.00	
43	29.50	24.70	22.70	0.00	0.00	0.00	0.00	0.00	0.00	
44	25.70	33.14	23.20	0.00	0.00	0.00	0.00	2.74	0.00	
45	27.20	24.74	25.14	0.00	0.00	0.00	7.64	0.00	0.00	
46	27.85	28.46	21.70	13.08	0.00	0.00	0.00	0.00	0.00	
47	33.14	21.24	22.20	0.00	12.35	0.00	0.00	2.61	0.00	
48	25.66	25.20	25.70	0.00	0.00	0.00	7.68	0.00	0.00	
49	28.20	21.20	25.20	0.00	0.00	0.00	0.00	0.00	0.00	
50	23.70	32.91	25.70	0.00	0.00	0.00	0.00	0.00	0.00	
51	25.70	25.70	22.69	0.00	0.00	0.00	0.00	0.00	0.00	
52	25.70	32.18	26.78	0.00	0.00	0.00	0.00	0.00	0.00	
53	29.84	25.70	32.16	0.00	0.00	0.00	0.00	0.00	0.00	
54	25.22	31.15	29.56	0.00	11.25	0.00	0.00	0.00	0.00	
55	24.30	25.20	24.70	0.00	0.00	0.00	0.00	0.00	0.00	
56	31.36	22.75	30.90	0.00	0.00	0.00	5.78	0.00	0.00	
57	25.20	30.90	25.70	0.00	12.36	0.00	0.00	2.34	0.00	
58	24.70	25.70	24.80	0.00	0.00	0.00	6.34	0.00	0.00	
59	30.96	25.70	31.38	13.68	0.00	10.69	0.00	0.00	0.00	
60	25.20	26.37	30.90	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1481.8	1543	1516.59	83.43	109.5	42.04	50.64	17.32	6.38	1319.0
AVG	25.37	25.98	21.48	12.58	12.37	11.69	6.48	2.41	2.11	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 09-02-22 WEDNESDAY TIME : 6 TO 7 PM			SPOT SPEED SURVEY							
MIN	4W	2W	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	20.40	25.26	19.67	0.00	0.00	0.00	0.00	0.00	0.00	
2	21.60	32.73	21.14	0.00	0.00	0.00	0.00	0.00	2.12	
3	22.10	20.80	26.28	10.26	11.27	0.00	0.00	2.19	0.00	
4	24.04	24.60	24.10	0.00	12.63	0.00	0.00	0.00	0.00	
5	20.60	28.74	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
6	21.10	24.12	27.61	0.00	0.00	0.00	6.38	0.00	0.00	
7	20.90	23.20	27.60	0.00	0.00	0.00	0.00	0.00	0.00	
8	28.40	30.26	26.40	0.00	10.59	0.00	0.00	2.68	0.00	
9	28.26	24.10	21.60	0.00	0.00	0.00	0.00	0.00	2.31	
10	22.60	23.60	20.40	13.58	0.00	0.00	0.00	0.00	0.00	
11	23.68	24.10	24.60	0.00	13.06	0.00	0.00	0.00	0.00	
12	24.10	20.10	23.70	0.00	0.00	0.00	7.58	0.00	0.00	
13	24.10	24.60	29.86	0.00	0.00	10.58	0.00	0.00	0.00	
14	24.60	23.60	24.10	0.00	0.00	0.00	5.27	0.00	0.00	
15	23.41	30.24	23.60	0.00	0.00	0.00	0.00	2.67	0.00	
16	20.54	23.64	24.10	0.00	0.00	0.00	0.00	0.00	0.00	
17	19.45	27.36	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
18	24.10	29.45	19.21	11.22	0.00	0.00	5.69	0.00	0.00	
19	23.60	32.08	20.60	0.00	0.00	0.00	7.59	0.00	0.00	
20	19.21	24.04	21.10	0.00	0.00	0.00	0.00	0.00	0.00	
21	27.10	23.48	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
22	22.60	22.21	20.60	0.00	11.67	0.00	0.00	0.00	2.16	
23	19.40	24.60	31.05	0.00	0.00	0.00	6.54	0.00	0.00	
24	29.80	20.10	29.80	0.00	0.00	9.68	0.00	0.00	0.00	
25	24.60	23.60	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
26	24.60	25.26	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
27	18.20	20.10	23.60	0.00	0.00	0.00	5.48	2.48	0.00	
28	19.99	20.80	29.80	13.06	11.49	0.00	5.38	0.00	0.00	
29	24.10	24.60	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
30	20.10	21.14	23.70	0.00	0.00	0.00	0.00	0.00	0.00	
31	24.60	26.28	30.28	0.00	0.00	0.00	0.00	0.00	0.00	
32	26.10	24.10	29.80	0.00	0.00	0.00	0.00	0.00	0.00	
33	26.75	31.05	22.05	0.00	14.27	0.00	0.00	0.00	0.00	
34	28.18	29.80	23.64	0.00	0.00	0.00	0.00	0.00	0.00	
35	24.56	24.60	27.36	0.00	0.00	0.00	0.00	0.00	0.00	
36	27.10	24.60	20.80	0.00	0.00	7.98	0.00	0.00	0.00	
37	29.40	32.59	24.60	0.00	0.00	0.00	7.61	0.00	0.00	
38	24.10	28.64	21.14	0.00	0.00	0.00	0.00	0.00	0.00	
39	24.60	24.10	26.28	0.00	0.00	0.00	0.00	0.00	0.00	
40	24.10	20.10	24.10	10.26	10.98	0.00	0.00	0.00	2.31	
41	24.60	24.60	23.60	0.00	0.00	0.00	0.00	2.64	0.00	
42	16.40	23.60	27.61	0.00	0.00	0.00	0.00	0.00	0.00	
43	24.10	32.04	27.60	0.00	0.00	8.59	0.00	0.00	0.00	
44	28.46	23.64	26.40	0.00	0.00	0.00	0.00	2.58	0.00	
45	21.16	27.36	21.60	13.71	11.27	0.00	6.18	0.00	0.00	
46	19.56	20.14	20.40	0.00	0.00	0.00	0.00	0.00	0.00	
47	20.22	24.10	21.60	0.00	12.47	0.00	0.00	0.00	0.00	
48	30.58	20.10	22.10	11.09	0.00	0.00	6.93	2.64	0.00	
49	24.60	31.81	24.04	0.00	0.00	0.00	0.00	0.00	0.00	
50	22.56	24.60	20.60	0.00	0.00	0.00	0.00	0.00	0.00	
51	20.40	31.08	21.10	0.00	0.00	0.00	0.00	0.00	0.00	
52	29.47	24.60	24.60	0.00	0.00	0.00	6.82	0.00	0.00	
53	20.60	30.05	24.10	0.00	0.00	0.00	0.00	0.00	0.00	
54	21.10	24.10	24.60	0.00	10.78	0.00	0.00	2.51	0.00	
55	20.90	21.65	21.59	0.00	0.00	0.00	0.00	0.00	0.00	
56	28.40	29.80	25.68	0.00	0.00	0.00	0.00	0.00	0.00	
57	30.29	24.60	31.06	0.00	0.00	0.00	0.00	2.42	0.00	
58	22.60	24.60	28.46	0.00	12.96	0.00	0.00	0.00	0.00	
59	31.08	30.29	23.60	12.87	0.00	9.68	0.00	0.00	0.00	
60	29.80	26.28	29.80	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1433.7	1527	1470.01	96.05	143.4	46.51	77.45	22.81	8.90	2212.0
AVG	23.87	24.36	20.47	12.69	11.74	9.66	6.57	2.34	2.14	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 09-02-22 WEDNESDAY TIME : 7 TO 8 PM				SPOT SPEED SURVEY						
MIN	4W	2W	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	21.51	26.37	20.78	9.31	11.43	0.00	0.00	0.00	0.00	
2	22.71	33.84	22.25	12.86	0.00	0.00	0.00	0.00	2.14	
3	23.21	21.91	27.39	0.00	0.00	11.29	0.00	2.68	0.00	
4	25.15	25.71	25.21	11.42	0.00	0.00	0.00	0.00	0.00	
5	21.71	29.85	24.71	0.00	0.00	0.00	0.00	0.00	0.00	
6	22.21	25.23	28.72	0.00	0.00	0.00	0.00	0.00	0.00	
7	22.01	24.31	28.71	0.00	0.00	0.00	7.08	0.00	0.00	
8	29.51	31.37	27.51	14.98	0.00	0.00	0.00	2.47	0.00	
9	29.37	25.21	22.71	0.00	0.00	10.28	0.00	0.00	2.31	
10	23.71	24.71	21.51	0.00	13.24	0.00	0.00	0.00	0.00	
11	24.79	25.21	25.71	12.05	0.00	0.00	0.00	0.00	0.00	
12	25.21	21.21	24.81	10.59	0.00	0.00	0.00	0.00	0.00	
13	25.21	25.71	30.97	0.00	0.00	0.00	0.00	0.00	0.00	
14	25.71	24.71	25.21	0.00	0.00	0.00	0.00	0.00	0.00	
15	24.52	31.35	24.71	11.40	0.00	0.00	0.00	2.69	0.00	
16	21.65	24.75	25.21	0.00	0.00	0.00	0.00	0.00	0.00	
17	20.56	28.47	24.71	0.00	8.78	12.47	0.00	0.00	0.00	
18	25.21	30.56	20.32	0.00	0.00	0.00	0.00	0.00	0.00	
19	24.71	33.19	21.71	12.50	0.00	0.00	0.00	0.00	0.00	
20	20.32	25.15	22.21	10.09	0.00	0.00	0.00	0.00	0.00	
21	28.21	24.59	25.71	0.00	0.00	0.00	0.00	0.00	0.00	
22	23.71	23.32	21.71	0.00	0.00	0.00	0.00	0.00	2.11	
23	20.51	25.71	32.16	0.00	0.00	0.00	0.00	0.00	0.00	
24	30.91	21.21	30.91	0.00	0.00	0.00	0.00	0.00	0.00	
25	25.71	24.71	25.71	14.57	10.92	0.00	0.00	0.00	0.00	
26	25.71	26.37	25.71	0.00	0.00	10.28	0.00	0.00	0.00	
27	19.31	21.21	24.71	0.00	0.00	0.00	0.00	2.85	0.00	
28	21.10	21.91	30.91	0.00	0.00	0.00	0.00	0.00	0.00	
29	25.21	25.71	25.71	0.00	0.00	0.00	0.00	0.00	0.00	
30	21.21	22.25	24.81	0.00	0.00	0.00	0.00	0.00	0.00	
31	25.71	27.39	31.39	11.73	0.00	0.00	0.00	0.00	0.00	
32	27.21	25.21	30.91	12.43	0.00	0.00	0.00	0.00	0.00	
33	27.86	32.16	23.16	0.00	0.00	0.00	7.45	0.00	0.00	
34	29.29	30.91	24.75	0.00	0.00	0.00	0.00	0.00	0.00	
35	25.67	25.71	28.47	0.00	0.00	0.00	0.00	0.00	0.00	
36	28.21	25.71	21.91	12.54	0.00	0.00	0.00	0.00	0.00	
37	30.51	33.70	25.71	0.00	10.21	0.00	0.00	0.00	0.00	
38	25.21	29.75	22.25	0.00	0.00	0.00	6.38	0.00	0.00	
39	25.71	25.21	27.39	0.00	0.00	0.00	0.00	0.00	0.00	
40	25.21	21.21	25.21	0.00	0.00	0.00	0.00	0.00	0.00	
41	25.71	25.71	24.71	13.65	0.00	0.00	0.00	0.00	0.00	
42	17.51	24.71	28.72	0.00	0.00	9.17	0.00	0.00	0.00	
43	25.21	33.15	28.71	11.87	0.00	0.00	0.00	0.00	0.00	
44	29.57	24.75	27.51	0.00	0.00	0.00	5.68	3.07	0.00	
45	22.27	28.47	22.71	0.00	0.00	0.00	0.00	0.00	0.00	
46	20.67	21.25	21.51	9.47	9.47	0.00	0.00	0.00	0.00	
47	21.33	25.21	22.71	0.00	0.00	0.00	0.00	0.00	0.00	
48	31.69	21.21	23.21	0.00	0.00	0.00	0.00	2.69	0.00	
49	25.71	32.92	25.15	0.00	0.00	0.00	0.00	0.00	0.00	
50	23.67	25.71	21.71	0.00	12.36	0.00	0.00	0.00	0.00	
51	21.51	32.19	22.21	10.19	0.00	0.00	0.00	0.00	0.00	
52	30.58	25.71	25.71	0.00	0.00	0.00	0.00	0.00	0.00	
53	21.71	31.16	25.21	0.00	0.00	0.00	0.00	0.00	0.00	
54	22.21	25.21	25.71	0.00	13.68	0.00	0.00	0.00	0.00	
55	22.01	22.76	22.70	12.13	0.00	0.00	0.00	0.00	0.00	
56	29.51	30.91	26.79	0.00	0.00	0.00	7.14	0.00	0.00	
57	31.40	25.71	32.17	0.00	0.00	0.00	0.00	3.65	0.00	
58	23.71	25.71	29.57	0.00	0.00	0.00	0.00	0.00	0.00	
59	32.19	31.40	24.71	0.00	9.31	0.00	0.00	0.00	0.00	
60	30.91	27.39	30.91	10.33	0.00	0.00	0.00	0.00	0.00	
TOTAL	1500.3	1594	1536.61	224.12	99.40	53.49	33.73	20.10	6.5	1290.0
AVG	25.01	27.36	23.57	12.86	12.64	9.64	6.48	2.43	2.13	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 09-02-22 wednesday TIME : 5 TO 6 AM				SPOT SPEED SURVEY						
MIN	4W	2W	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	24.60	24.60	25.20	0.00	0.00	0.00	0.00	0.00	0.00	
2	26.10	32.59	24.70	0.00	0.00	0.00	0.00	0.00	0.00	
3	26.75	31.05	25.20	0.00	11.27	0.00	0.00	0.00	0.00	
4	32.04	29.80	21.20	0.00	0.00	0.00	0.00	0.00	0.00	
5	24.56	24.60	25.70	10.28	0.00	0.00	0.00	0.00	0.00	
6	27.10	24.60	24.70	0.00	0.00	0.00	0.00	2.31	0.00	
7	22.60	32.59	23.15	0.00	0.00	0.00	7.06	0.00	0.00	
8	24.60	28.64	24.74	0.00	10.59	0.00	0.00	0.00	0.00	
9	24.60	24.10	28.46	0.00	0.00	0.00	0.00	0.00	0.00	
10	28.74	20.10	21.90	13.58	0.00	0.00	0.00	0.00	0.00	
11	24.12	24.60	25.70	0.00	0.00	0.00	0.00	2.14	0.00	
12	23.20	23.60	22.24	0.00	0.00	0.00	0.00	0.00	0.00	
13	24.70	32.04	27.38	0.00	0.00	0.00	0.00	0.00	0.00	
14	20.31	23.64	25.20	0.00	0.00	0.00	0.00	0.00	0.00	
15	28.20	27.36	24.70	0.00	0.00	0.00	7.04	0.00	0.00	
16	23.70	20.14	28.71	0.00	0.00	0.00	0.00	0.00	0.00	
17	20.50	24.10	28.70	0.00	0.00	0.00	0.00	0.00	0.00	
18	30.90	20.10	27.50	11.22	0.00	0.00	0.00	0.00	0.00	
19	25.70	31.81	22.70	0.00	0.00	0.00	0.00	0.00	0.00	
20	25.70	24.60	21.50	0.00	10.89	0.00	0.00	0.00	0.00	
21	19.30	31.08	22.70	0.00	0.00	0.00	0.00	0.00	0.00	
22	20.40	24.60	23.20	0.00	0.00	0.00	0.00	0.00	0.00	
23	21.60	30.05	25.14	0.00	0.00	0.00	0.00	0.00	0.00	
24	22.10	24.10	21.70	10.36	0.00	0.00	0.00	0.00	0.00	
25	24.04	21.65	22.20	0.00	13.07	0.00	0.00	0.00	0.00	
26	20.60	29.80	25.70	0.00	0.00	0.00	0.00	0.00	0.00	
27	21.10	24.60	25.20	0.00	0.00	0.00	0.00	0.00	2.51	
28	20.90	24.60	25.70	13.06	11.49	0.00	6.82	2.36	0.00	
29	28.40	30.29	22.69	0.00	0.00	0.00	0.00	0.00	0.00	
30	28.26	26.28	23.70	0.00	0.00	0.00	0.00	0.00	0.00	
31	22.60	20.10	29.86	0.00	0.00	0.00	0.00	0.00	0.00	
32	23.68	23.60	24.10	0.00	0.00	0.00	0.00	0.00	0.00	
33	24.10	25.26	23.60	0.00	14.27	0.00	0.00	0.00	0.00	
34	24.10	20.10	24.10	0.00	0.00	6.87	0.00	0.00	0.00	
35	24.60	20.80	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
36	23.41	24.60	19.21	0.00	10.78	0.00	0.00	0.00	0.00	
37	20.54	21.14	20.60	11.56	0.00	0.00	6.84	0.00	0.00	
38	19.45	26.28	21.10	0.00	0.00	0.00	0.00	0.00	0.00	
39	24.10	24.10	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
40	24.10	23.60	20.60	10.26	10.98	0.00	7.08	0.00	0.00	
41	24.10	27.61	31.05	0.00	0.00	0.00	0.00	0.00	0.00	
42	24.60	22.60	29.80	0.00	0.00	0.00	0.00	0.00	0.00	
43	23.41	24.26	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
44	20.54	25.20	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
45	19.45	21.20	23.60	13.71	11.27	0.00	0.00	0.00	0.00	
46	24.10	25.66	29.80	0.00	0.00	0.00	5.85	0.00	0.00	
47	23.60	25.70	24.60	0.00	0.00	0.00	0.00	3.01	0.00	
48	19.21	21.20	23.70	11.09	0.00	0.00	0.00	0.00	0.00	
49	27.10	24.70	30.28	0.00	0.00	0.00	6.58	0.00	0.00	
50	22.60	26.36	29.80	0.00	0.00	11.28	0.00	0.00	2.14	
51	19.40	33.83	24.60	0.00	0.00	0.00	0.00	3.11	0.00	
52	29.80	21.90	20.60	0.00	0.00	0.00	0.00	0.00	0.00	
53	24.60	25.70	31.05	0.00	0.00	0.00	0.00	0.00	0.00	
54	24.60	29.84	29.80	0.00	10.78	0.00	0.00	0.00	0.00	
55	18.20	25.22	18.30	0.00	0.00	10.27	0.00	2.08	0.00	
56	19.99	24.30	25.16	0.00	0.00	0.00	5.47	0.00	0.00	
57	24.10	31.36	27.59	0.00	0.00	0.00	0.00	0.00	0.00	
58	20.10	25.20	22.26	0.00	12.96	0.00	0.00	0.00	0.00	
59	24.60	24.70	29.64	12.87	0.00	0.00	6.28	0.00	0.00	
60	26.10	25.20	22.24	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1426.30	1533	1491.65	117.99	128.4	28.42	59.02	15.01	4.65	1269.0
AVG	24.64	25.83	20.48	12.46	12.64	9.68	6.48	2.44	2.12	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 09-02-22 wednesday TIME : 6 TO 7 AM			SPOT SPEED SURVEY							
MIN	4W	2W	rikshaw	truck	bus	tractor	cycle	pedestain	other	vehicles
1	27.60	24.60	25.65	0.00	0.00	0.00	0.00	0.00	0.00	
2	20.60	24.10	15.54	0.00	0.00	0.00	6.58	2.34	0.00	
3	21.10	24.60	19.67	0.00	0.00	0.00	0.00	0.00	0.00	
4	20.90	28.60	17.09	0.00	0.00	0.00	0.00	0.00	0.00	
5	24.47	24.10	18.98	0.00	0.00	0.00	0.00	0.00	0.00	
6	27.60	23.60	11.24	0.00	0.00	8.64	0.00	2.15	0.00	
7	26.40	29.80	14.06	13.66	12.48	0.00	5.47	0.00	0.00	
8	28.10	24.60	16.88	0.00	0.00	0.00	0.00	0.00	0.00	
9	20.60	29.64	15.21	0.00	0.00	0.00	0.00	0.00	0.00	
10	21.10	30.06	13.28	0.00	0.00	0.00	0.00	2.54	0.00	
11	20.40	24.60	14.98	0.00	0.00	0.00	0.00	0.00	0.00	
12	21.60	27.60	18.65	0.00	0.00	0.00	0.00	0.00	0.00	
13	22.10	28.60	17.56	0.00	0.00	0.00	0.00	0.00	0.00	
14	24.04	24.10	19.82	0.00	0.00	0.00	0.00	2.68	0.00	
15	20.90	23.60	19.71	0.00	0.00	0.00	6.58	0.00	0.00	
16	23.68	29.80	15.67	0.00	0.00	0.00	0.00	0.00	0.00	
17	24.10	24.60	12.51	0.00	12.69	0.00	0.00	0.00	0.00	
18	24.10	24.10	19.67	13.58	0.00	0.00	0.00	0.00	0.00	
19	24.60	24.60	19.67	0.00	11.84	0.00	0.00	0.00	0.00	
20	23.41	28.60	16.64	0.00	0.00	0.00	0.00	0.00	0.00	
21	20.54	24.10	25.65	0.00	0.00	0.00	0.00	0.00	0.00	
22	22.84	23.60	15.54	0.00	0.00	0.00	0.00	0.00	0.00	
23	24.10	28.60	17.09	12.33	0.00	0.00	7.15	0.00	0.00	
24	23.60	24.70	18.98	0.00	0.00	0.00	0.00	0.00	0.00	
25	22.28	20.40	14.98	0.00	0.00	0.00	0.00	0.00	0.00	
26	24.60	21.60	12.51	0.00	0.00	0.00	0.00	0.00	0.00	
27	24.60	20.40	19.67	0.00	0.00	0.00	0.00	0.00	2.16	
28	21.60	27.60	20.04	0.00	0.00	0.00	6.89	2.47	0.00	
29	20.40	28.60	25.65	0.00	0.00	0.00	0.00	0.00	0.00	
30	29.80	24.10	15.54	0.00	0.00	0.00	0.00	0.00	0.00	
31	24.60	23.60	17.09	0.00	0.00	0.00	0.00	0.00	0.00	
32	20.10	29.80	18.98	13.69	0.00	0.00	7.08	0.00	0.00	
33	23.60	24.60	10.88	0.00	0.00	0.00	0.00	0.00	0.00	
34	19.80	24.27	16.64	0.00	0.00	9.18	0.00	0.00	0.00	
35	22.60	20.10	18.06	0.00	0.00	0.00	0.00	0.00	0.00	
36	24.60	28.64	16.12	0.00	13.47	0.00	0.00	0.00	0.00	
37	19.30	23.48	19.89	0.00	0.00	0.00	0.00	0.00	0.00	
38	20.40	22.21	16.12	0.00	0.00	0.00	0.00	0.00	0.00	
39	27.60	24.60	19.82	0.00	13.28	0.00	0.00	0.00	0.00	
40	20.60	20.10	17.09	11.08	0.00	0.00	6.38	0.00	0.00	
41	21.10	23.60	11.16	0.00	0.00	0.00	0.00	0.00	0.00	
42	20.90	25.26	10.92	0.00	0.00	0.00	0.00	2.58	0.00	
43	20.14	20.10	10.87	0.00	0.00	0.00	0.00	0.00	0.00	
44	27.60	29.36	22.09	0.00	0.00	0.00	0.00	0.00	0.00	
45	26.40	24.60	14.36	0.00	0.00	0.00	0.00	0.00	0.00	
46	24.60	21.14	19.82	0.00	0.00	0.00	0.00	0.00	0.00	
47	23.41	26.28	15.54	0.00	0.00	0.00	0.00	0.00	0.00	
48	20.54	24.10	17.09	0.00	0.00	0.00	0.00	2.84	0.00	
49	16.40	23.60	25.65	12.55	0.00	0.00	5.81	0.00	2.14	
50	24.10	27.61	15.54	0.00	0.00	0.00	0.00	0.00	0.00	
51	23.60	22.60	19.67	0.00	0.00	10.80	0.00	3.01	0.00	
52	29.80	24.26	17.09	0.00	0.00	0.00	7.14	0.00	0.00	
53	24.60	24.60	18.98	13.08	0.00	0.00	0.00	0.00	0.00	
54	24.60	20.40	11.20	0.00	0.00	0.00	0.00	0.00	0.00	
55	24.10	29.80	17.39	0.00	0.00	9.68	0.00	3.11	0.00	
56	23.60	24.60	20.04	0.00	0.00	0.00	0.00	0.00	0.00	
57	29.80	20.10	14.98	0.00	0.00	0.00	0.00	0.00	0.00	
58	24.60	23.60	18.65	0.00	0.00	0.00	0.00	0.00	0.00	
59	22.57	27.68	14.48	0.00	12.47	0.00	6.58	0.00	0.00	
60	23.65	22.60	12.54	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1401.1	1495	1026.89	89.97	76.23	38.30	65.66	23.72	2.00	2086.0
AVG	23.48	24.57	19.47	12.68	11.76	9.61	6.73	2.41	2.15	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 09-02-22 wednesday TIME : 7 TO 8 AM				SPOT SPEED SURVEY						
MIN	4W	2W	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	28.71	25.71	26.76	0.00	0.00	0.00	0.00	0.00	0.00	
2	21.71	25.21	16.65	0.00	0.00	0.00	0.00	0.00	0.00	
3	22.21	25.71	20.78	0.00	0.00	0.00	0.00	0.00	0.00	
4	22.01	29.71	18.20	0.00	0.00	0.00	0.00	0.00	0.00	
5	25.58	25.21	20.09	0.00	0.00	0.00	0.00	0.00	0.00	
6	28.71	24.71	12.35	0.00	0.00	0.00	0.00	2.57	0.00	
7	27.51	30.91	15.17	0.00	0.00	0.00	6.07	0.00	0.00	
8	29.21	25.71	17.99	0.00	0.00	0.00	0.00	0.00	0.00	
9	21.71	30.75	16.32	0.00	0.00	0.00	0.00	0.00	0.00	
10	22.21	31.17	14.39	0.00	0.00	0.00	0.00	0.00	0.00	
11	21.51	25.71	16.09	0.00	0.00	0.00	0.00	2.36	0.00	
12	22.71	28.71	19.76	13.08	0.00	0.00	0.00	0.00	0.00	
13	23.21	29.71	18.67	0.00	0.00	0.00	0.00	0.00	0.00	
14	25.15	25.21	20.93	0.00	0.00	0.00	0.00	0.00	0.00	
15	22.01	24.71	20.82	0.00	0.00	0.00	6.74	0.00	0.00	
16	24.79	30.91	16.78	0.00	0.00	0.00	0.00	0.00	0.00	
17	25.21	25.71	13.62	0.00	0.00	0.00	0.00	0.00	0.00	
18	25.21	25.21	20.78	0.00	0.00	13.28	0.00	0.00	0.00	
19	25.71	25.71	20.78	0.00	0.00	0.00	0.00	0.00	0.00	
20	24.52	29.71	17.75	0.00	0.00	0.00	0.00	0.00	0.00	
21	21.65	25.21	26.76	0.00	12.68	0.00	0.00	0.00	0.00	
22	23.95	24.71	16.65	0.00	0.00	0.00	0.00	0.00	0.00	
23	25.21	29.71	18.20	0.00	0.00	0.00	0.00	0.00	0.00	
24	24.71	25.81	20.09	0.00	0.00	0.00	7.04	0.00	0.00	
25	23.39	21.51	16.09	0.00	0.00	0.00	0.00	0.00	0.00	
26	25.71	22.71	13.62	0.00	0.00	0.00	0.00	0.00	0.00	
27	25.71	21.51	20.78	0.00	13.87	0.00	0.00	0.00	2.11	
28	22.71	28.71	21.15	0.00	0.00	0.00	5.27	2.17	0.00	
29	21.51	29.71	26.76	0.00	0.00	0.00	0.00	0.00	0.00	
30	30.91	25.21	16.65	0.00	0.00	0.00	0.00	0.00	0.00	
31	25.71	24.71	18.20	0.00	0.00	0.00	0.00	0.00	0.00	
32	21.21	30.91	20.09	0.00	0.00	0.00	0.00	0.00	0.00	
33	24.71	25.71	11.99	0.00	0.00	0.00	6.28	0.00	0.00	
34	20.91	25.38	17.75	0.00	0.00	11.28	0.00	0.00	0.00	
35	23.71	21.21	19.17	0.00	0.00	0.00	0.00	0.00	0.00	
36	25.71	29.75	17.23	11.28	0.00	0.00	0.00	0.00	0.00	
37	20.41	24.59	21.00	0.00	0.00	0.00	0.00	0.00	0.00	
38	21.51	23.32	17.23	0.00	0.00	0.00	0.00	0.00	0.00	
39	28.71	25.71	20.93	0.00	0.00	0.00	6.81	0.00	0.00	
40	21.71	21.21	18.20	0.00	0.00	0.00	0.00	0.00	0.00	
41	22.21	24.71	12.27	10.25	0.00	0.00	0.00	0.00	0.00	
42	22.01	26.37	12.03	0.00	0.00	0.00	0.00	0.00	0.00	
43	21.25	21.21	11.98	0.00	0.00	0.00	0.00	0.00	0.00	
44	28.71	30.47	23.20	0.00	0.00	0.00	0.00	0.00	0.00	
45	27.51	25.71	15.47	0.00	11.08	0.00	0.00	0.00	0.00	
46	25.71	22.25	20.93	0.00	0.00	0.00	0.00	0.00	0.00	
47	24.52	27.39	16.65	13.25	0.00	0.00	0.00	0.00	0.00	
48	21.65	25.21	18.20	0.00	0.00	0.00	0.00	0.00	0.00	
49	17.51	24.71	26.76	0.00	0.00	0.00	6.91	0.00	2.31	
50	25.21	28.72	16.65	12.58	12.46	0.00	0.00	0.00	0.00	
51	24.71	23.71	20.78	0.00	0.00	0.00	0.00	2.35	0.00	
52	30.91	25.37	18.20	0.00	0.00	0.00	0.00	0.00	0.00	
53	25.71	25.71	20.09	0.00	0.00	0.00	0.00	0.00	0.00	
54	25.71	21.51	12.31	0.00	0.00	0.00	0.00	0.00	0.00	
55	25.21	30.91	18.50	0.00	0.00	9.17	0.00	2.47	0.00	
56	24.71	25.71	21.15	13.56	12.47	0.00	0.00	0.00	0.00	
57	30.91	21.21	16.09	0.00	0.00	0.00	0.00	0.00	0.00	
58	25.71	24.71	19.76	0.00	0.00	0.00	0.00	0.00	0.00	
59	23.68	28.79	15.59	0.00	13.58	0.00	6.42	0.00	0.00	
60	24.76	23.71	13.65	0.00	0.00	0.00	0.00	0.00	0.00	
[illegible]	1467.7	1561	1093.49	74.00	76.14	33.73	51.54	11.92	4.41	1189.0
[illegible]	25.47	27.64	22.48	12.76	12.46	9.86	6.48	2.34	2.11	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 06-02-22 SUNDAY TIME : 7 TO 8 AM				SPOT SPEED SURVEY						
MIN	4w	2W	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	25.21	22.22	20.79	0.00	0.00	0.00	0.00	0.00	0.00	
2	20.55	26.38	23.51	0.00	0.00	0.00	5.14	2.94	2.11	
3	25.21	29.82	20.79	0.00	0.00	0.00	0.00	0.00	0.00	
4	24.71	19.62	17.76	11.28	12.49	9.64	0.00	0.00	0.00	
5	25.19	28.72	19.18	0.00	0.00	0.00	0.00	0.00	0.00	
6	20.93	23.39	17.24	0.00	0.00	0.00	0.00	2.38	0.00	
7	25.17	25.82	23.13	0.00	0.00	0.00	0.00	0.00	0.00	
8	21.30	21.52	17.24	0.00	10.86	0.00	0.00	0.00	0.00	
9	23.67	22.72	20.94	0.00	0.00	0.00	0.00	0.00	0.00	
10	25.71	21.52	18.21	13.58	0.00	0.00	0.00	0.00	0.00	
11	22.19	22.59	12.28	0.00	0.00	8.54	0.00	2.64	0.00	
12	19.61	27.63	12.04	0.00	0.00	0.00	0.00	0.00	0.00	
13	23.88	28.73	20.60	0.00	0.00	0.00	0.00	0.00	0.00	
14	24.20	21.26	24.53	0.00	0.00	0.00	5.01	0.00	0.00	
15	25.81	21.22	20.42	0.00	11.76	0.00	0.00	0.00	0.00	
16	21.51	25.22	21.52	16.27	0.00	0.00	0.00	0.00	0.00	
17	22.71	21.22	19.02	0.00	0.00	0.00	0.00	0.00	0.00	
18	23.92	20.12	21.72	11.22	0.00	0.00	0.00	0.00	0.00	
19	26.17	25.72	22.22	0.00	10.33	9.67	0.00	0.00	0.00	
20	25.21	25.22	22.02	0.00	0.00	0.00	5.22	0.00	0.00	
21	25.71	24.72	21.23	0.00	0.00	0.00	0.00	2.14	0.00	
22	21.51	26.40	16.52	0.00	10.28	0.00	0.00	0.00	0.00	
23	25.17	25.82	18.00	0.00	0.00	0.00	0.00	2.28	0.00	
24	21.71	21.52	16.33	10.36	0.00	0.00	0.00	0.00	0.00	
25	22.21	22.72	21.77	0.00	11.59	0.00	0.00	0.00	0.00	
26	22.01	21.52	18.29	14.21	0.00	0.00	0.00	0.00	0.00	
27	18.37	30.92	12.99	0.00	0.00	0.00	0.00	2.67	0.00	
28	23.18	25.72	20.83	0.00	12.56	0.00	0.00	0.00	0.00	
29	25.77	21.72	23.13	0.00	0.00	0.00	0.00	0.00	2.31	
30	21.20	22.22	13.63	0.00	0.00	0.00	0.00	2.67	0.00	
31	21.61	28.05	28.32	12.88	0.00	9.14	6.04	0.00	0.00	
32	25.71	23.59	25.72	0.00	0.00	0.00	0.00	0.00	0.00	
33	20.35	19.62	20.42	0.00	11.63	0.00	0.00	0.00	0.00	
34	19.41	28.72	21.52	11.08	0.00	0.00	0.00	2.57	0.00	
35	25.21	25.33	19.02	0.00	0.00	7.24	0.00	0.00	0.00	
36	21.21	21.26	21.72	0.00	12.41	0.00	0.00	0.00	0.00	
37	21.91	30.92	22.22	11.56	0.00	0.00	0.00	0.00	0.00	
38	23.71	25.72	22.02	0.00	12.07	0.00	0.00	0.00	0.00	
39	25.67	28.06	20.79	0.00	0.00	0.00	7.05	2.48	0.00	
40	21.91	25.72	16.52	10.26	0.00	0.00	0.00	0.00	0.00	
41	25.41	25.72	15.54	0.00	11.83	0.00	0.00	0.00	0.00	
42	19.01	28.98	20.10	11.05	0.00	9.58	0.00	0.00	0.00	
43	21.71	29.76	17.40	0.00	0.00	0.00	7.08	0.00	0.00	
44	24.75	25.22	12.36	0.00	12.09	0.00	0.00	2.65	0.00	
45	24.67	21.22	15.18	13.71	0.00	0.00	0.00	0.00	0.00	
46	22.21	25.72	20.79	0.00	0.00	0.00	0.00	0.00	0.00	
47	21.02	24.72	25.22	0.00	11.05	0.00	0.00	0.00	2.14	
48	21.97	27.46	24.72	11.09	0.00	0.00	6.87	0.00	0.00	
49	24.82	24.76	25.22	0.00	0.00	0.00	0.00	0.00	0.00	
50	27.21	28.48	24.72	0.00	0.00	0.00	0.00	0.00	0.00	
51	23.71	21.26	20.33	10.56	11.74	0.00	0.00	0.00	0.00	
52	24.79	23.33	21.72	0.00	0.00	0.00	6.28	0.00	0.00	
53	20.93	25.72	22.22	0.00	0.00	0.00	0.00	0.00	0.00	
54	17.34	21.22	25.72	0.00	12.57	0.00	0.00	0.00	0.00	
55	19.47	24.72	21.72	14.28	0.00	0.00	6.34	0.00	0.00	
56	24.52	26.38	23.68	0.00	0.00	9.67	0.00	2.65	0.00	
57	21.65	21.22	25.23	15.29	0.00	0.00	0.00	0.00	0.00	
58	20.56	21.92	25.72	0.00	12.57	0.00	0.00	2.17	0.00	
59	21.69	25.72	25.72	12.87	0.00	0.00	0.00	0.00	0.00	
60	23.26	25.40	21.73	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1377.1	1479.9	1231.19	211.55	187.8	63.48	55.03	30.24	16.56	1688.0
AVG	22.954	24.87	21.28	12.58	11.78	9.87	7.48	2.42	2.11	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 06-02-22 SUNDAY TIME : 8 TO 9 AM			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	24.10	21.10	19.67	0.00	12.45	0.00	0.00	0.00	0.00	
2	19.44	25.26	22.39	0.00	0.00	0.00	7.84	2.51	2.13	
3	24.10	28.70	19.67	0.00	11.27	9.87	0.00	0.00	0.00	
4	23.60	18.50	16.64	10.26	12.63	0.00	6.24	0.00	0.00	
5	24.08	27.60	18.06	0.00	0.00	0.00	0.00	0.00	0.00	
6	19.82	22.27	16.12	0.00	0.00	0.00	0.00	2.84	0.00	
7	24.06	24.70	22.01	0.00	0.00	9.89	7.01	0.00	0.00	
8	20.19	20.40	16.12	0.00	0.00	11.78	6.11	0.00	0.00	
9	22.56	21.60	19.82	13.25	0.00	0.00	6.29	0.00	0.00	
10	24.60	20.40	17.09	0.00	0.00	0.00	0.00	0.00	2.16	
11	21.08	21.47	11.16	0.00	13.06	0.00	0.00	2.91	0.00	
12	18.50	26.51	10.92	0.00	0.00	0.00	7.28	0.00	0.00	
13	22.77	27.61	19.48	0.00	0.00	10.49	7.99	0.00	0.00	
14	23.09	20.14	23.41	0.00	0.00	0.00	0.00	0.00	0.00	
15	24.70	20.10	19.30	0.00	14.05	0.00	0.00	0.00	0.00	
16	20.40	24.10	20.40	16.27	0.00	0.00	0.00	0.00	0.00	
17	21.60	20.10	17.90	0.00	0.00	0.00	0.00	0.00	0.00	
18	22.81	19.00	20.60	11.22	0.00	9.78	0.00	0.00	0.00	
19	25.06	24.60	21.10	0.00	0.00	0.00	0.00	0.00	0.00	
20	24.10	24.10	20.90	0.00	10.89	0.00	0.00	0.00	0.00	
21	24.60	23.60	20.11	0.00	0.00	0.00	0.00	2.75	0.00	
22	20.40	25.28	15.40	0.00	0.00	0.00	7.18	0.00	0.00	
23	24.06	24.70	16.88	0.00	10.45	0.00	0.00	2.96	0.00	
24	20.60	20.40	15.21	0.00	0.00	0.00	6.28	0.00	0.00	
25	21.10	21.60	20.65	0.00	0.00	0.00	0.00	0.00	0.00	
26	20.90	20.40	17.17	14.21	12.55	11.47	0.00	0.00	0.00	
27	17.26	29.80	11.87	0.00	0.00	0.00	0.00	2.82	0.00	
28	22.07	24.60	19.71	13.06	11.49	0.00	0.00	0.00	0.00	
29	24.66	20.60	22.01	0.00	0.00	0.00	0.00	0.00	2.31	
30	20.09	21.10	12.51	0.00	0.00	0.00	0.00	2.58	0.00	
31	20.50	26.93	27.20	0.00	0.00	0.00	0.00	0.00	2.21	
32	24.60	22.47	24.60	0.00	0.00	0.00	0.00	0.00	0.00	
33	19.24	18.50	19.30	0.00	14.27	10.47	6.51	0.00	0.00	
34	18.30	27.60	20.40	0.00	0.00	0.00	7.21	2.99	0.00	
35	24.10	24.21	17.90	0.00	0.00	0.00	0.00	0.00	0.00	
36	20.10	20.14	20.60	0.00	10.78	0.00	0.00	2.18	0.00	
37	20.80	29.80	21.10	11.56	0.00	0.00	0.00	0.00	0.00	
38	22.60	24.60	20.90	0.00	13.25	0.00	0.00	0.00	0.00	
39	24.56	26.94	19.67	0.00	0.00	0.00	0.00	0.00	0.00	
40	20.80	24.60	15.40	10.26	10.98	0.00	0.00	0.00	0.00	
41	24.30	24.60	14.42	0.00	0.00	0.00	0.00	0.00	0.00	
42	17.90	27.86	18.98	11.05	13.27	0.00	0.00	2.69	0.00	
43	20.60	28.64	16.28	0.00	0.00	0.00	6.39	0.00	0.00	
44	23.64	24.10	11.24	0.00	12.85	9.47	0.00	0.00	0.00	
45	23.56	20.10	14.06	13.71	0.00	0.00	7.58	0.00	0.00	
46	21.10	24.60	19.67	0.00	0.00	0.00	0.00	2.47	0.00	
47	19.91	23.60	24.10	0.00	12.47	0.00	0.00	0.00	0.00	
48	20.86	26.34	23.60	11.09	10.25	0.00	0.00	2.68	0.00	
49	23.71	23.64	24.10	0.00	0.00	0.00	6.78	0.00	0.00	
50	26.10	27.36	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
51	22.60	20.14	19.21	10.56	12.57	0.00	7.19	0.00	0.00	
52	23.68	22.21	20.60	0.00	0.00	9.64	0.00	0.00	0.00	
53	19.82	24.60	21.10	0.00	0.00	0.00	0.00	0.00	0.00	
54	16.23	20.10	24.60	0.00	10.78	0.00	0.00	0.00	0.00	
55	18.36	23.60	20.60	14.28	0.00	0.00	7.18	0.00	0.00	
56	23.41	25.26	22.56	0.00	11.63	0.00	7.48	2.14	0.00	
57	20.54	20.10	24.11	15.29	0.00	0.00	0.00	0.00	0.00	
58	19.45	20.80	24.60	0.00	0.00	0.00	0.00	2.65	0.00	
59	20.58	24.60	24.60	0.00	0.00	10.45	5.28	0.00	0.00	
60	22.15	24.28	20.61	11.02	0.00	0.00	0.00	0.00	0.00	
TOTAL	1311	1412.7	1164.0	187.09	241.9	103.31	123.82	37.17	3.81	1480.0
AVG	20.18	23.75	20.98	11.29	10.84	9.34	6.48	2.57	2.21	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 06-02-22 SUNDAY TIME : 9 TO 10 AM				SPOT SPEED SURVEY						
MIN	4w	2W	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	26.33	23.34	21.91	0.00	9.37	0.00	0.00	0.00	0.00	
2	21.67	27.50	24.63	0.00	0.00	0.00	6.27	2.48	2.21	
3	26.33	30.94	21.91	12.28	11.67	0.00	0.00	0.00	0.00	
4	25.83	20.74	18.88	11.08	12.49	0.00	7.49	0.00	0.00	
5	26.31	29.84	20.30	0.00	0.00	0.00	7.55	0.00	0.00	
6	22.05	24.51	18.36	0.00	0.00	0.00	6.89	2.64	0.00	
7	26.29	26.94	24.25	0.00	0.00	8.47	0.00	0.00	0.00	
8	22.42	22.64	18.36	10.28	10.86	0.00	0.00	0.00	0.00	
9	24.79	23.84	22.06	0.00	0.00	0.00	7.36	0.00	0.00	
10	26.83	22.64	19.33	0.00	0.00	9.21	7.48	0.00	0.00	
11	23.31	23.71	13.40	10.85	11.48	0.00	0.00	2.67	0.00	
12	20.73	28.75	13.16	0.00	0.00	0.00	0.00	0.00	0.00	
13	25.00	29.85	21.72	12.76	0.00	0.00	0.00	0.00	0.00	
14	25.32	22.38	25.65	0.00	0.00	0.00	0.00	0.00	0.00	
15	26.93	22.34	21.54	0.00	11.76	0.00	6.34	0.00	0.00	
16	22.63	26.34	22.64	12.64	0.00	9.64	0.00	0.00	0.00	
17	23.83	22.34	20.14	0.00	0.00	0.00	0.00	0.00	0.00	
18	25.04	21.24	22.84	11.86	0.00	0.00	0.00	0.00	0.00	
19	27.29	26.84	23.34	0.00	10.33	0.00	0.00	0.00	0.00	
20	26.33	26.34	23.14	0.00	0.00	0.00	6.88	0.00	0.00	
21	26.83	25.84	22.35	0.00	0.00	10.28	0.00	2.37	0.00	
22	22.63	27.52	17.64	0.00	10.28	0.00	0.00	0.00	0.00	
23	26.29	26.94	19.12	0.00	10.05	0.00	0.00	2.49	0.00	
24	22.83	22.64	17.45	0.00	0.00	0.00	6.52	0.00	0.00	
25	23.33	23.84	22.89	0.00	0.00	0.00	0.00	0.00	0.00	
26	23.13	22.64	19.41	12.76	11.47	0.00	0.00	0.00	0.00	
27	19.49	32.04	14.11	0.00	0.00	0.00	0.00	2.14	0.00	
28	24.30	26.84	21.95	0.00	12.56	0.00	0.00	0.00	0.00	
29	26.89	22.84	24.25	0.00	0.00	0.00	7.51	0.00	2.34	
30	22.32	23.34	14.75	0.00	0.00	9.18	0.00	2.97	0.00	
31	22.73	29.17	29.44	11.39	0.00	0.00	0.00	0.00	0.00	
32	26.83	24.71	26.84	0.00	0.00	0.00	0.00	0.00	0.00	
33	21.47	20.74	21.54	0.00	11.63	0.00	7.28	0.00	0.00	
34	20.53	29.84	22.64	0.00	0.00	0.00	0.00	2.67	0.00	
35	26.33	26.45	20.14	0.00	0.00	0.00	0.00	0.00	0.00	
36	22.33	22.38	22.84	0.00	12.41	0.00	0.00	0.00	0.00	
37	23.03	32.04	23.34	10.86	0.00	0.00	7.58	2.97	0.00	
38	24.83	26.84	23.14	0.00	12.07	0.00	0.00	0.00	0.00	
39	26.79	29.18	21.91	13.27	0.00	10.58	6.48	0.00	0.00	
40	23.03	26.84	17.64	0.00	0.00	0.00	0.00	0.00	0.00	
41	26.53	26.84	16.66	12.09	11.83	0.00	0.00	0.00	0.00	
42	20.13	30.10	21.22	0.00	0.00	0.00	6.39	0.00	0.00	
43	22.83	30.88	18.52	0.00	0.00	0.00	0.00	0.00	0.00	
44	25.87	26.34	13.48	0.00	12.09	9.11	0.00	0.00	0.00	
45	25.79	22.34	16.30	0.00	0.00	0.00	0.00	0.00	0.00	
46	23.33	26.84	21.91	11.08	0.00	0.00	6.84	0.00	0.00	
47	22.14	25.84	26.34	0.00	0.00	0.00	0.00	0.00	0.00	
48	23.09	28.58	25.84	0.00	11.68	0.00	0.00	0.00	0.00	
49	25.94	25.88	26.34	12.39	0.00	0.00	0.00	0.00	0.00	
50	28.33	29.60	25.84	0.00	0.00	0.00	7.24	0.00	0.00	
51	24.83	22.38	21.45	0.00	11.74	0.00	0.00	0.00	0.00	
52	25.91	24.45	22.84	0.00	0.00	9.37	0.00	0.00	0.00	
53	22.05	26.84	23.34	12.47	0.00	0.00	0.00	0.00	0.00	
54	18.46	22.34	26.84	0.00	12.57	0.00	0.00	0.00	0.00	
55	20.59	25.84	22.84	0.00	0.00	0.00	0.00	0.00	0.00	
56	25.64	27.50	24.80	0.00	11.08	0.00	0.00	2.84	0.00	
57	22.77	22.34	26.35	11.87	0.00	8.27	0.00	0.00	2.14	
58	21.68	23.04	26.84	0.00	12.57	0.00	0.00	0.00	0.00	
59	22.81	26.84	26.84	0.00	0.00	10.24	0.00	0.00	0.00	
60	24.38	26.52	22.85	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1444	1547.1	1298.39	23.00	278.04	94.35	112.10	26.24	6.69	1588.0
AVG	24.38	25.67	22.18	12.98	12.74	10.28	7.48	2.64	2.12	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 06-02-22 SUNDAY TIME : 7 TO 8 AM				SPOT SPEED SURVEY						
MIN	4w	2 W	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	24.68	22.20	25.37	0.00	0.00	0.00	0.00	0.00	0.00	
2	22.22	21.92	27.43	0.00	0.00	0.00	0.00	0.00	0.00	
3	21.03	25.72	20.52	11.18	0.00	0.00	0.00	0.00	0.00	
4	21.98	25.22	19.62	0.00	11.46	0.00	0.00	0.00	0.00	
5	24.83	25.72	28.72	0.00	0.00	0.00	0.00	0.00	0.00	
6	22.16	26.48	29.72	0.00	12.47	0.00	0.00	2.47	0.00	
7	25.41	25.22	17.24	0.00	0.00	0.00	0.00	0.00	0.00	
8	22.57	24.72	21.26	0.00	0.00	0.00	0.00	0.00	0.00	
9	28.72	26.08	17.24	0.00	0.00	0.00	6.47	0.00	0.00	
10	21.46	25.82	24.08	13.58	0.00	0.00	0.00	0.00	0.00	
11	20.65	21.52	14.42	0.00	13.87	0.00	0.00	0.00	0.00	
12	21.62	22.72	18.21	0.00	0.00	11.58	0.00	0.00	0.00	
13	25.42	21.52	20.10	0.00	0.00	0.00	0.00	0.00	0.00	
14	21.28	27.48	12.00	0.00	0.00	0.00	0.00	0.00	0.00	
15	24.37	25.72	12.36	0.00	0.00	0.00	0.00	0.00	0.00	
16	25.79	17.32	15.18	16.27	15.36	0.00	0.00	0.00	0.00	
17	30.92	25.82	20.79	0.00	0.00	0.00	0.00	0.00	0.00	
18	25.72	21.29	17.76	11.22	0.00	0.00	0.00	0.00	0.00	
19	25.72	25.72	17.40	0.00	0.00	0.00	0.00	0.00	0.00	
20	19.32	21.22	17.24	0.00	0.00	11.28	0.00	0.00	0.00	
21	21.34	24.72	14.45	0.00	0.00	10.28	0.00	0.00	0.00	
22	25.22	20.92	14.40	0.00	0.00	0.00	0.00	2.84	0.00	
23	21.22	21.22	25.22	0.00	0.00	0.00	0.00	0.00	0.00	
24	25.22	21.92	24.72	10.36	0.00	0.00	0.00	0.00	0.00	
25	24.72	25.72	25.22	0.00	14.27	0.00	0.00	0.00	0.00	
26	25.72	21.14	24.72	14.21	0.00	0.00	0.00	0.00	0.00	
27	24.53	25.72	21.16	0.00	0.00	0.00	0.00	0.00	0.00	
28	21.08	27.03	16.68	13.06	0.00	0.00	0.00	0.00	0.00	
29	21.80	25.22	21.12	0.00	0.00	0.00	0.00	2.64	0.00	
30	25.22	24.72	16.77	0.00	0.00	0.00	0.00	0.00	0.00	
31	24.72	25.40	16.79	12.88	0.00	0.00	0.00	0.00	0.00	
32	20.33	25.72	18.51	0.00	0.00	0.00	0.00	0.00	0.00	
33	24.76	19.62	17.92	0.00	0.00	0.00	7.14	0.00	0.00	
34	22.01	28.72	20.79	0.00	0.00	0.00	0.00	0.00	0.00	
35	19.82	25.40	17.76	0.00	13.86	0.00	0.00	0.00	0.00	
36	19.06	25.82	19.18	0.00	0.00	0.00	0.00	2.18	0.00	
37	26.73	21.52	17.24	11.56	0.00	0.00	7.08	0.00	0.00	
38	25.72	22.72	21.01	0.00	11.44	8.47	0.00	2.81	0.00	
39	20.42	21.52	17.24	0.00	0.00	0.00	0.00	0.00	0.00	
40	21.52	22.59	26.77	10.26	0.00	0.00	6.28	2.75	0.00	
41	19.02	27.63	16.66	11.89	0.00	0.00	0.00	0.00	0.00	
42	21.72	28.73	18.21	11.05	0.00	0.00	0.00	0.00	2.14	
43	22.22	21.26	20.10	0.00	0.00	0.00	6.84	0.00	0.00	
44	20.99	28.68	16.10	0.00	12.04	0.00	0.00	2.36	0.00	
45	21.19	21.22	21.16	13.71	0.00	0.00	0.00	0.00	0.00	
46	25.77	25.68	26.77	12.04	0.00	0.00	0.00	0.00	2.17	
47	25.22	25.72	26.46	0.00	0.00	0.00	6.21	0.00	0.00	
48	24.72	21.22	21.33	11.09	0.00	9.67	0.00	2.95	0.00	
49	20.33	24.72	15.18	0.00	0.00	0.00	0.00	0.00	0.00	
50	21.72	26.38	20.79	0.00	0.00	0.00	6.68	0.00	0.00	
51	22.22	21.22	17.76	10.56	13.33	0.00	0.00	2.17	0.00	
52	20.99	21.92	19.18	11.08	0.00	0.00	7.08	0.00	0.00	
53	21.26	23.13	17.24	0.00	0.00	0.00	0.00	0.00	0.00	
54	24.98	25.22	14.45	0.00	0.00	0.00	6.09	2.94	0.00	
55	25.68	24.72	26.77	14.28	0.00	9.55	0.00	0.00	2.14	
56	22.72	20.33	20.79	0.00	12.47	0.00	0.00	0.00	0.00	
57	19.02	28.22	21.30	15.29	0.00	0.00	0.00	0.00	0.00	
58	19.62	23.72	20.83	0.00	0.00	0.00	6.21	0.00	0.00	
59	20.79	26.49	16.79	12.87	0.00	0.00	0.00	2.17	0.00	
60	23.26	27.34	16.38	11.02	0.00	0.00	0.00	0.00	0.00	
TOTAL	1380.5	1450.3	1188.61	259.46	130.6	60.83	66.08	28.28	6.45	1420.0
AVG	23.47	23.47	20.74	11.84	12.88	10.28	7.81	2.46	2.13	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 06-02-22 SUNDAY TIME : 8 TO 9 AM			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	23.56	21.08	24.25	0.00	0.00	0.00	0.00	0.00	0.00	
2	21.10	20.80	26.31	12.05	0.00	0.00	6.84	2.15	0.00	
3	19.91	24.60	19.40	0.00	12.05	0.00	0.00	0.00	0.00	
4	20.86	24.10	18.50	0.00	0.00	0.00	0.00	0.00	0.00	
5	23.71	24.60	27.60	0.00	0.00	0.00	0.00	0.00	0.00	
6	21.04	25.36	28.60	0.00	0.00	9.67	0.00	0.00	0.00	
7	24.29	24.10	16.12	13.28	0.00	0.00	7.14	0.00	0.00	
8	21.45	23.60	20.14	0.00	0.00	0.00	0.00	0.00	0.00	
9	27.60	24.96	16.12	0.00	0.00	0.00	0.00	0.00	0.00	
10	20.34	24.70	22.96	0.00	0.00	0.00	0.00	3.83	0.00	
11	19.53	20.40	13.30	10.47	0.00	0.00	0.00	0.00	0.00	
12	20.50	21.60	17.09	0.00	0.00	0.00	6.89	0.00	0.00	
13	24.30	20.40	18.98	0.00	0.00	0.00	0.00	0.00	0.00	
14	20.16	26.36	10.88	0.00	11.25	0.00	0.00	0.00	0.00	
15	23.25	24.60	11.24	0.00	0.00	0.00	6.47	0.00	0.00	
16	24.67	16.20	14.06	12.59	0.00	0.00	0.00	0.00	0.00	
17	29.80	24.70	19.67	0.00	0.00	0.00	7.58	0.00	0.00	
18	24.60	20.17	16.64	0.00	0.00	0.00	0.00	0.00	0.00	
19	24.60	24.60	16.28	13.88	0.00	0.00	0.00	0.00	0.00	
20	18.20	20.10	16.12	0.00	0.00	0.00	7.29	3.27	0.00	
21	20.22	23.60	13.33	0.00	0.00	0.00	0.00	0.00	0.00	
22	24.10	19.80	13.28	0.00	0.00	0.00	0.00	0.00	0.00	
23	20.10	20.10	24.10	12.07	0.00	9.67	6.81	0.00	0.00	
24	24.10	20.80	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
25	23.60	24.60	24.10	0.00	0.00	0.00	0.00	0.00	0.00	
26	24.60	20.02	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
27	23.41	24.60	20.04	11.06	0.00	0.00	6.28	2.42	0.00	
28	19.96	25.91	15.56	0.00	0.00	0.00	0.00	0.00	0.00	
29	20.68	24.10	20.00	0.00	0.00	0.00	0.00	0.00	0.00	
30	24.10	23.60	15.65	0.00	0.00	8.94	7.59	0.00	0.00	
31	23.60	24.28	15.67	0.00	11.63	0.00	0.00	2.18	0.00	
32	19.21	24.60	17.39	13.08	0.00	0.00	6.28	0.00	0.00	
33	23.64	18.50	16.80	0.00	0.00	0.00	0.00	2.59	0.00	
34	20.89	27.60	19.67	12.09	0.00	0.00	0.00	0.00	0.00	
35	18.70	24.28	16.64	0.00	0.00	0.00	0.00	0.00	0.00	
36	17.94	24.70	18.06	0.00	0.00	0.00	6.84	0.00	0.00	
37	25.61	20.40	16.12	0.00	0.00	0.00	0.00	0.00	0.00	
38	24.60	21.60	19.89	11.74	0.00	0.00	0.00	0.00	0.00	
39	19.30	20.40	16.12	0.00	0.00	0.00	0.00	0.00	0.00	
40	20.40	21.47	25.65	0.00	0.00	0.00	6.38	2.87	0.00	
41	17.90	26.51	15.54	0.00	12.09	0.00	0.00	0.00	0.00	
42	20.60	27.61	17.09	0.00	0.00	0.00	0.00	0.00	2.14	
43	21.10	20.14	18.98	10.89	0.00	0.00	0.00	0.00	0.00	
44	19.87	27.56	14.98	0.00	0.00	0.00	0.00	0.00	0.00	
45	20.07	20.10	20.04	0.00	0.00	0.00	0.00	0.00	0.00	
46	24.65	24.56	25.65	0.00	0.00	0.00	0.00	0.00	0.00	
47	24.10	24.60	25.34	0.00	0.00	9.64	0.00	0.00	2.31	
48	23.60	20.10	20.21	0.00	0.00	0.00	0.00	0.00	0.00	
49	19.21	23.60	14.06	0.00	0.00	0.00	7.54	0.00	0.00	
50	20.60	25.26	19.67	0.00	0.00	0.00	0.00	0.00	0.00	
51	21.10	20.10	16.64	11.09	0.00	10.28	0.00	0.00	0.00	
52	19.87	20.80	18.06	0.00	0.00	0.00	0.00	0.00	0.00	
53	20.14	22.01	16.12	0.00	0.00	0.00	0.00	0.00	2.15	
54	23.86	24.10	13.33	0.00	0.00	0.00	0.00	3.84	0.00	
55	24.56	23.60	25.65	0.00	0.00	0.00	0.00	0.00	2.61	
56	21.60	19.21	19.67	0.00	0.00	9.64	0.00	0.00	0.00	
57	17.90	27.10	20.18	12.57	0.00	0.00	0.00	0.00	0.00	
58	18.50	22.60	19.71	0.00	0.00	0.00	0.00	0.00	0.00	
59	19.67	25.37	15.67	0.00	12.73	0.00	0.00	2.47	0.00	
60	22.14	26.22	15.26	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1313	1383.1	1121.4	156.86	59.75	57.84	89.93	25.62	9.21	1165.0
AVG	21.84	22.48	19.48	11.47	11.11	9.17	6.17	2.86	2.11	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 06-02-22 SUNDAY TIME : 9 TO 10 AM				SPOT SPEED SURVEY						
MIN	4w	2W	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	25.66	22.20	26.37	0.00	0.00	0.00	0.00	0.00	0.00	
2	23.20	21.92	28.43	0.00	0.00	0.00	0.00	0.00	0.00	
3	22.01	25.72	21.52	14.24	0.00	0.00	0.00	0.00	0.00	
4	22.96	25.22	20.62	0.00	12.49	0.00	0.00	0.00	0.00	
5	25.81	25.72	29.72	13.29	0.00	0.00	0.00	0.00	0.00	
6	23.14	26.48	30.72	0.00	0.00	0.00	0.00	3.01	0.00	
7	26.39	25.22	18.24	13.66	0.00	0.00	0.00	0.00	0.00	
8	23.55	24.72	22.26	0.00	10.86	0.00	0.00	0.00	0.00	
9	29.70	26.08	18.24	0.00	0.00	0.00	6.37	0.00	0.00	
10	22.44	25.82	25.08	0.00	0.00	0.00	0.00	0.00	0.00	
11	21.63	21.52	15.42	0.00	0.00	0.00	0.00	0.00	0.00	
12	22.60	22.72	19.21	0.00	0.00	0.00	0.00	0.00	0.00	
13	26.40	21.52	21.10	0.00	0.00	0.00	0.00	0.00	0.00	
14	22.26	27.48	13.00	0.00	0.00	0.00	0.00	0.00	0.00	
15	25.35	25.72	13.36	0.00	11.76	0.00	0.00	0.00	0.00	
16	26.77	17.32	16.18	12.47	0.00	0.00	0.00	0.00	0.00	
17	31.90	25.82	21.79	0.00	0.00	0.00	0.00	0.00	0.00	
18	26.70	21.29	18.76	13.58	0.00	0.00	0.00	0.00	0.00	
19	26.70	25.72	18.40	0.00	10.33	0.00	0.00	0.00	0.00	
20	20.30	21.22	18.24	0.00	0.00	11.28	0.00	0.00	0.00	
21	22.32	24.72	15.45	0.00	0.00	0.00	0.00	0.00	0.00	
22	26.20	20.92	15.40	0.00	10.28	0.00	0.00	2.34	0.00	
23	22.20	21.22	26.22	12.33	0.00	0.00	0.00	0.00	0.00	
24	26.20	21.92	25.72	0.00	0.00	0.00	0.00	0.00	0.00	
25	25.70	25.72	26.22	0.00	11.59	0.00	0.00	0.00	2.12	
26	26.70	21.14	25.72	0.00	0.00	0.00	0.00	0.00	0.00	
27	25.51	25.72	22.16	14.87	0.00	0.00	0.00	0.00	0.00	
28	22.06	27.03	17.68	0.00	12.56	0.00	0.00	0.00	0.00	
29	22.78	25.22	22.12	0.00	0.00	0.00	0.00	2.47	2.13	
30	26.20	24.72	17.77	0.00	0.00	0.00	0.00	0.00	0.00	
31	25.70	25.40	17.79	0.00	0.00	0.00	0.00	0.00	0.00	
32	21.31	25.72	19.51	13.69	0.00	0.00	0.00	0.00	0.00	
33	25.74	19.62	18.92	0.00	11.63	0.00	7.08	0.00	0.00	
34	22.99	28.72	21.79	0.00	0.00	0.00	0.00	0.00	0.00	
35	20.80	25.40	18.76	0.00	0.00	0.00	0.00	0.00	0.00	
36	20.04	25.82	20.18	0.00	12.41	0.00	0.00	2.98	0.00	
37	27.71	21.52	18.24	0.00	0.00	0.00	6.64	0.00	0.00	
38	26.70	22.72	22.01	0.00	12.07	0.00	0.00	0.00	0.00	
39	21.40	21.52	18.24	0.00	0.00	0.00	0.00	0.00	0.00	
40	22.50	22.59	27.77	11.08	11.59	0.00	0.00	0.00	0.00	
41	20.00	27.63	17.66	0.00	11.83	0.00	6.18	0.00	2.47	
42	22.70	28.73	19.21	0.00	0.00	0.00	0.00	0.00	0.00	
43	23.20	21.26	21.10	0.00	0.00	10.24	0.00	0.00	0.00	
44	21.97	28.68	17.10	0.00	12.09	0.00	0.00	3.01	0.00	
45	22.17	21.22	22.16	0.00	0.00	0.00	0.00	0.00	0.00	
46	26.75	25.68	27.77	0.00	0.00	0.00	0.00	0.00	0.00	
47	26.20	25.72	27.46	0.00	12.87	0.00	5.28	0.00	0.00	
48	25.70	21.22	22.33	0.00	11.68	0.00	0.00	0.00	0.00	
49	21.31	24.72	16.18	12.55	0.00	0.00	0.00	2.47	0.00	
50	22.70	26.38	21.79	0.00	0.00	0.00	6.94	0.00	0.00	
51	23.20	21.22	18.76	0.00	11.74	0.00	0.00	2.64	0.00	
52	21.97	21.92	20.18	0.00	0.00	0.00	7.05	0.00	0.00	
53	22.24	23.13	18.24	13.08	0.00	0.00	0.00	0.00	0.00	
54	25.96	25.22	15.45	0.00	12.57	0.00	0.00	0.00	0.00	
55	26.66	24.72	27.77	0.00	0.00	9.17	6.08	0.00	2.64	
56	23.70	20.33	21.79	0.00	11.08	0.00	0.00	2.34	0.00	
57	20.00	28.22	22.30	0.00	0.00	0.00	0.00	0.00	0.00	
58	20.60	23.72	21.83	0.00	12.57	0.00	6.32	0.00	0.00	
59	21.77	26.49	17.79	0.00	0.00	0.00	0.00	2.17	0.00	
60	24.24	27.34	17.38	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1439	1450.3	1248.61	144.84	224.00	30.69	57.94	23.43	9.36	1386.0
AVG	24.31	25.18	22.47	12.67	12.47	10.28	7.18	2.64	2.12	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 06-02-22 SUNDAY TIME : 5 TO 6 PM				SPOT SPEED SURVEY						
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	14.26	25.22	24.72	0.00	0.00	0.00	0.00	0.00	0.00	
2	23.12	25.72	20.92	11.68	0.00	0.00	0.00	0.00	0.00	
3	26.76	29.72	23.72	0.00	0.00	0.00	5.28	0.00	0.00	
4	20.78	25.22	19.32	0.00	0.00	0.00	0.00	0.00	0.00	
5	17.75	24.72	21.22	0.00	0.00	0.00	0.00	0.00	2.14	
6	19.17	30.92	25.22	0.00	12.07	0.00	0.00	2.37	0.00	
7	17.23	25.72	21.22	10.58	0.00	11.28	0.00	0.00	0.00	
8	20.59	30.92	20.12	0.00	0.00	0.00	0.00	0.00	0.00	
9	24.52	25.72	25.72	0.00	0.00	0.00	0.00	2.57	0.00	
10	26.76	21.22	25.22	12.98	0.00	0.00	0.00	0.00	0.00	
11	16.65	24.72	24.72	0.00	11.29	0.00	0.00	0.00	0.00	
12	18.20	20.92	29.72	10.78	0.00	0.00	0.00	0.00	0.00	
13	26.76	23.72	25.82	0.00	0.00	0.00	0.00	2.07	0.00	
14	19.56	19.32	21.52	0.00	11.68	0.00	0.00	0.00	0.00	
15	18.20	21.22	22.72	13.05	0.00	0.00	0.00	0.00	0.00	
16	20.09	25.22	21.52	0.00	0.00	0.00	0.00	2.58	0.00	
17	16.09	21.22	30.92	0.00	0.00	0.00	0.00	0.00	0.00	
18	21.15	20.12	25.72	0.00	0.00	0.00	0.00	0.00	0.00	
19	16.51	25.72	17.32	0.00	12.08	0.00	0.00	0.00	0.00	
20	15.30	25.22	19.32	0.00	0.00	0.00	0.00	0.00	0.00	
21	25.78	24.72	30.92	0.00	0.00	0.00	6.25	0.00	0.00	
22	22.21	29.72	25.72	12.73	10.58	0.00	0.00	0.00	0.00	
23	22.01	25.82	17.32	0.00	0.00	0.00	0.00	0.00	0.00	
24	20.09	21.52	22.38	0.00	0.00	0.00	7.14	0.00	0.00	
25	16.51	22.72	24.71	0.00	0.00	0.00	6.87	0.00	0.00	
26	27.58	21.52	25.27	0.00	11.73	0.00	0.00	3.08	0.00	
27	15.17	30.92	24.57	0.00	0.00	0.00	0.00	0.00	0.00	
28	20.78	25.72	21.70	0.00	0.00	0.00	0.00	0.00	0.00	
29	17.75	17.32	28.76	0.00	0.00	10.24	0.00	0.00	2.12	
30	20.78	19.32	25.27	13.08	0.00	0.00	0.00	0.00	0.00	
31	17.75	30.92	25.72	0.00	0.00	0.00	0.00	2.14	0.00	
32	19.17	25.72	19.32	0.00	0.00	0.00	0.00	0.00	0.00	
33	17.23	17.32	25.72	11.86	0.00	0.00	0.00	2.95	0.00	
34	21.00	22.38	20.22	0.00	11.69	0.00	7.14	0.00	0.00	
35	17.23	24.71	21.72	0.00	0.00	0.00	0.00	0.00	0.00	
36	20.93	25.27	22.22	0.00	0.00	0.00	0.00	0.00	0.00	
37	18.20	24.57	30.80	0.00	0.00	0.00	0.00	0.00	0.00	
38	25.89	21.70	29.82	11.08	11.86	0.00	6.34	2.68	0.00	
39	27.35	28.76	19.62	0.00	0.00	0.00	0.00	0.00	0.00	
40	21.09	25.27	28.72	12.09	0.00	0.00	0.00	0.00	0.00	
41	23.20	25.72	29.72	0.00	12.93	0.00	0.00	0.00	0.00	
42	26.37	19.32	25.82	12.74	0.00	0.00	0.00	0.00	0.00	
43	20.93	25.72	30.92	0.00	12.07	0.00	0.00	0.00	0.00	
44	23.12	20.22	25.72	10.28	0.00	0.00	0.00	0.00	0.00	
45	20.09	21.72	21.22	0.00	11.08	0.00	0.00	0.00	0.00	
46	29.75	22.22	24.72	0.00	0.00	0.00	5.28	0.00	0.00	
47	20.78	30.80	20.92	11.67	0.00	0.00	0.00	3.08	0.00	
48	29.52	29.82	21.22	0.00	0.00	0.00	0.00	0.00	0.00	
49	25.27	19.62	21.92	0.00	11.83	0.00	6.31	2.84	0.00	
50	16.92	28.72	25.72	12.08	0.00	0.00	0.00	0.00	0.00	
51	24.68	29.72	25.22	0.00	0.00	0.00	0.00	0.00	0.00	
52	21.15	25.82	25.72	0.00	0.00	0.00	0.00	0.00	0.00	
53	26.76	30.92	29.72	0.00	10.96	0.00	5.96	0.00	0.00	
54	16.65	25.72	25.22	0.00	0.00	9.47	0.00	0.00	0.00	
55	18.20	21.22	24.72	10.83	0.00	0.00	0.00	0.00	0.00	
56	20.09	24.72	30.92	0.00	11.83	0.00	0.00	0.00	0.00	
57	23.50	20.92	25.72	11.37	0.00	0.00	0.00	0.00	0.00	
58	21.15	21.22	30.92	0.00	12.73	0.00	0.00	0.00	0.00	
59	16.67	21.92	25.72	0.00	0.00	0.00	0.00	0.00	0.00	
60	21.11	20.58	21.22	0.00	0.00	0.00	0.00	2.97	0.00	
TOTAL	1260	1465	1470.20	188.88	176.4	30.99	56.57	29.33	4.26	1519
Avg	21.00	24.42	24.50	3.15	2.94	0.52	0.94	0.49	0.07	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 06-02-22 SUNDAY TIME : 6 TO 7 PM			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	29.80	21.60	13.15	9.31	11.43	0.00	0.00	0.00	0.00	
2	24.60	20.40	22.01	12.86	0.00	0.00	6.17	2.47	0.00	
3	24.60	29.80	25.65	0.00	0.00	0.00	0.00	0.00	0.00	
4	18.20	24.60	19.67	11.42	0.00	0.00	0.00	0.00	0.00	
5	18.30	20.10	16.64	0.00	0.00	0.00	0.00	0.00	2.14	
6	24.10	23.60	18.06	0.00	0.00	0.00	0.00	0.00	0.00	
7	20.10	19.80	16.12	0.00	0.00	6.47	0.00	0.00	0.00	
8	24.10	22.60	19.48	14.98	0.00	0.00	0.00	0.00	0.00	
9	23.60	18.20	23.41	0.00	0.00	0.00	5.27	0.00	0.00	
10	29.80	20.10	25.65	0.00	13.24	0.00	0.00	0.00	0.00	
11	24.60	24.10	15.54	12.05	0.00	0.00	5.17	0.00	0.00	
12	26.10	20.10	17.09	10.59	0.00	0.00	0.00	0.00	0.00	
13	18.20	19.00	25.65	0.00	0.00	0.00	0.00	0.00	0.00	
14	18.30	24.60	18.45	0.00	0.00	0.00	0.00	0.00	0.00	
15	28.70	18.20	17.09	11.40	0.00	0.00	0.00	0.00	0.00	
16	27.10	24.60	18.98	0.00	0.00	0.00	0.00	0.00	0.00	
17	22.60	19.10	14.98	0.00	8.78	0.00	0.00	0.00	0.00	
18	19.40	20.60	20.04	0.00	0.00	0.00	0.00	0.00	0.00	
19	27.20	21.10	15.40	12.50	0.00	0.00	0.00	0.00	0.00	
20	24.60	29.68	14.19	10.09	0.00	0.00	0.00	0.00	0.00	
21	27.20	28.70	24.67	0.00	0.00	0.00	5.69	0.00	0.00	
22	24.60	18.50	21.10	0.00	0.00	0.00	0.00	0.00	0.00	
23	19.30	27.60	20.90	0.00	0.00	0.00	0.00	0.00	0.00	
24	20.40	28.60	18.98	0.00	0.00	0.00	0.00	2.79	0.00	
25	27.60	24.70	15.40	14.57	10.92	0.00	6.47	0.00	0.00	
26	20.60	20.40	26.47	0.00	0.00	0.00	0.00	0.00	0.00	
27	21.10	21.60	14.06	0.00	0.00	0.00	0.00	0.00	0.00	
28	20.90	20.40	19.67	0.00	0.00	0.00	0.00	0.00	0.00	
29	20.14	21.47	16.64	0.00	0.00	9.57	0.00	0.00	2.13	
30	27.60	26.51	19.67	0.00	0.00	0.00	0.00	0.00	0.00	
31	26.40	27.61	16.64	11.73	0.00	0.00	0.00	0.00	0.00	
32	21.60	20.14	18.06	12.43	0.00	0.00	5.17	0.00	0.00	
33	20.40	27.56	16.12	0.00	0.00	0.00	0.00	2.67	0.00	
34	21.60	23.45	19.89	0.00	0.00	0.00	0.00	0.00	0.00	
35	22.10	27.61	16.12	0.00	0.00	0.00	0.00	0.00	0.00	
36	24.04	23.89	19.82	12.54	0.00	0.00	7.98	0.00	0.00	
37	20.90	24.60	17.09	0.00	10.21	0.00	0.00	0.00	2.14	
38	23.68	20.10	24.78	0.00	0.00	0.00	0.00	0.00	0.00	
39	24.10	23.60	26.24	0.00	0.00	0.00	0.00	0.00	0.00	
40	24.10	19.80	19.98	0.00	0.00	0.00	0.00	2.68	0.00	
41	24.60	20.10	22.09	13.65	0.00	0.00	0.00	0.00	0.00	
42	23.41	20.80	25.26	0.00	0.00	0.00	6.28	0.00	0.00	
43	20.54	24.60	19.82	11.87	0.00	0.00	0.00	0.00	0.00	
44	16.40	24.10	22.01	0.00	0.00	0.00	6.37	0.00	0.00	
45	24.10	24.60	18.98	0.00	0.00	0.00	0.00	0.00	0.00	
46	23.60	28.60	28.64	9.47	9.47	0.00	0.00	2.18	0.00	
47	19.21	24.10	19.67	0.00	0.00	0.00	0.00	0.00	0.00	
48	23.64	23.60	28.41	0.00	0.00	0.00	0.00	2.68	0.00	
49	20.89	28.60	24.16	0.00	0.00	0.00	0.00	0.00	0.00	
50	20.14	24.70	15.81	0.00	0.00	0.00	7.07	0.00	0.00	
51	24.56	20.40	23.57	10.19	0.00	0.00	0.00	2.47	0.00	
52	23.48	21.60	20.04	0.00	0.00	0.00	0.00	0.00	2.53	
53	24.60	20.40	25.65	0.00	0.00	0.00	0.00	0.00	0.00	
54	16.20	29.80	15.54	0.00	0.00	0.00	6.47	0.00	0.00	
55	18.20	24.60	17.09	12.13	0.00	0.00	0.00	2.38	0.00	
56	18.30	16.20	18.98	0.00	0.00	0.00	0.00	0.00	0.00	
57	28.70	18.20	22.39	0.00	0.00	8.47	0.00	0.00	0.00	
58	27.10	29.80	20.04	0.00	0.00	0.00	0.00	0.00	0.00	
59	22.60	24.60	15.56	0.00	9.31	0.00	0.00	2.17	0.00	
60	19.40	16.20	20.00	10.33	0.00	0.00	0.00	0.00	0.00	
TOTAL	1372	1384	1193.3	224.12	73.36	24.51	68.11	22.49	18.94	2585
AVG	22.83	22.46	19.47	9.57	9.48	8.67	6.38	2.41	2.11	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : METODA GIDC TO KATARIYA SHOWROM										
DATE : 06-02-22 SUNDAY TIME : 7 TO 8 PM				SPOT SPEED SURVEY						
MIN	4w	2W	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	29.83	25.73	25.83	0.00	0.00	0.00	0.00	0.00	0.00	
2	23.03	21.93	22.03	11.39	0.00	0.00	6.74	2.84	0.00	
3	26.53	24.73	24.83	0.00	0.00	0.00	0.00	0.00	0.00	
4	20.13	20.33	20.43	0.00	0.00	0.00	0.00	0.00	0.00	
5	22.83	22.23	22.33	0.00	0.00	0.00	0.00	0.00	2.16	
6	23.33	26.23	26.33	0.00	0.00	0.00	0.00	0.00	0.00	
7	22.63	22.23	22.33	0.00	0.00	10.58	0.00	0.00	0.00	
8	23.83	21.13	21.23	10.86	0.00	0.00	0.00	0.00	0.00	
9	24.33	26.73	26.83	0.00	0.00	0.00	7.14	0.00	0.00	
10	26.27	26.23	26.33	0.00	0.00	0.00	0.00	0.00	0.00	
11	23.13	25.73	25.83	0.00	0.00	0.00	7.39	0.00	0.00	
12	25.91	30.73	30.83	12.09	0.00	0.00	0.00	0.00	0.00	
13	26.33	26.83	26.93	0.00	0.00	0.00	0.00	0.00	0.00	
14	21.63	22.53	22.63	0.00	12.45	0.00	0.00	0.00	0.00	
15	29.43	23.73	23.83	0.00	0.00	0.00	0.00	0.00	0.00	
16	26.83	22.53	22.63	0.00	0.00	0.00	0.00	0.00	0.00	
17	29.43	31.93	32.03	11.08	0.00	0.00	0.00	0.00	0.00	
18	26.83	26.73	26.83	0.00	11.47	0.00	0.00	0.00	0.00	
19	21.53	18.33	18.43	0.00	0.00	0.00	0.00	0.00	0.00	
20	22.63	20.33	20.43	0.00	13.47	0.00	0.00	0.00	0.00	
21	30.93	31.93	32.03	0.00	0.00	0.00	5.27	0.00	0.00	
22	29.33	26.73	26.83	0.00	0.00	0.00	0.00	0.00	0.00	
23	24.83	18.33	18.43	12.08	11.08	0.00	0.00	0.00	0.00	
24	21.63	23.39	23.49	0.00	0.00	0.00	0.00	2.61	0.00	
25	29.43	25.72	25.82	0.00	0.00	0.00	0.00	0.00	0.00	
26	26.83	26.28	26.38	0.00	0.00	0.00	0.00	0.00	0.00	
27	21.53	25.58	25.68	0.00	0.00	0.00	0.00	0.00	0.00	
28	22.63	22.71	22.81	11.87	0.00	0.00	0.00	0.00	0.00	
29	29.83	29.77	29.87	0.00	0.00	9.47	0.00	0.00	2.11	
30	22.83	26.28	26.38	0.00	0.00	0.00	0.00	0.00	0.00	
31	24.33	26.73	26.83	0.00	0.00	0.00	0.00	0.00	0.00	
32	26.27	20.33	20.43	0.00	0.00	0.00	6.34	0.00	0.00	
33	23.13	26.73	26.83	0.00	13.29	0.00	0.00	2.71	0.00	
34	25.91	21.23	21.33	11.24	0.00	0.00	0.00	0.00	0.00	
35	26.33	22.73	22.83	0.00	12.26	0.00	0.00	0.00	0.00	
36	26.33	23.23	23.33	0.00	0.00	0.00	0.00	0.00	0.00	
37	26.83	31.81	31.91	12.39	0.00	0.00	0.00	0.00	0.00	
38	25.64	30.83	30.93	0.00	0.00	0.00	0.00	0.00	0.00	
39	22.77	20.63	20.73	10.28	0.00	0.00	0.00	0.00	0.00	
40	18.63	29.73	29.83	0.00	0.00	0.00	0.00	0.00	0.00	
41	26.33	30.73	30.83	0.00	0.00	0.00	0.00	0.00	0.00	
42	25.83	26.83	26.93	0.00	11.54	0.00	6.18	0.00	0.00	
43	21.44	31.93	32.03	0.00	0.00	0.00	0.00	0.00	0.00	
44	26.83	26.73	26.83	12.76	0.00	0.00	6.28	0.00	0.00	
45	26.83	22.23	22.33	0.00	12.08	0.00	0.00	0.00	0.00	
46	20.43	25.73	25.83	0.00	0.00	0.00	0.00	2.54	0.00	
47	20.53	21.93	22.03	12.64	0.00	0.00	0.00	0.00	0.00	
48	26.33	22.23	22.33	0.00	0.00	0.00	0.00	0.00	0.00	
49	22.33	22.93	23.03	13.28	0.00	0.00	0.00	0.00	0.00	
50	26.33	26.73	26.83	0.00	0.00	0.00	0.00	0.00	0.00	
51	25.83	26.23	26.33	11.86	0.00	0.00	0.00	2.94	0.00	
52	32.03	26.73	26.83	0.00	0.00	0.00	5.64	0.00	0.00	
53	26.83	30.73	30.83	0.00	0.00	0.00	0.00	0.00	0.00	
54	28.33	26.23	26.33	0.00	0.00	0.00	0.00	0.00	0.00	
55	20.43	25.73	25.83	13.07	0.00	0.00	0.00	0.00	0.00	
56	20.53	31.93	32.03	0.00	0.00	0.00	0.00	0.00	0.00	
57	26.33	26.73	26.83	0.00	0.00	0.00	0.00	0.00	0.00	
58	22.33	31.93	32.03	0.00	0.00	0.00	0.00	0.00	0.00	
59	23.03	26.73	26.83	0.00	12.97	0.00	5.39	2.71	0.00	
60	24.83	22.23	22.33	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1496	1531	1536.80	166.89	110.6	20.05	56.37	16.35	4.27	1402
AVG	24.93	25.51	25.84	22.57	11.94	12.48	10.68	7.11	2.61	2.13

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 06-02-22 SUNDAY TIME : 5 TO 6 AM				SPOT SPEED SURVEY						
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	27.38	20.50	19.00	0.00	0.00	0.00	0.00	0.00	0.00	
2	28.61	19.60	21.70	0.00	0.00	0.00	0.00	0.00	0.00	
3	29.61	28.70	22.20	10.26	11.27	0.00	0.00	0.00	0.00	
4	25.71	29.70	22.00	0.00	12.63	0.00	0.00	2.37	0.00	
5	21.41	25.80	14.79	0.00	0.00	0.00	0.00	0.00	0.00	
6	22.61	21.50	16.50	0.00	0.00	0.00	0.00	0.00	0.00	
7	27.61	22.70	17.30	0.00	0.00	0.00	0.00	0.00	0.00	
8	30.41	21.50	19.30	0.00	10.59	0.00	0.00	0.00	0.00	
9	25.11	30.90	28.70	0.00	0.00	0.00	0.00	0.00	0.00	
10	25.61	25.70	29.70	13.58	0.00	0.00	0.00	0.00	0.00	
11	25.11	17.30	25.80	0.00	13.06	0.00	0.00	0.00	0.00	
12	25.61	19.30	21.50	0.00	0.00	0.00	0.00	2.64	0.00	
13	17.41	30.90	22.70	0.00	0.00	0.00	0.00	0.00	0.00	
14	25.11	25.70	27.70	0.00	0.00	0.00	0.00	2.84	0.00	
15	24.61	17.30	30.50	0.00	0.00	0.00	0.00	0.00	0.00	
16	30.81	19.30	20.50	0.00	0.00	0.00	0.00	0.00	0.00	
17	25.61	28.70	17.22	0.00	0.00	0.00	0.00	0.00	0.00	
18	17.21	29.70	20.99	11.22	0.00	0.00	6.38	0.00	0.00	
19	19.21	25.80	17.22	0.00	0.00	0.00	0.00	2.85	0.00	
20	30.81	21.50	26.75	0.00	10.89	0.00	0.00	0.00	0.00	
21	25.61	22.70	16.64	0.00	0.00	0.00	0.00	0.00	0.00	
22	17.21	27.70	18.19	0.00	11.67	0.00	7.81	0.00	0.00	
23	19.21	30.50	17.30	0.00	0.00	0.00	0.00	0.00	0.00	
24	19.31	20.50	19.30	10.36	0.00	0.00	0.00	0.00	0.00	
25	29.71	19.60	19.40	0.00	13.07	0.00	0.00	0.00	0.00	
26	28.11	28.70	29.80	0.00	0.00	0.00	0.00	0.00	0.00	
27	23.61	29.70	28.20	0.00	0.00	0.00	0.00	0.00	0.00	
28	20.41	25.80	23.70	13.06	11.49	0.00	0.00	2.74	0.00	
29	30.81	21.50	20.50	0.00	0.00	0.00	0.00	0.00	0.00	
30	25.61	22.70	18.80	0.00	0.00	0.00	0.00	0.00	0.00	
31	25.61	21.50	23.19	0.00	0.00	0.00	5.74	0.00	0.00	
32	19.21	21.50	15.46	0.00	0.00	0.00	0.00	0.00	0.00	
33	19.31	30.90	20.92	0.00	14.27	0.00	0.00	0.00	0.00	
34	25.11	25.70	20.81	0.00	0.00	0.00	6.83	0.00	0.00	
35	21.11	21.20	16.77	0.00	0.00	0.00	0.00	0.00	0.00	
36	21.81	24.70	13.61	0.00	10.78	0.00	0.00	0.00	0.00	
37	23.61	20.90	20.77	11.56	0.00	0.00	0.00	0.00	0.00	
38	28.61	21.20	12.34	0.00	0.00	0.00	6.39	0.00	0.00	
39	21.81	21.90	21.14	0.00	0.00	0.00	0.00	0.00	0.00	
40	25.31	25.70	26.75	10.26	10.98	0.00	0.00	0.00	2.14	
41	18.91	25.20	16.64	0.00	0.00	0.00	0.00	0.00	0.00	
42	21.61	25.70	18.19	0.00	0.00	0.00	6.71	0.00	0.00	
43	22.11	29.70	20.08	0.00	0.00	0.00	0.00	0.00	0.00	
44	21.91	25.20	11.98	0.00	0.00	0.00	0.00	0.00	0.00	
45	29.41	24.70	12.34	13.71	11.27	0.00	0.00	2.61	0.00	
46	18.91	30.90	16.50	0.00	0.00	0.00	0.00	0.00	0.00	
47	19.51	25.70	20.77	0.00	12.47	9.68	0.00	0.00	0.00	
48	28.61	20.50	28.70	11.09	0.00	0.00	5.79	0.00	0.00	
49	29.61	19.30	29.70	0.00	0.00	0.00	0.00	2.31	2.13	
50	25.71	25.70	25.80	0.00	0.00	0.00	0.00	0.00	0.00	
51	21.41	28.70	21.50	0.00	0.00	0.00	0.00	0.00	0.00	
52	22.61	29.70	22.70	0.00	0.00	9.47	6.48	0.00	0.00	
53	21.41	25.20	21.50	0.00	0.00	0.00	0.00	2.61	0.00	
54	22.61	24.70	22.70	0.00	10.78	0.00	0.00	0.00	0.00	
55	23.11	30.90	23.20	0.00	0.00	0.00	7.07	0.00	0.00	
56	23.11	25.70	21.14	0.00	0.00	0.00	0.00	0.00	0.00	
57	21.91	20.50	26.75	0.00	0.00	0.00	0.00	0.00	0.00	
58	25.71	21.20	16.64	0.00	12.96	9.18	6.87	0.00	0.00	
59	25.11	20.70	18.19	12.87	0.00	0.00	0.00	0.00	2.13	
60	21.61	25.70	20.08	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1442	1472	1260.76	117.97	178.2	28.33	66.07	20.97	6.39	1433
Avg.	24.04	24.85	21.58	12.98	12.74	9.87	6.46	2.61	2.13	

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 06-02-22 SUNDAY TIME : 6 TO 7 AM			SPOT SPEED SURVEY							
MIN	4w	2w	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	24.10	25.72	20.94	0.00	9.37	0.00	0.00	0.00	0.00	
2	23.60	26.48	18.21	0.00	0.00	0.00	6.74	0.00	0.00	
3	24.60	25.22	12.28	14.23	0.00	0.00	0.00	0.00	0.00	
4	23.41	24.72	12.04	0.00	0.00	0.00	0.00	2.68	0.00	
5	19.96	26.08	20.60	0.00	0.00	0.00	0.00	0.00	0.00	
6	20.68	25.82	24.53	0.00	0.00	0.00	0.00	0.00	0.00	
7	24.10	21.52	20.42	13.66	0.00	0.00	0.00	0.00	0.00	
8	23.60	22.72	21.52	0.00	10.86	0.00	0.00	0.00	0.00	
9	19.21	21.52	19.02	0.00	0.00	0.00	6.94	0.00	0.00	
10	23.64	27.48	21.72	0.00	0.00	0.00	0.00	0.00	0.00	
11	20.89	25.72	22.22	0.00	0.00	0.00	0.00	0.00	0.00	
12	18.70	17.32	22.02	0.00	0.00	0.00	0.00	2.38	0.00	
13	17.94	25.82	21.23	0.00	0.00	0.00	0.00	0.00	0.00	
14	25.61	21.29	16.52	0.00	0.00	0.00	5.98	0.00	0.00	
15	24.60	25.72	18.00	0.00	11.76	0.00	0.00	0.00	0.00	
16	19.30	21.22	16.33	11.28	0.00	0.00	0.00	0.00	0.00	
17	20.40	24.72	21.77	0.00	0.00	0.00	0.00	0.00	0.00	
18	17.90	20.92	18.29	13.58	0.00	0.00	5.83	0.00	0.00	
19	20.60	21.22	19.82	0.00	0.00	0.00	0.00	2.75	0.00	
20	21.10	21.92	17.09	0.00	0.00	0.00	0.00	0.00	0.00	
21	19.87	25.72	11.16	0.00	0.00	8.64	0.00	0.00	0.00	
22	20.07	21.14	10.92	0.00	10.28	0.00	0.00	0.00	0.00	
23	24.65	25.72	19.48	12.33	0.00	0.00	0.00	0.00	0.00	
24	24.10	27.03	23.41	0.00	0.00	0.00	0.00	2.68	0.00	
25	23.60	25.22	19.30	0.00	0.00	0.00	0.00	0.00	0.00	
26	19.21	24.72	20.40	0.00	11.47	0.00	6.18	0.00	0.00	
27	20.60	26.36	17.90	14.87	0.00	0.00	0.00	0.00	0.00	
28	21.10	24.60	20.60	0.00	12.56	0.00	0.00	2.96	0.00	
29	19.87	16.20	21.10	0.00	0.00	0.00	0.00	0.00	0.00	
30	20.14	24.70	20.90	0.00	0.00	0.00	0.00	0.00	0.00	
31	23.86	20.17	20.11	0.00	0.00	0.00	6.17	0.00	0.00	
32	24.56	24.60	15.40	13.69	0.00	9.17	0.00	0.00	0.00	
33	21.60	20.10	16.88	0.00	11.63	0.00	0.00	0.00	0.00	
34	17.90	23.60	15.21	0.00	0.00	0.00	0.00	0.00	0.00	
35	18.50	19.80	20.65	0.00	0.00	0.00	0.00	0.00	0.00	
36	19.67	20.10	17.17	0.00	0.00	0.00	0.00	0.00	0.00	
37	22.14	20.80	11.87	0.00	0.00	0.00	0.00	0.00	0.00	
38	23.56	24.60	19.71	0.00	12.07	0.00	0.00	0.00	0.00	
39	21.10	20.02	22.01	0.00	0.00	0.00	0.00	0.00	0.00	
40	19.91	24.60	12.51	11.08	11.59	0.00	6.81	2.48	2.72	
41	20.86	25.91	27.20	0.00	0.00	0.00	0.00	0.00	0.00	
42	23.71	24.10	24.60	0.00	0.00	0.00	0.00	2.68	0.00	
43	21.04	23.60	19.30	0.00	0.00	0.00	0.00	0.00	0.00	
44	24.29	24.28	20.40	0.00	12.09	0.00	7.12	0.00	0.00	
45	21.45	24.60	17.90	0.00	0.00	8.64	0.00	0.00	2.34	
46	27.60	18.50	20.60	0.00	0.00	0.00	0.00	0.00	0.00	
47	20.34	27.60	21.10	0.00	0.00	0.00	0.00	2.27	0.00	
48	19.53	24.28	20.90	0.00	11.68	0.00	0.00	0.00	0.00	
49	20.50	24.70	19.67	12.55	0.00	0.00	7.14	0.00	0.00	
50	24.30	20.40	15.40	0.00	0.00	0.00	0.00	0.00	0.00	
51	20.16	21.60	14.42	0.00	11.74	0.00	0.00	0.00	0.00	
52	23.25	20.40	18.98	0.00	0.00	0.00	5.97	0.00	0.00	
53	24.67	21.52	16.28	13.08	0.00	0.00	0.00	0.00	0.00	
54	29.80	22.72	11.24	0.00	13.08	0.00	0.00	0.00	0.00	
55	24.60	21.52	14.06	0.00	0.00	0.00	0.00	0.00	0.00	
56	24.60	22.59	19.67	0.00	0.00	0.00	0.00	0.00	0.00	
57	18.20	27.63	24.10	0.00	0.00	0.00	0.00	2.38	0.00	
58	20.22	28.73	23.60	0.00	12.57	10.58	6.47	0.00	0.00	
59	24.10	21.26	24.10	0.00	0.00	0.00	0.00	0.00	[illegible]	
60	20.10	28.68	23.60	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1313	1408	1138.4	130.35	162.8	37.03	71.35	23.26	7.20	2336
AVG	22.77	23.17	20.74	11.85	11.39	8.61	6.27	2.42	2.11	

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DIRECTION : KATARIYA SHOWROOM TO METODA GIDC										
DATE : 06-02-22 SUNDAY TIME : 7 TO 8 AM				SPOT SPEED SURVEY						
MIN	4w	2W	rikshaw	truck	bus	tractor	cycle	pedestain	other vehicles	
1	25.20	26.82	22.04	0.00	9.37	0.00	0.00	0.00	0.00	
2	24.70	27.58	19.31	0.00	0.00	0.00	0.00	0.00	0.00	
3	25.70	26.32	13.38	11.24	0.00	0.00	0.00	0.00	0.00	
4	24.51	25.82	13.14	0.00	0.00	0.00	0.00	2.37	0.00	
5	21.06	27.18	21.70	0.00	0.00	0.00	0.00	0.00	0.00	
6	21.78	26.92	25.63	12.39	0.00	0.00	0.00	0.00	0.00	
7	25.20	22.62	21.52	0.00	0.00	0.00	0.00	0.00	0.00	
8	24.70	23.82	22.62	10.28	10.86	0.00	0.00	0.00	0.00	
9	20.31	22.62	20.12	0.00	0.00	0.00	0.00	2.45	0.00	
10	24.74	28.58	22.82	0.00	0.00	0.00	0.00	0.00	0.00	
11	21.99	26.82	23.32	0.00	0.00	0.00	0.00	0.00	0.00	
12	19.80	18.42	23.12	0.00	0.00	0.00	5.24	2.97	0.00	
13	19.04	26.92	22.33	12.76	0.00	0.00	0.00	0.00	0.00	
14	26.71	22.39	17.62	0.00	0.00	0.00	0.00	0.00	0.00	
15	25.70	26.82	19.10	0.00	11.76	0.00	0.00	0.00	0.00	
16	20.40	22.32	17.43	12.64	0.00	0.00	0.00	0.00	0.00	
17	21.50	25.82	22.87	0.00	0.00	0.00	0.00	0.00	0.00	
18	19.00	22.02	19.39	13.28	0.00	0.00	6.63	0.00	0.00	
19	21.70	22.32	20.92	0.00	0.00	0.00	0.00	3.04	0.00	
20	22.20	23.02	18.19	11.86	0.00	0.00	0.00	0.00	0.00	
21	20.97	26.82	12.26	0.00	0.00	0.00	0.00	0.00	0.00	
22	21.17	22.24	12.02	0.00	10.28	0.00	0.00	2.98	0.00	
23	25.75	26.82	20.58	0.00	0.00	0.00	0.00	0.00	0.00	
24	25.20	28.13	24.51	13.07	0.00	0.00	0.00	0.00	0.00	
25	24.70	26.32	20.40	0.00	0.00	0.00	0.00	0.00	0.00	
26	20.31	25.82	21.50	0.00	11.47	0.00	0.00	0.00	0.00	
27	21.70	27.46	19.00	0.00	0.00	0.00	0.00	0.00	0.00	
28	22.20	25.70	21.70	0.00	0.00	0.00	0.00	2.34	0.00	
29	20.97	17.30	22.20	0.00	0.00	0.00	0.00	0.00	0.00	
30	21.24	25.80	22.00	0.00	0.00	0.00	0.00	0.00	0.00	
31	24.96	21.27	21.21	11.39	0.00	0.00	6.71	2.38	0.00	
32	25.66	25.70	16.50	0.00	0.00	0.00	0.00	0.00	0.00	
33	22.70	21.20	17.98	0.00	11.63	0.00	0.00	0.00	0.00	
34	19.00	24.70	16.31	0.00	0.00	0.00	0.00	0.00	0.00	
35	19.60	20.90	21.75	0.00	0.00	0.00	0.00	0.00	0.00	
36	20.77	21.20	18.27	0.00	0.00	0.00	0.00	0.00	0.00	
37	23.24	21.90	12.97	10.86	0.00	0.00	0.00	2.34	0.00	
38	24.66	25.70	20.81	0.00	12.07	0.00	0.00	0.00	0.00	
39	22.20	21.12	23.11	0.00	0.00	0.00	0.00	0.00	0.00	
40	21.01	25.70	13.61	0.00	11.59	0.00	0.00	0.00	2.01	
41	21.96	27.01	28.30	12.09	0.00	0.00	0.00	0.00	0.00	
42	24.81	25.20	25.70	0.00	0.00	0.00	6.17	0.00	0.00	
43	22.14	24.70	20.40	0.00	0.00	0.00	0.00	0.00	0.00	
44	25.39	25.38	21.50	0.00	12.09	0.00	0.00	0.00	0.00	
45	22.55	25.70	19.00	0.00	0.00	0.00	0.00	2.65	0.00	
46	28.70	19.60	21.70	11.08	0.00	0.00	5.35	0.00	0.00	
47	21.44	28.70	22.20	0.00	0.00	0.00	0.00	2.41	0.00	
48	20.63	25.38	22.00	0.00	11.68	0.00	6.28	0.00	0.00	
49	21.60	25.80	20.77	0.00	0.00	0.00	0.00	0.00	0.00	
50	25.40	21.50	16.50	0.00	0.00	0.00	0.00	0.00	0.00	
51	21.26	22.70	15.52	0.00	11.74	0.00	6.42	0.00	0.00	
52	24.35	21.50	20.08	12.08	0.00	0.00	0.00	0.00	0.00	
53	25.77	22.62	17.38	0.00	0.00	0.00	0.00	3.04	0.00	
54	30.90	23.82	12.34	0.00	13.08	0.00	6.71	0.00	0.00	
55	25.70	22.62	15.16	0.00	0.00	0.00	0.00	2.61	0.00	
56	25.70	23.69	20.77	0.00	0.00	0.00	7.14	0.00	0.00	
57	19.30	28.73	25.20	11.87	0.00	0.00	0.00	0.00	0.00	
58	21.32	29.83	24.70	0.00	0.00	9.67	0.00	0.00	0.00	
59	25.20	22.36	25.20	0.00	0.00	0.00	6.47	0.00	2.24	
60	21.20	29.78	24.70	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	1379	1474	1204.36	166.89	137.6	9.67	63.12	31.58	4.13	1321
AVG	24.61	25.94	22.67	12.84	12.69	9.67	6.42	2.42	2.11	

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CHAPTER- 5 ACCIDENT DATA ANALYSIS

"The increasing number of road and traffic accidents is a challenging issue to the transportation systems. It not only concern with health issues but also associated with economic burden on the society". Therefore, "it is an important task for the safety analysis to carry out a comparative study of road accidents to identify the factors that causes an accident to happen, so that preventive actions can be taken to overcome the accident rate and severity of accidents".

		ACCIDENT DATA	2017				
VEHICLES	MONTHS	NUMBER OF ACCIDENT		LOCATION		TYPES OFINJURIES	DAY - NIGHT
2-WHEELER	JANUARY	0				FATAL	DAY
5	FEBRUARY	1		2	HARIPAR PATIYU PAL	4	7
	MARTH	0		4	KANKOT PATIYU		
3-WHEELER	APRIL	1		3	KATARIYA CHOKDI	SERIOUS	NIGHT
1	MAY	0		0	COSMOPLEX	2	3
	JUNE	2		1	ESCONE TEMPLE		
4-WHEELER	JULY	3				MINORE	MALE
3	AUGUST	1				2	8
	SEPTMBER	0					
BUS & TRUCK	OCTOMBER	0				NO INJURED	FEMALE
1	NOVEMBER	2				2	2
	DESEMBER	0					
	TOTAL	10					

Figure 5.1

		ACCIDENT DATA	2018				
VEHICLES	MONTHS	NUMBER OF ACCIDENT		LOCATION		TYPES OFINJURIES	DAY - NIGHT
2-WHEELER	JANUARY	0				FATAL	DAY
6	FEBRUARY	1		2	HARIPAR PATIYU PAL	5	9
	MARTH	2		6	KANKOT PATIYU		
3-WHEELER	APRIL	2		2	KATARIYA CHOKDI	SERIOUS	NIGHT
2	MAY	0		1	COSMOPLEX	3	4
	JUNE	3		2	ESCONE TEMPLE		
4-WHEELER	JULY	2				MINORE	MALE
4	AUGUST	2				4	12
	SEPTMBER	0					
BUS & TRUCK	OCTOMBER	0				NO INJURED	FEMALE
1	NOVEMBER	1				1	1
	DESEMBER	0					
	TOTAL	13					

Figure 5.2

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		ACCIDENT DATA	2019				
VEHICLES	MONTHS	NUMBER OF ACCIDENT		LOCATION		TYPES OFINJURIES	DAY - NIGHT
2-WHEELER	JANUARY	2				FATAL	DAY
4	FEBRUARY	1	1	HARIPAR PATIYU PAL		1	5
	MARTH	0	1	KANKOT PATIYU			
3-WHEELER	APRIL	0	4	KATARIYA CHOKDI		SERIOUS	NIGHT
0	MAY	1	2	COSMOPLEX		3	3
	JUNE	3	0	ESCONE TEMPLE			
4-WHEELER	JULY	0				MINORE	MALE
2	AUGUST	0				3	7
	SEPTMBER	1					
BUS & TRUCK	OCTOMBER	0				NO INJURED	FEMALE
2	NOVEMBER	0				1	1
	DESEMBER	0					
	TOTAL	8					

Figure 5.3

		ACCIDENT DATA	2020				
VEHICLES	MONTHS	NUMBER OF ACCIDENT		LOCATION		TYPES OFINJURIES	DAY - NIGHT
2-WHEELER	JANUARY	1				FATAL	DAY
3	FEBRUARY	0	1	HARIPAR PATIYU PAL		3	4
	MARTH	2	3	KANKOT PATIYU			
3-WHEELER	APRIL	0	2	KATARIYA CHOKDI		SERIOUS	NIGHT
1	MAY	0	1	COSMOPLEX		3	2
	JUNE	1	0	ESCONE TEMPLE			
4-WHEELER	JULY	0				MINORE	MALE
2	AUGUST	1				1	6
	SEPTMBER	0					
BUS & TRUCK	OCTOMBER	0				NO INJURED	FEMALE
1	NOVEMBER	2				0	1
	DESEMBER	0					
	TOTAL	7					

Figure 5.4

		ACCIDENT DATA	2021				
VEHICLES	MONTHS	NUMBER OF ACCIDENT		LOCATION		TYPES OFINJURIES	DAY - NIGHT
2-WHEELER	JANUARY	2				FATAL	DAY
4	FEBRUARY	1	1	HARIPAR PATIYU PAL		2	6
	MARTH	0	2	KANKOT PATIYU			
3-WHEELER	APRIL	2	4	KATARIYA CHOKDI		SERIOUS	NIGHT
2	MAY	0	1	COSMOPLEX		4	3
	JUNE	3	1	ESCONE TEMPLE			
4-WHEELER	JULY	0				MINORE	MALE
2	AUGUST	0				2	8
	SEPTMBER	1					
BUS & TRUCK	OCTOMBER	0				NO INJURED	FEMALE
1	NOVEMBER	0				1	1
	DESEMBER	0					
	TOTAL	9					

Figure 5.5

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The development of road transport in Rajkot city is very fast as compare to other city's. There is also increase in vehicle ownership and population in the rajkot city in few years.The accident data collected from rajkot taluka police station. These data has been extracted and analysed.

5.1 Fatality Rate based on Total Accidents

The fatality rate is also expressed as number of fatal accidents per 100 numbers of total accidents Year-wise fatality rate based on number of total accidents is calculated by the following formula.

FR = FA * 100 / TA

Where FR = Fatality rate

FA = Fatal Accidents

TA = Total Accidents

Fatality rate based on number of total accidents is represented in Table no. 4.5.1

Year	Total Accident	Fatal Accidents	Fatality Rate %	Average
2017	10	4	26.67	
2018	13	5	33.33	
2019	8	1	6.67	20%
2020	7	3	20.00	
2021	9	2	13.33	
Total	**47**	**15**	**100%**	**20%**

Table 5.1.1

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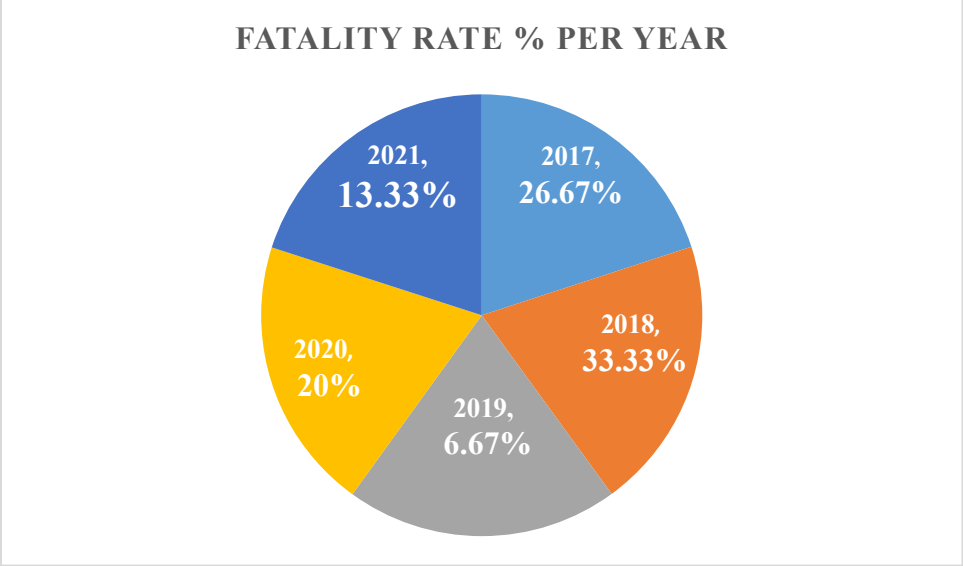

Figure 5.1.2

5.2 The accident data analyze as per types of injuries

The total road traffic accident within study area year from 2017 to 2021 are shows in table 5.2.1 and graphically in figure 5.2.2. The road traffic accidents are classified in fatal , serious , minore and not injured in types of accident.

During these 5 year the population raised but the number of total accidents and fatal accidents has remained approximately constant. Accidents classified according to year from 2017 to 2021.

No of accident as per types of injuries				
YEAR	FATAL	SERIOUS	MINORE	NO INJURED
2017	4	3	2	2
2018	5	3	4	1
2019	1	3	3	1
2020	3	4	1	0
2021	2	4	1	1
Total	**15**	**17**	**11**	**5**

Table 5.2.1

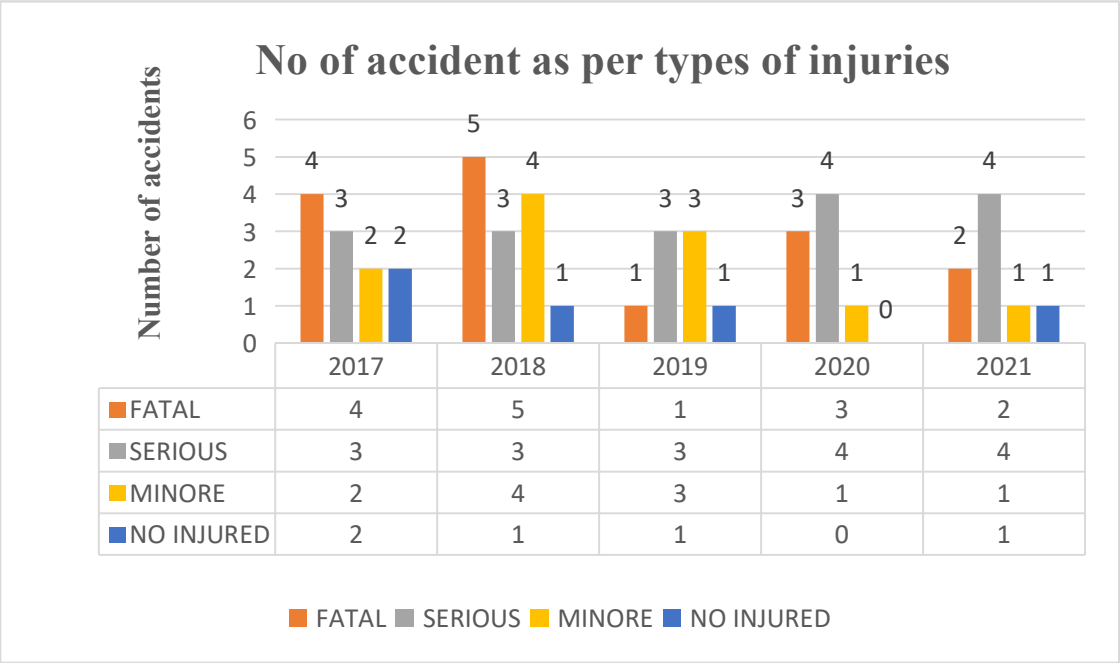

Figure 5.2.2

5.3 The accident data analyze as per months

Accident analyze as per months year from 2017 - 2021. Month wise accident data collected and compiled in table 5.3.1 to table 5.3.5 .

It shows monthly spectrum of accidents for year from 2017 to 2021 figure 5.3.7 to 5.3.11 give graphical representation of the accident data. This showing that the maximum number of total accident is reported in months of January and June. It is also seen that there is no variation are considerable.

Maximum number of fatal accidents occur in the month of June , because in these months due to foggy weather and poor visibility. Minimum or zero number of accident as observed in the monsoon month in may and august.

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ACIDDENT ANALYSIS AS PER MONTHS OF 2017					
MONTHS	FATAL	SERIOUS	MINORE	NO INJURED	TOTAL ACCIDENTS
JANUARY	0	0	0	0	0
FEBRUARY	1	0	0	0	1
MARTH	0	0	0	0	0
APRIL	0	0	1	0	1
MAY	0	0	0	0	0
JUNE	2	0	0	0	2
JULY	1	1	1	0	3
AUGUST	0	0	0	1	1
SEPTMBER	0	0	0	0	0
OCTOMBER	0	0	0	0	0
NOVEMBER	0	1	0	1	2
DESEMBER	0	0	0	0	0

Table 5.3.1

ACIDDENT ANALYSIS AS PER MONTHS OF 2018					
MONTHS	FATAL	SERIOUS	MINORE	NO INJURED	TOTAL ACCIDENTS
JANUARY	0	0	0	0	0
FEBRUARY	1	0	0	0	1
MARTH	0	1	1	0	2
APRIL	1	0	1	0	2
MAY	0	0	0	0	0
JUNE	2	1	0	0	3
JULY	0	0	2	0	2
AUGUST	0	1	0	1	2
SEPTMBER	0	0	0	0	0
OCTOMBER	0	0	0	0	0
NOVEMBER	1	0	0	0	1
DESEMBER	0	0	0	0	0

Table 5.3.2

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ACIDDENT ANALYSIS AS PER MONTHS OF 2019					
MONTHS	FATAL	SERIOUS	MINORE	NO INJURED	TOTAL ACCIDENTS
JANUARY	1	0	0	1	2
FEBRUARY	0	1	0	0	1
MARTH	0	0	0	0	0
APRIL	0	0	0	0	0
MAY	0	0	1	0	1
JUNE	0	1	2	0	3
JULY	0	0	0	0	0
AUGUST	0	0	0	0	0
SEPTMBER	0	1	0	0	1
OCTOMBER	0	0	0	0	0
NOVEMBER	0	0	0	0	0
DESEMBER	0	0	0	0	0

Table 5.3.3

ACIDDENT ANALYSIS AS PER MONTHS OF 2020					
MONTHS	FATAL	SERIOUS	MINORE	NO INJURED	TOTAL ACCIDENTS
JANUARY	1	0	0	0	1
FEBRUARY	0	0	0	0	0
MARTH	0	1	1	0	2
APRIL	0	0	0	0	0
MAY	0	0	0	0	0
JUNE	1	0	0	0	1
JULY	0	0	0	0	0
AUGUST	0	1	0	0	1
SEPTMBER	0	0	0	0	0
OCTOMBER	0	0	0	0	0
NOVEMBER	1	1	0	0	2
DESEMBER	0	0	0	0	0

Table 5.3.4

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ACIDDENT ANALYSIS AS PER MONTHS OF 2021					
MONTHS	FATAL	SERIOUS	MINORE	NO INJURED	TOTAL ACCIDENTS
JANUARY	1	0	1	0	2
FEBRUARY	0	1	0	0	1
MARTH	0	0	0	0	0
APRIL	0	2	0	0	2
MAY	0	0	0	0	0
JUNE	1	1	0	1	3
JULY	0	0	0	0	0
AUGUST	0	0	0	0	0
SEPTMBER	0	0	1	0	1
OCTOMBER	0	0	0	0	0
NOVEMBER	0	0	0	0	0
DESEMBER	0	0	0	0	0

Table 5.3.5

No. of Accident as per months						
Months	**2017**	**2018**	**2019**	**2020**	**2021**	
JANUARY	0	0	2	1	2	5
FEBRUARY	1	1	1	0	1	4
MARTH	0	2	0	2	0	4
APRIL	1	2	0	0	2	5
MAY	0	0	1	0	0	1
JUNE	2	3	3	1	3	12
JULY	3	2	0	0	0	5
AUGUST	1	2	0	1	0	4
SEPTMBER	0	0	1	0	1	2
OCTOMBER	0	0	0	0	0	0
NOVEMBER	2	1	0	2	0	5
DESEMBER	0	0	0	0	0	0
Total	**10**	**13**	**8**	**7**	**9**	**47**

Table 5.3.6

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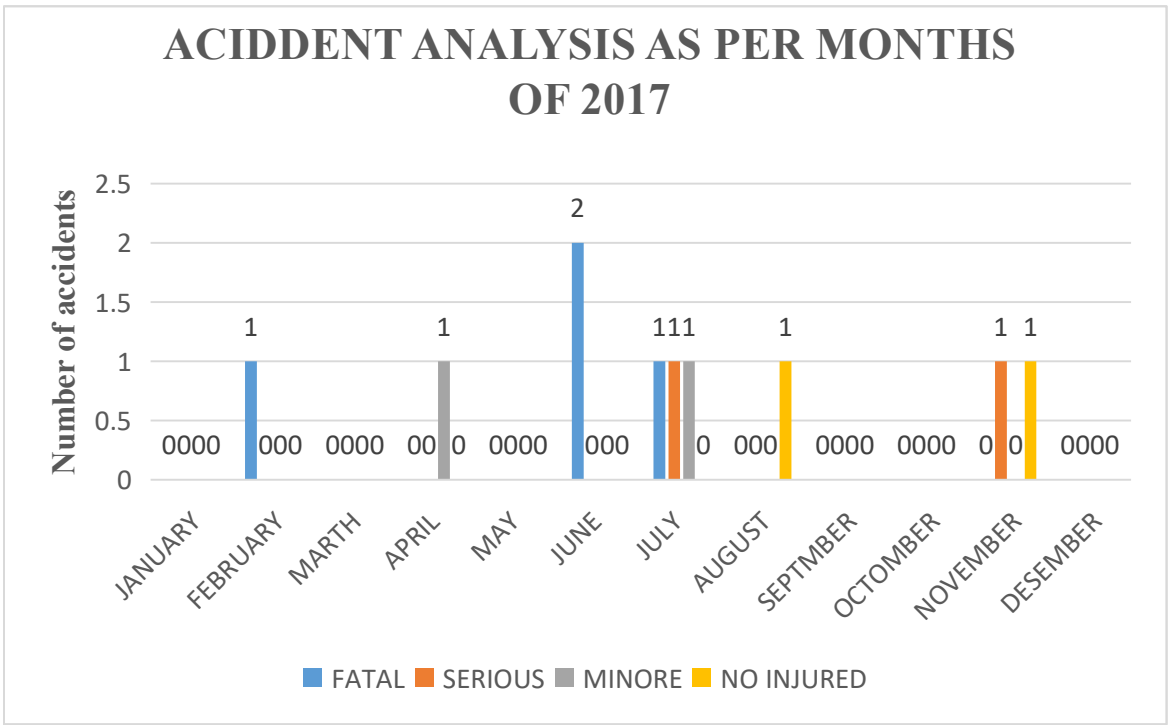

Figure 5.3.7

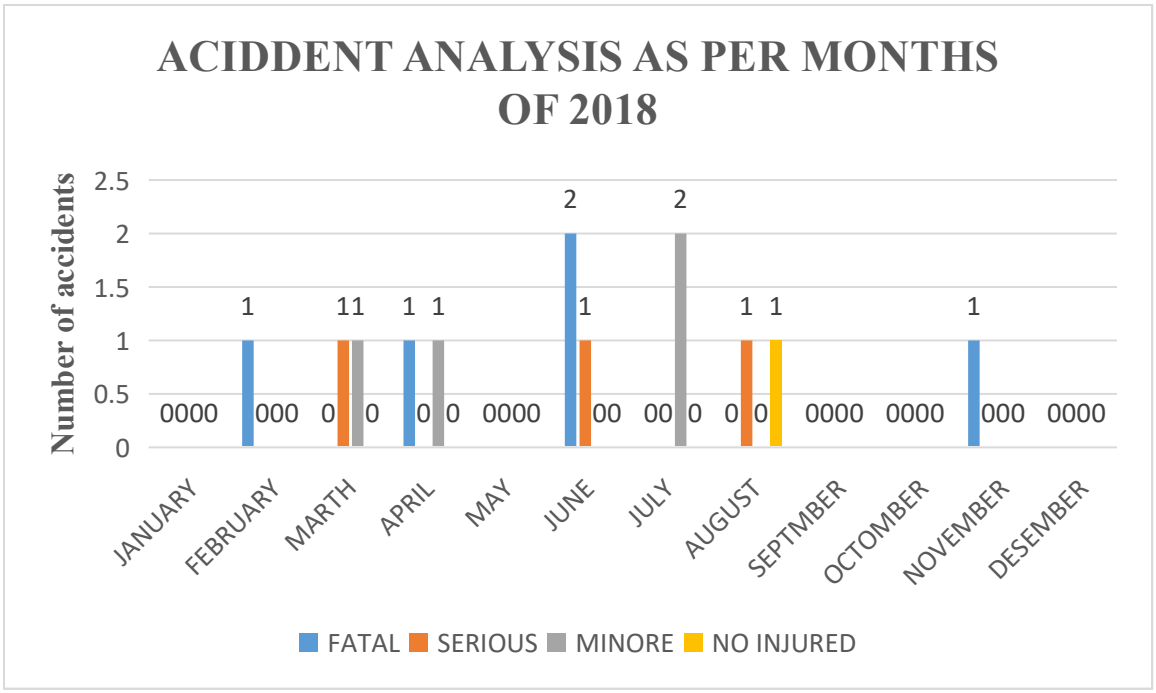

Figure 5.3.8

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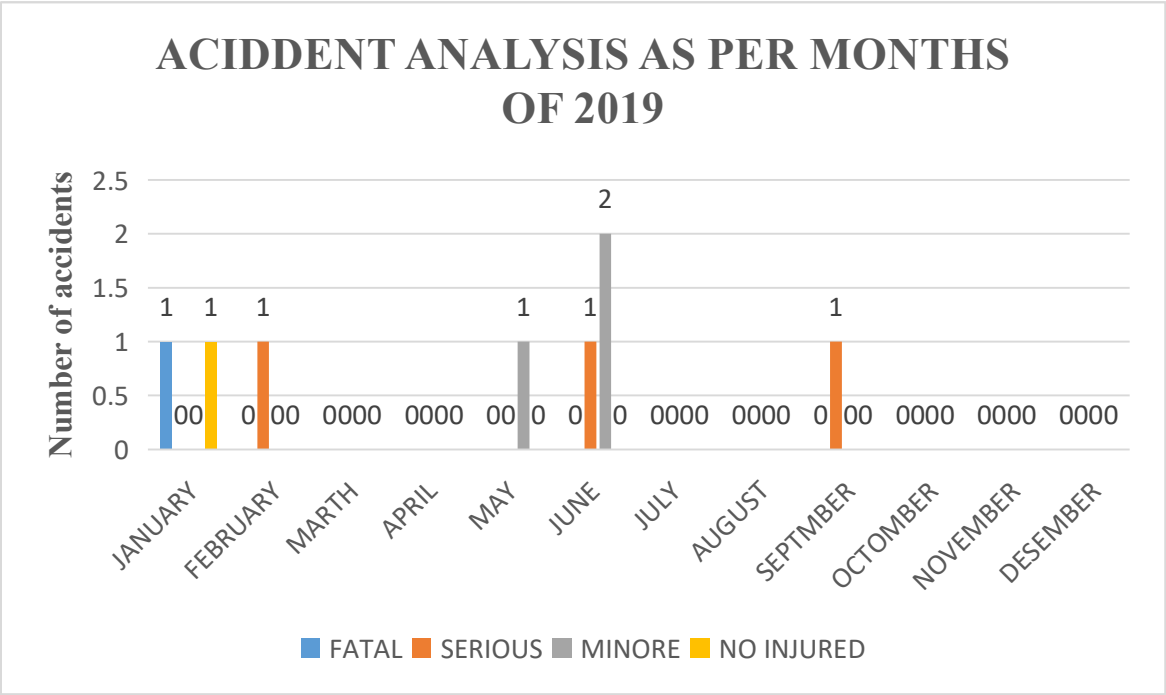

Figure 5.3.9

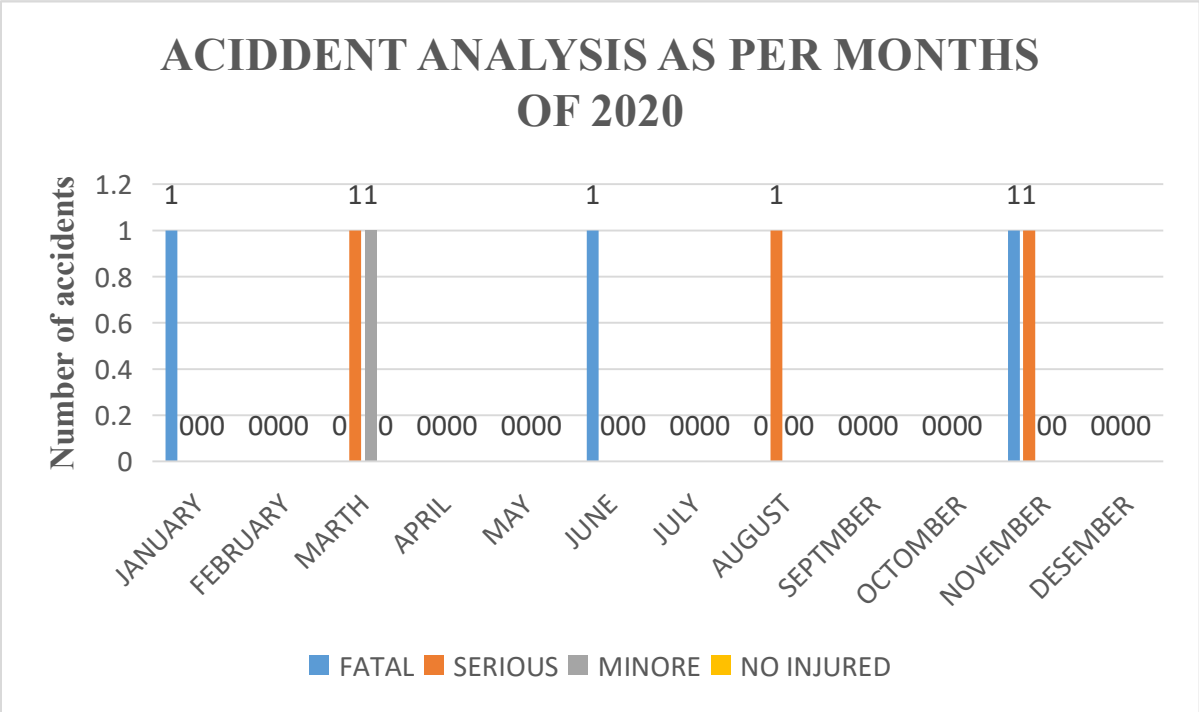

Figure 5.3.10

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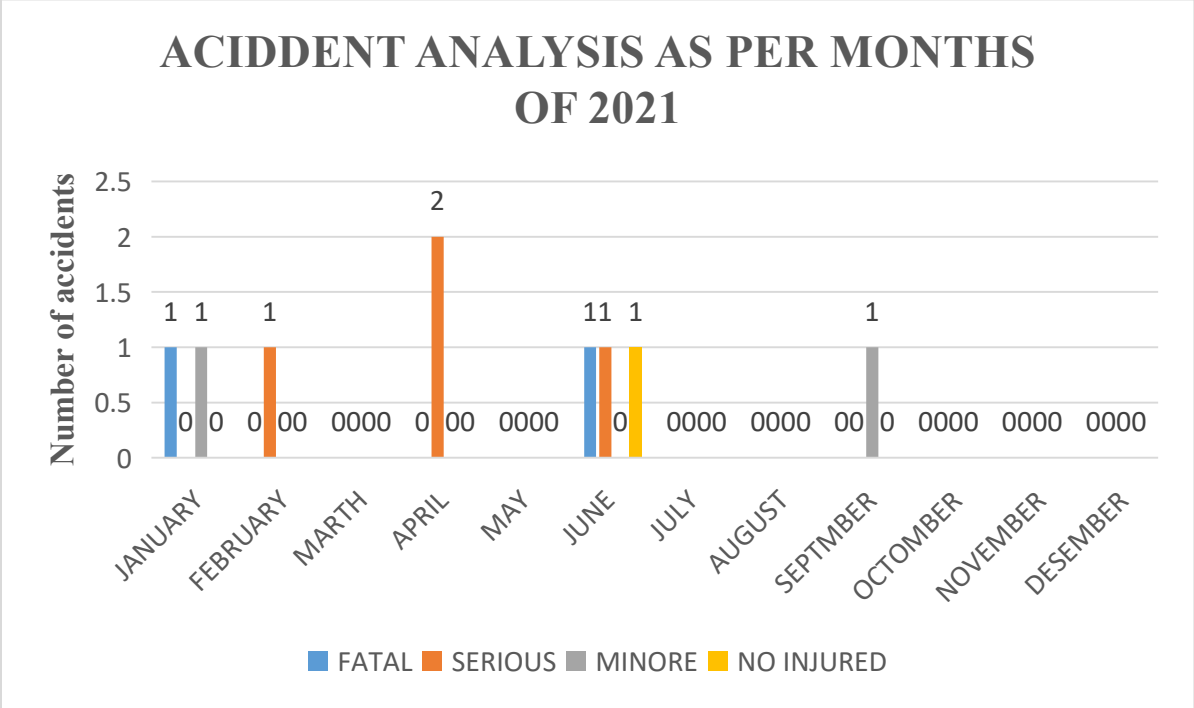

Figure 5.3.11

5.4 The accident data analyze as per time

Accident analyze as per times year from 2017 to 2021. when we considered the time in accident analysis, the most of accident are occur in day time. Table 5.4.1 to Table 5.4.5 shows hourly accident occur details from year 2017 to 2021.

Total number of accident is highest during 10 to 12 in morning and 5 to 8 in evening. It is clear that during peak the chances of accident are extremely high. during the peak hour volume of traffic will be high and it affects on the chances of road traffic accident.

The evening time is more phone to fatal accident especially from 6 to 7 because of poor visibility. Figure 5.4.7 to Figure 5.4.11 shows graphical representation for the same. In the accident analysis as per time the number of accident are high in day time as compare to night time.

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No. of accidents as per time	
Time	**2017**
6 am to 11:59am	4
12 pm to 5:59pm	3
6 pm to 11:59pm	2
12 am to 5:59 am	1
Total	**10**

Table 5.4.1

No. of accidents as per time	
Time	**2018**
6 am to 11:59am	4
12 pm to 5:59pm	3
6 pm to 11:59pm	4
12 am to 5:59 am	2
Total	**13**

Table 5.4.2

No. of accidents as per time	
Time	**2019**
6 am to 11:59am	2
12 pm to 5:59pm	1
6 pm to 11:59pm	3
12 am to 5:59 am	2
Total	**8**

Table 5.4.3

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No. of accidents as per time	
Time	**2020**
6 am to 11:59am	3
12 pm to 5:59pm	0
6 pm to 11:59pm	2
12 am to 5:59 am	2
Total	**7**

Table 5.4.4

No. of accidents as per time	
Time	**2021**
6 am to 11:59am	4
12 pm to 5:59pm	2
6 pm to 11:59pm	1
12 am to 5:59 am	2
Total	**9**

Table 5.4.5

No. of accidents as per time										
Time	**2017**		**2018**		**2019**		**2020**		**2021**	
	Fatal	**TA**	**Fatal**	**TA**	**Fatal**	**TA**	**Fatal**	**TA**	**Fatal**	**TA**
6 am to 11:59am	2	4	2	4	1	2	1	3	1	4
12 pm to 5:59pm	1	3	2	3	0	1	0	0	0	2
6 pm to 11:59pm	0	2	1	4	0	3	1	2	0	1
12 am to 5:59 am	1	1	0	2	0	2	1	2	1	2
Total	**4**	**10**	**5**	**13**	**1**	**8**	**3**	**7**	**2**	**9**

Table 5.4.6

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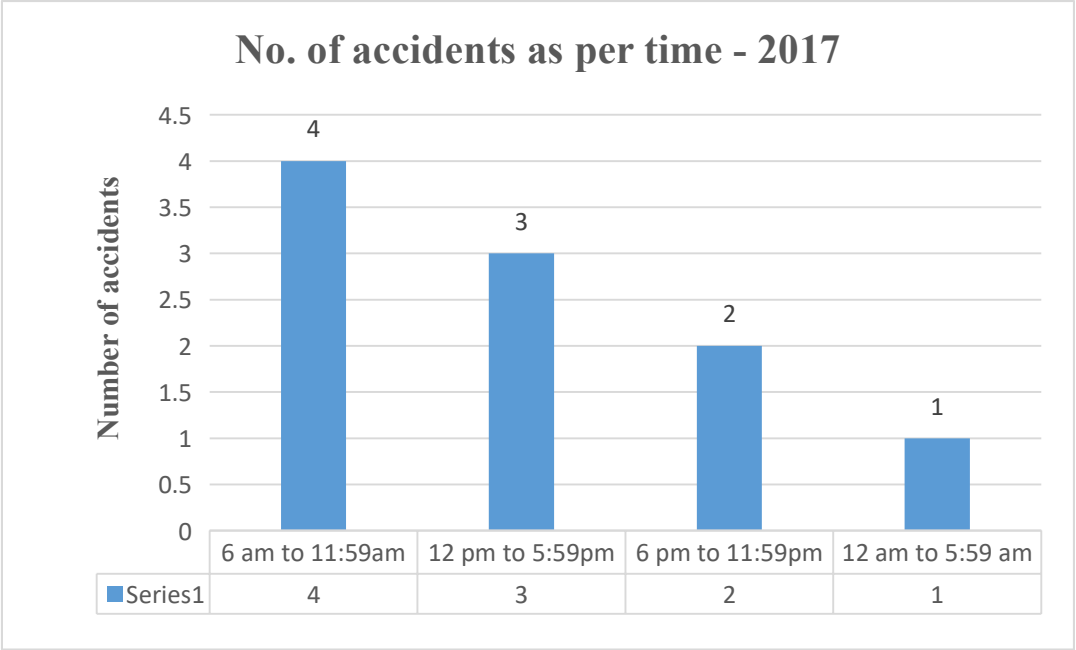

Figure 5.4.7

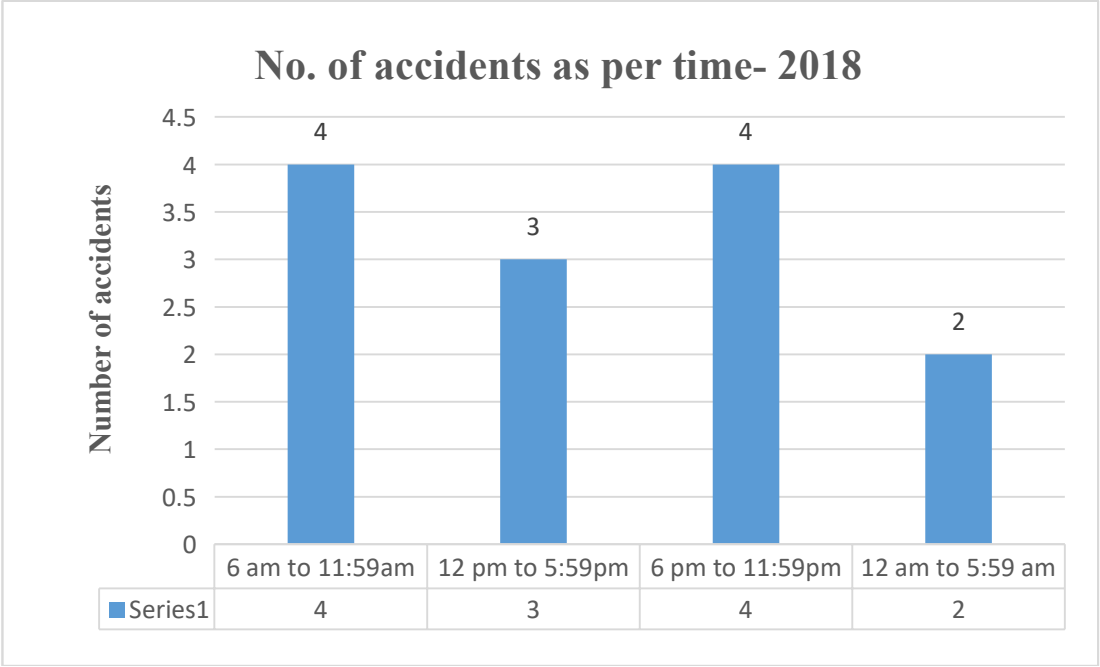

Figure 5.4.8

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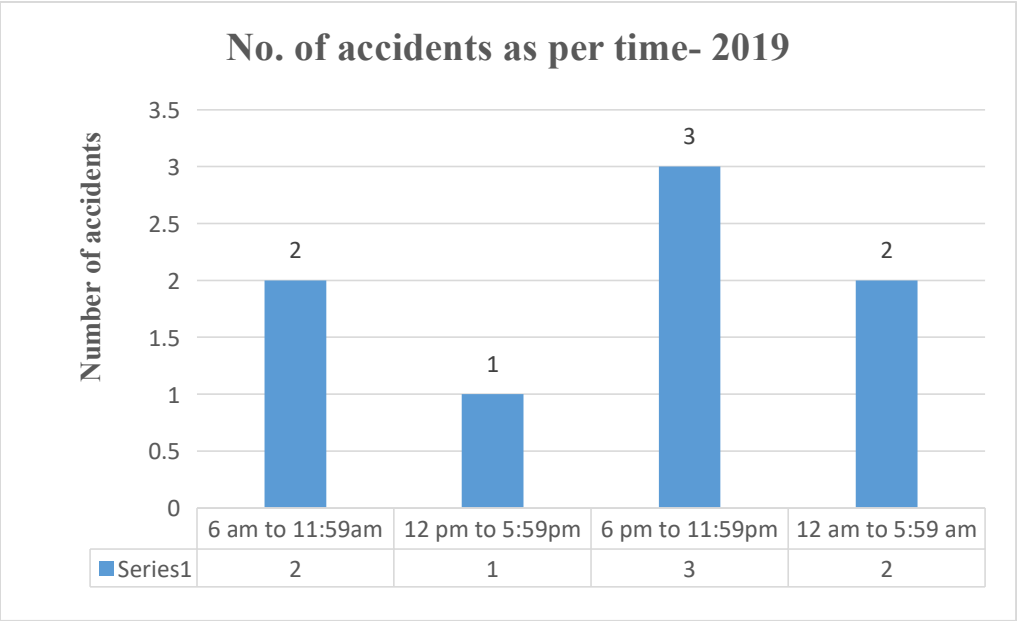

Figure 5.4.9

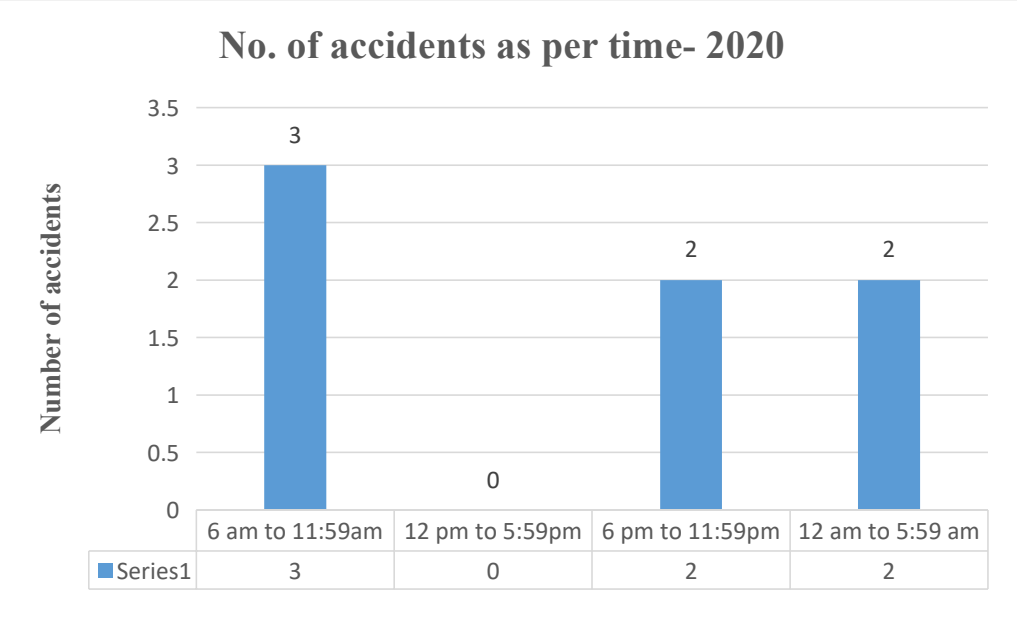

Figure 5.4.10

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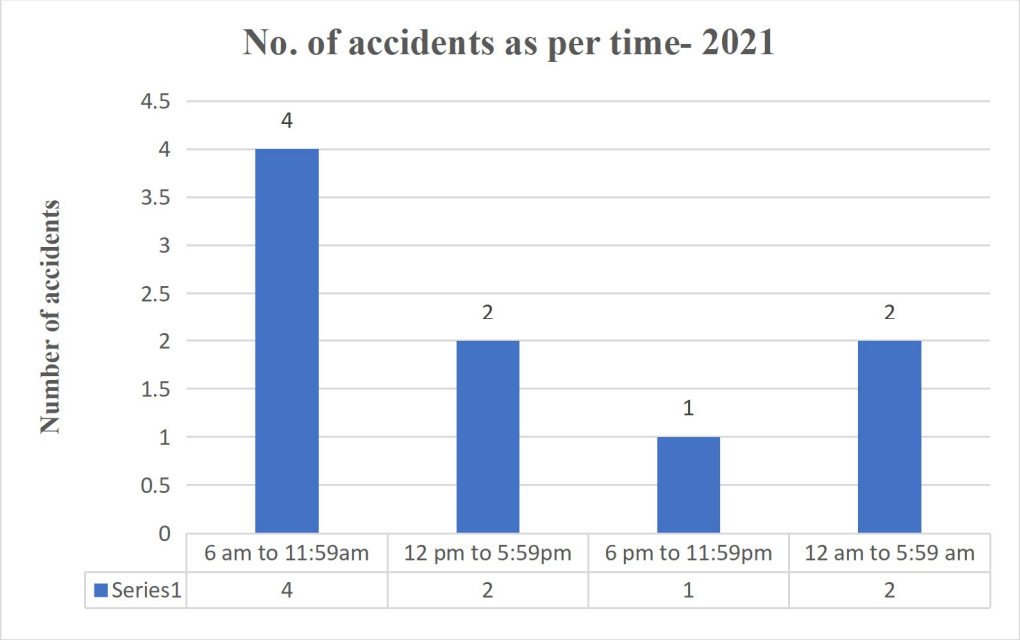

Figure 5.4.11

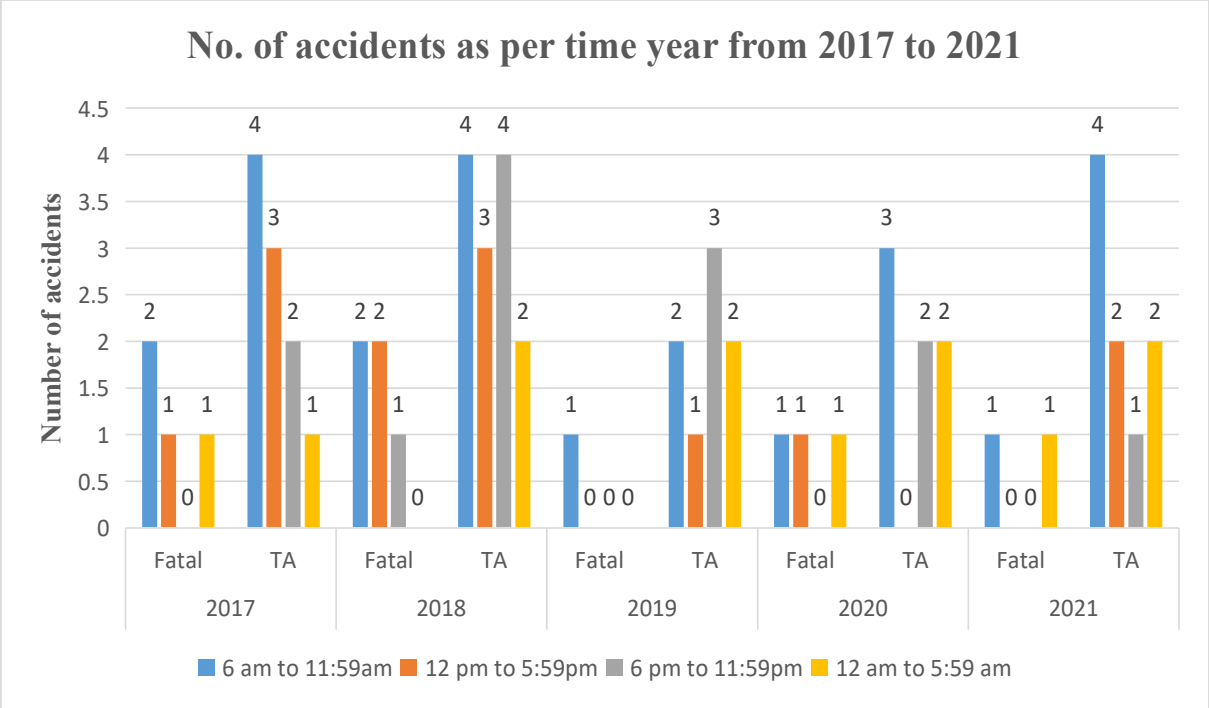

Figure 5.4.12

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5.5 The accident data analyze as per location wise

The location wise analysis of road traffic accident is shows in Table 5.5.1 to 5.5.5 as per year , and it is also represented graphically in figure 5.5.7 to 5.5.11. The accident data classification as per location within study area.

The collision of two or more vehicles takes place at such as junctions. Over speeding by the driver and Pedestrain behaviour also play good role in occur of road traffic accident.

Accident analysis as per location (2017)	
Location	**Total accident**
HARIPAR PATIYU PAL	2
KANKOT PATIYU	4
KATARIYA CHOKDI	3
COSMOPLEX	0
ESCONE TEMPLE	1
Total	**10**

Table 5.5.1

Accident analysis as per location (2018)	
Location	**Total accident**
HARIPAR PATIYU PAL	2
KANKOT PATIYU	6
KATARIYA CHOKDI	2
COSMOPLEX	1
ESCONE TEMPLE	2
Total	**13**

Table 5.5.2

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Accident analysis as per location (2019)	
Location	**Total accident**
HARIPAR PATIYU PAL	1
KANKOT PATIYU	1
KATARIYA CHOKDI	4
COSMOPLEX	2
ESCONE TEMPLE	0
Total	**8**

Table 5.5.3

Accident analysis as per location (2020)	
Location	**Total accident**
HARIPAR PATIYU PAL	1
KANKOT PATIYU	3
KATARIYA CHOKDI	2
COSMOPLEX	1
ESCONE TEMPLE	0
Total	**7**

Table 5.5.4

Accident analysis as per location (2021)	
Location	**Total accident**
HARIPAR PATIYU PAL	1
KANKOT PATIYU	2
KATARIYA CHOKDI	4
COSMOPLEX	1
ESCONE TEMPLE	1
Total	**9**

Table 5.5.5

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Accident analysis as per location wise year from 2017 to 2021										
Location	2017		2018		2019		2020		2021	
	Fatal	Ta	Fatal	Ta	Fatal	Ta	Fatal	Ta	Fatal	Ta
HARIPAR PATIYU PAL	0	2	1	2	0	1	0	1	0	1
KANKOT PATIYU	2	4	3	6	1	1	2	3	1	2
KATARIYA CHOKDI	2	3	1	2	0	4	1	2	1	4
COSMOPLEX	0	0	0	1	0	2	0	1	0	1
ESCONE TEMPLE	0	1	0	2	0	0	0	0	0	1
Total	**4**	**10**	**5**	**13**	**1**	**8**	**3**	**7**	**2**	**9**

Table 5.5.6

We can easily identify black spot location by help of Table 5.5.6. our black spot location is kankot patiyu and katariya chokdi.

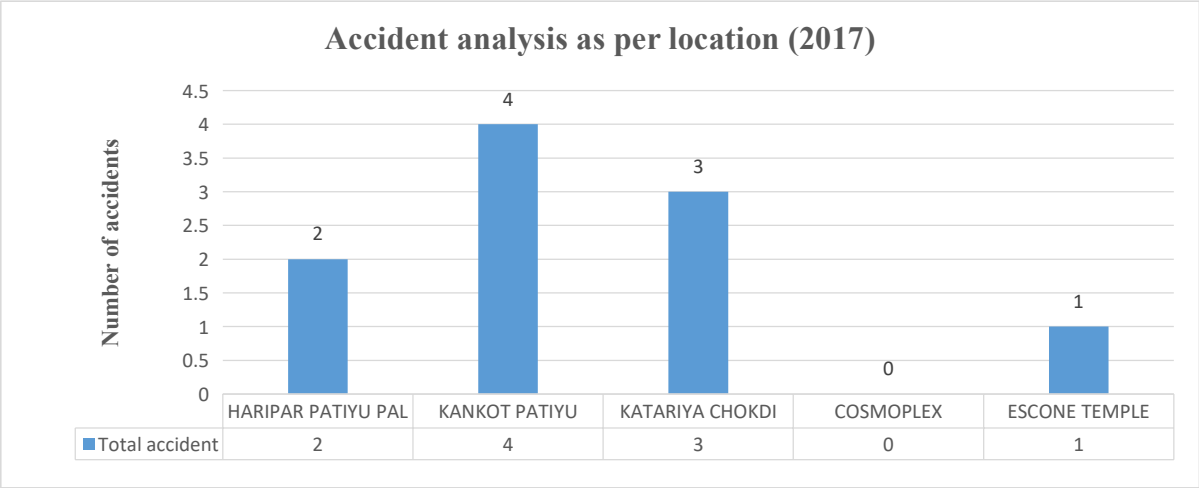

Figure 5.5.7

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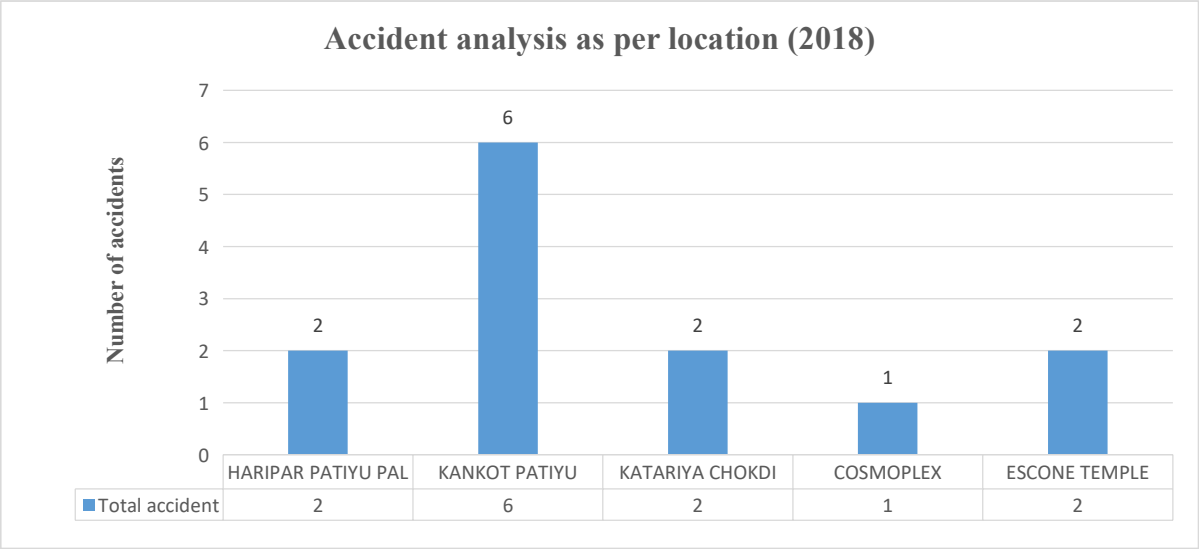

Figure 5.5.8

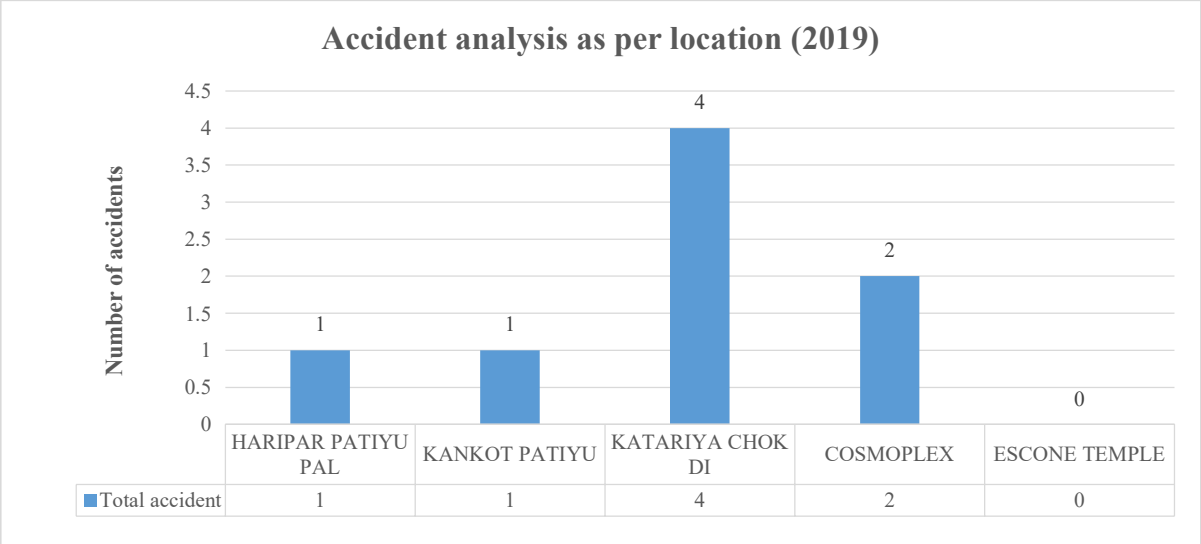

Figure 5.5.9

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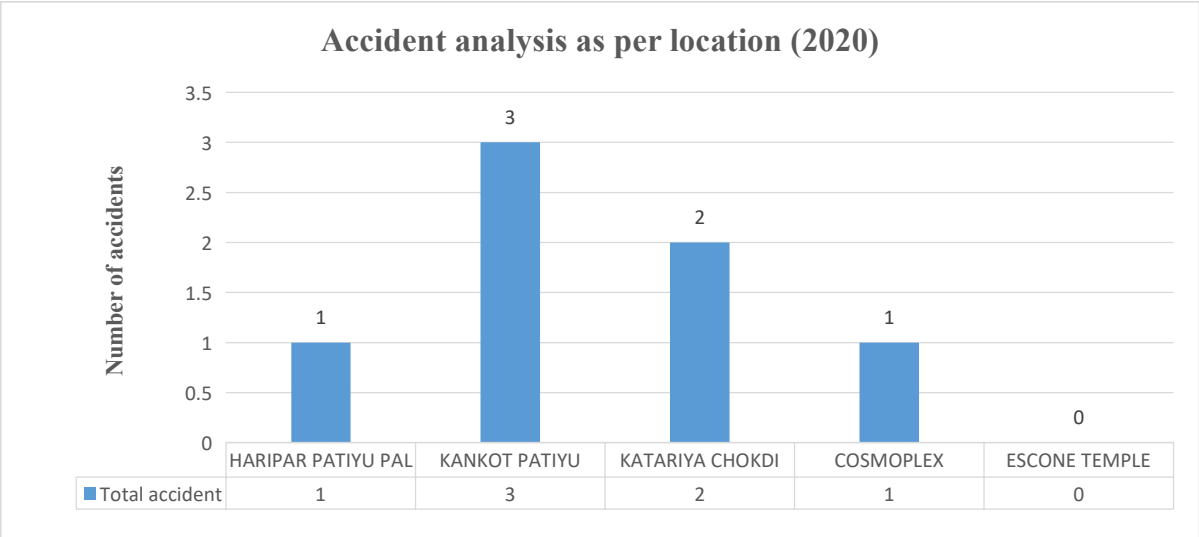

Figure 5.5.10

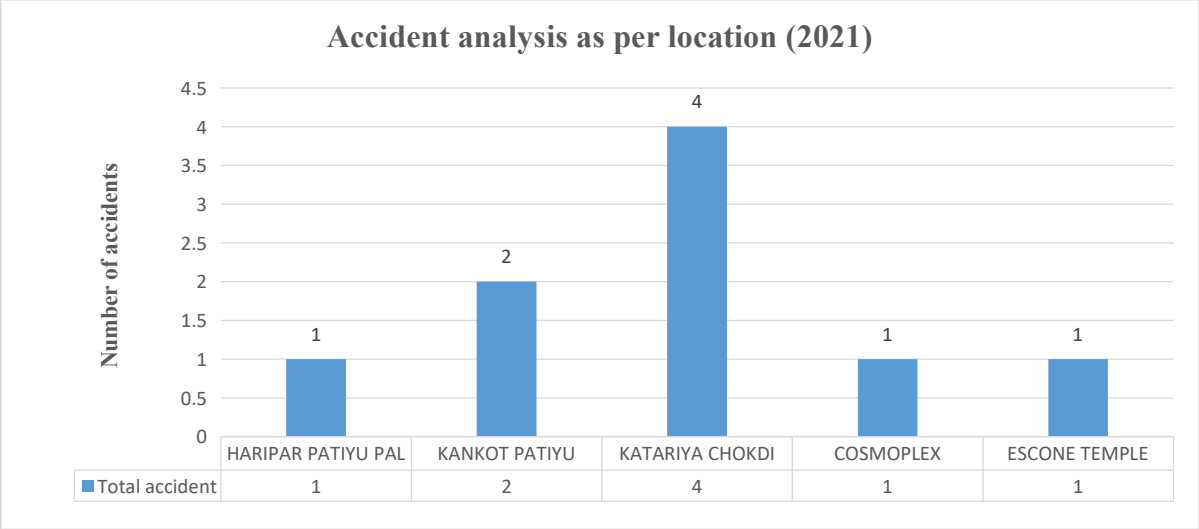

Figure 5.5.11

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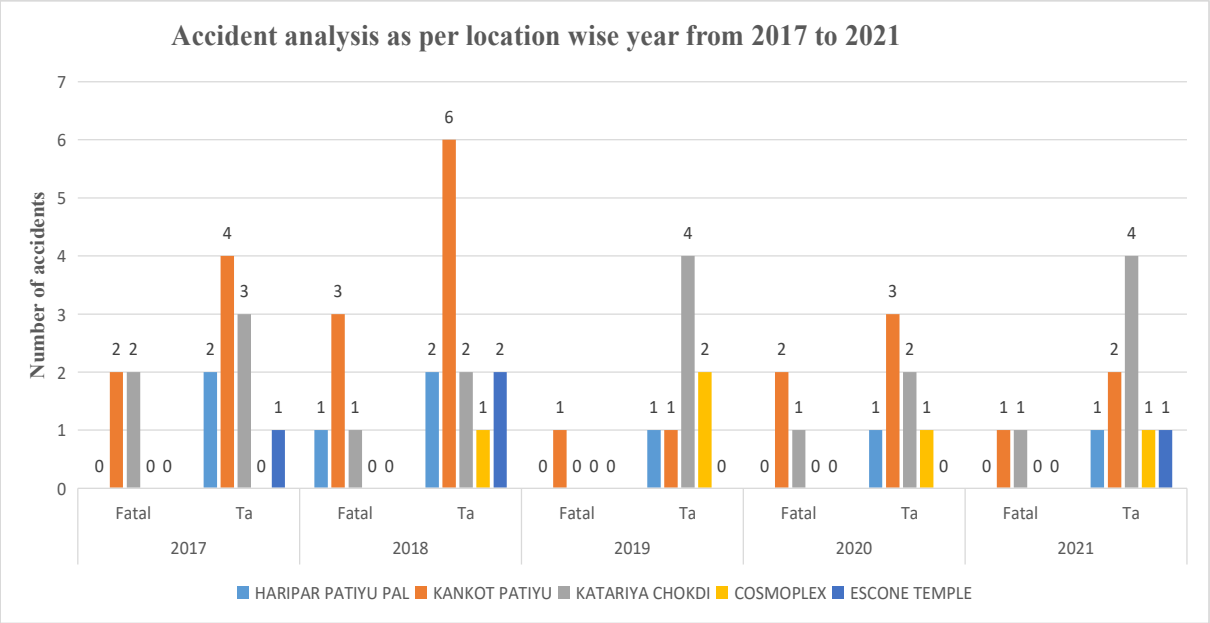

Figure 5.5.12

5.6 The accident data analyze as per types of vehicle use

Table 5.6.1 to Table 5.6.5 is give the compiled vehicle wise distribution of accidents from the year 2017 to 2021. The maximum number of fatal accident is caused by 2 wheelers.

Some the reason for road accident by these modes of transportation may be attributed to extremely speed , rush driving , over loading of passengers or goods and poor service or maintenance of vehicles. Figure 5.6.7 to 5.6.11 is also graphically represented accident analysis vehicles wise distribution.

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Accident analysis as per vehicles type(2017)	
Types of Vehicles	**Total accidents**
2 wheeler	5
3 wheeler	1
4 whleers	3
bus & truck	1
etc	0
Total	**10**

Table 5.6.1

Accident analysis as per vehicles type(2018)	
Types of Vehicles	**Total accidents**
2 wheeler	6
3 wheeler	2
4 whleers	4
bus & truck	1
etc	0
Total	**13**

Table 5.6.2

Accident analysis as per vehicles type(2019)	
Types of Vehicles	**Total accidents**
2 wheeler	4
3 wheeler	0
4 whleers	2
bus & truck	2
etc	0
Total	**8**

Table 5.6.3

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Accident analysis as per vehicles type(2020)	
Types of Vehicles	**Total accidents**
2 wheeler	3
3 wheeler	1
4 whleers	2
bus & truck	1
etc	0
Total	**7**

Table 5.6.4

Accident analysis as per vehicles type(2021)	
Types of Vehicles	**Total accidents**
2 wheeler	4
3 wheeler	2
4 whleers	2
bus & truck	1
etc	0
Total	**9**

Table 5.6.5

Accident analysis as per vehicle type from year 2017 to 2021										
Types of Vehicles	**2017**		**2018**		**2019**		**2020**		**2021**	
	Fatal	**Ta**	**Fatal**	**Ta**	**Fatal**	**Ta**	**Fatal**	**Ta**	**Fatal**	**Ta**
2 wheeler	2	5	3	6	1	4	2	3	2	4
3 wheeler	1	1	0	2	0	0	0	1	0	2
4 whleers	1	3	1	4	0	2	1	2	0	2
bus & truck	0	1	1	1	0	2	0	1	0	1
etc	0	0	0	0	0	0	0	0	0	0
Total	**4**	**10**	**5**	**13**	**1**	**8**	**3**	**7**	**2**	**9**

Table 5.6.6

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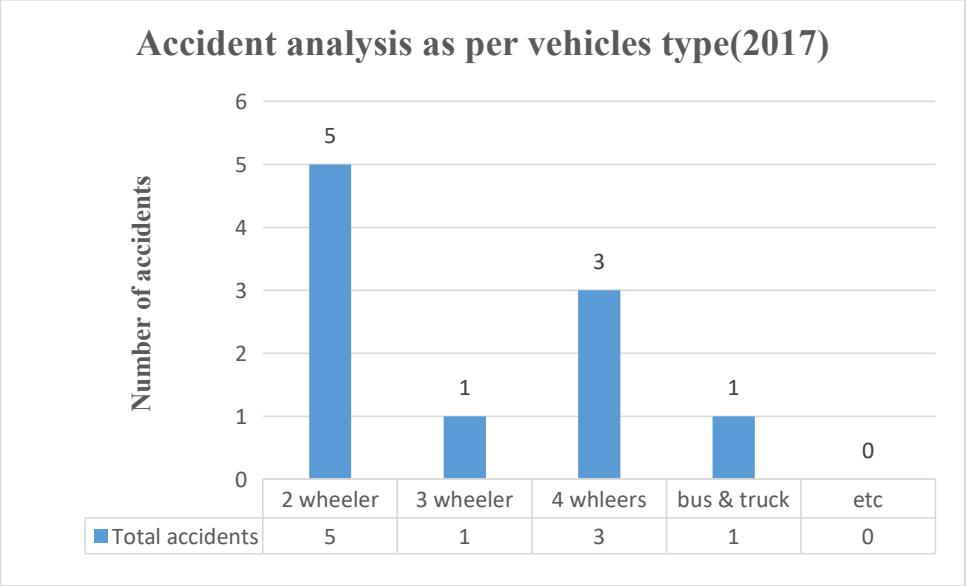

Figure 5.6.7

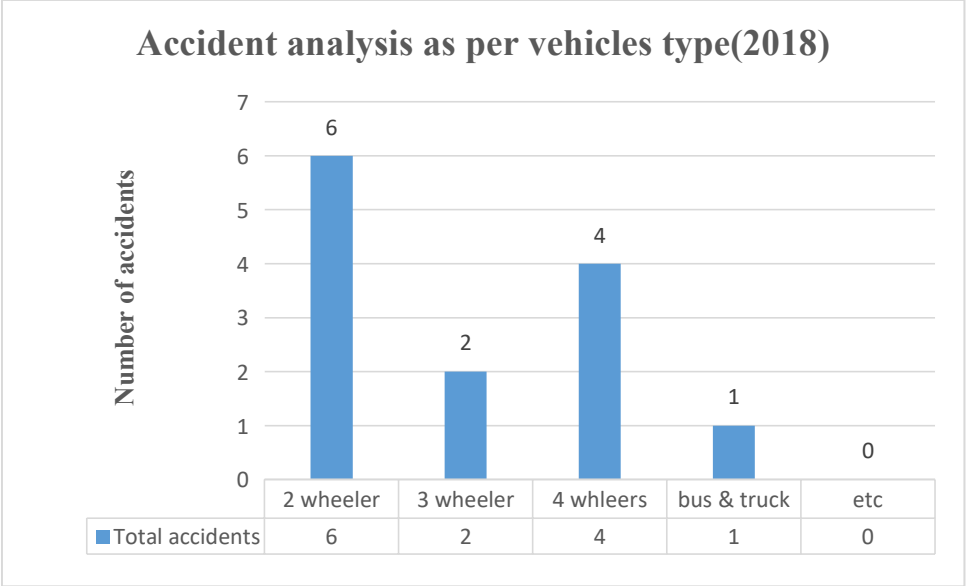

Figure 5.6.8

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Rajkot

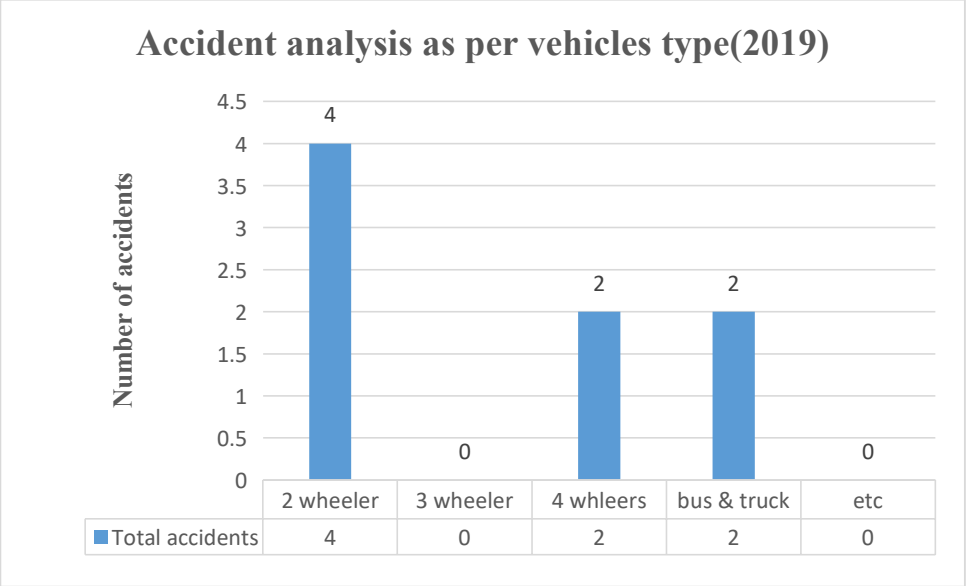

Figure 5.6.9

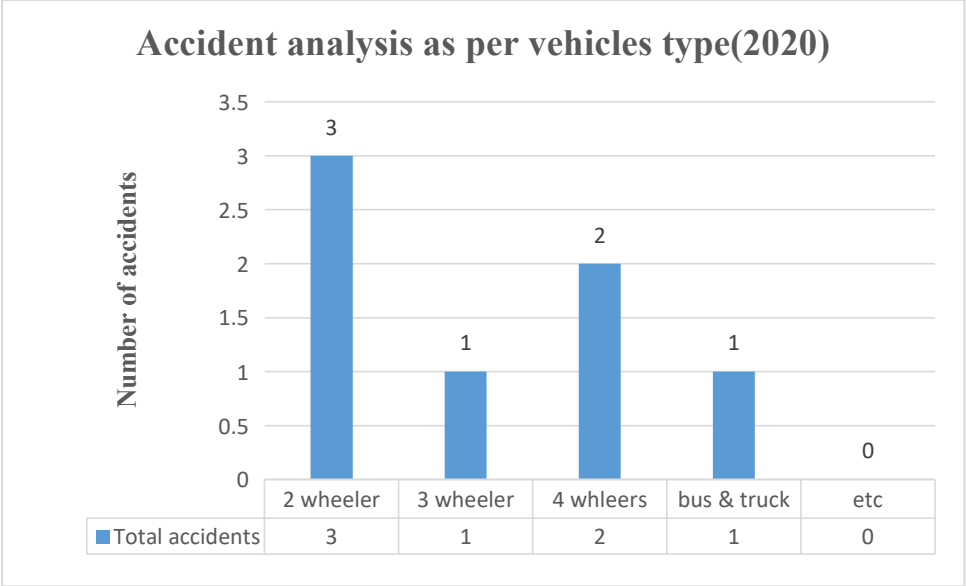

Figure 5.6.10

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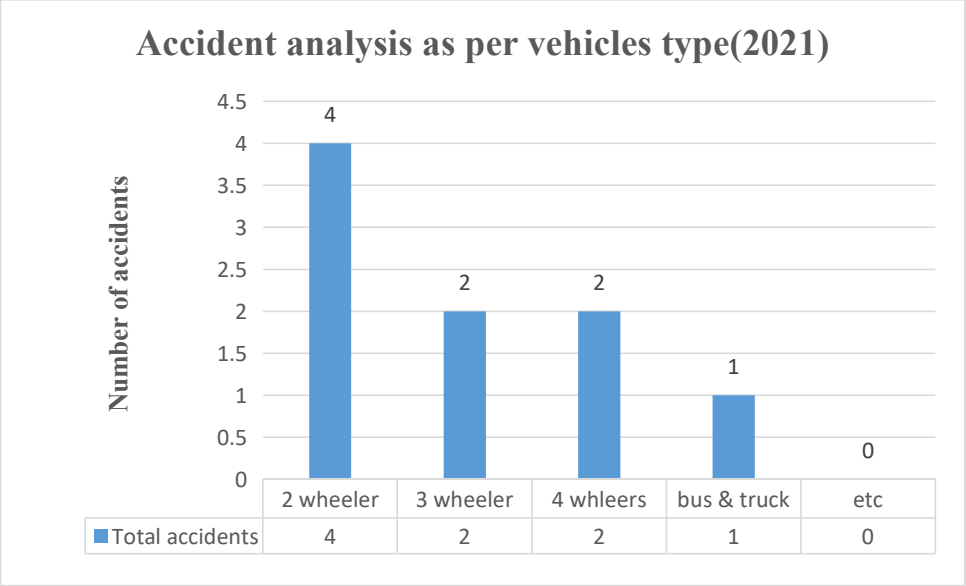

Figure 5.6.11

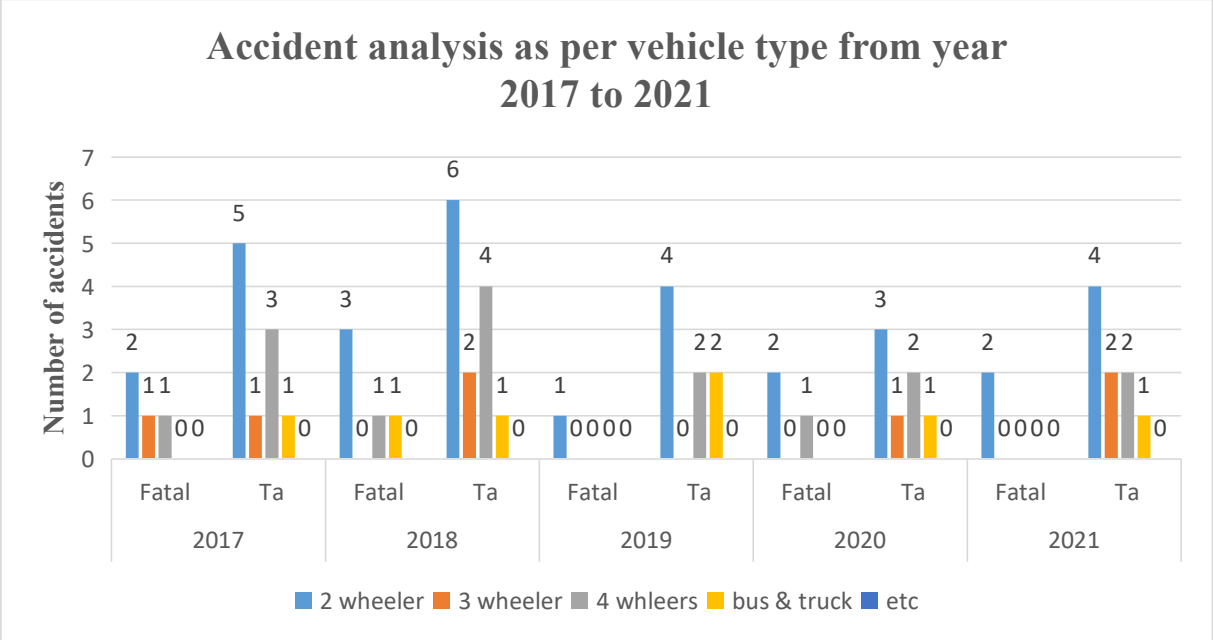

Figure 5.6.12

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5.7 The accident data analyze as per drivers age

The road traffic accident analysis as per drivers age distribution shows in Table 5.7.1 to Table 5.7.5. It is indicated that maximum number of driver involved in fatal accident are age between 21 to 35 years.

This is happened may be due to more of study and work strips. Males faces are involved higher than female faces.

Accident analysis as per driver age (2017)	
Age	**Total accident**
18-30	5
30-40	1
40-50	2
50-60	2
>60	0
Total	**10**

Table 5.7.1

Accident analysis as per driver age (2018)	
Age	**Total accident**
18-30	5
30-40	2
40-50	2
50-60	3
>60	1
Total	**13**

Table 5.7.2

Accident analysis as per driver age (2019)	
Age	**Total accident**
18-30	3
30-40	0
40-50	2
50-60	2
>60	1
Total	**8**

Table 5.7.3

Accident analysis as per driver age (2020)	
Age	**Total accident**
18-30	4
30-40	1
40-50	0
50-60	2
>60	0
Total	**7**

Table 5.7.4

Accident analysis as per driver age (2021)	
Age	**Total accident**
18-30	4
30-40	0
40-50	2
50-60	3
>60	0
Total	**9**

Table 5.7.5

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Rajkot

Accident analysis as per driver age										
Age	2017		2018		2019		2020		2021	
	Fatal	Ta	Fatal	Ta	Fatal	Ta	Fatal	Ta	Fatal	Ta
18-30	3	5	3	5	1	3	2	4	2	4
30-40	0	1	1	2	0	0	0	1	0	0
40-50	1	2	0	2	0	2	0	0	0	2
50-60	0	2	1	3	0	2	1	2	0	3
>60	0	0	0	1	0	1	0	0	0	0
Total	**4**	**10**	**5**	**13**	**1**	**8**	**3**	**7**	**2**	**9**

Table 5.7.6

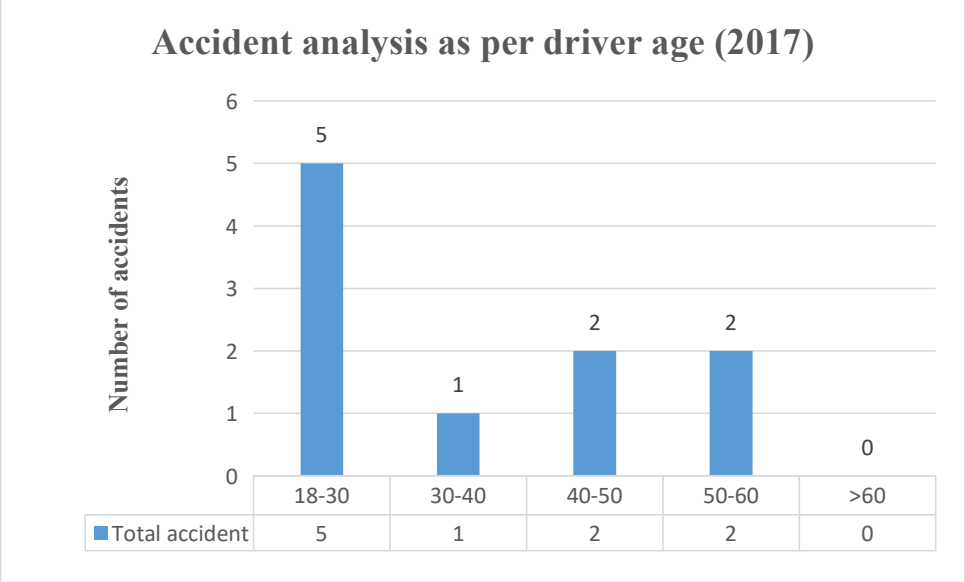

Figure 5.7.7

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Rajkot

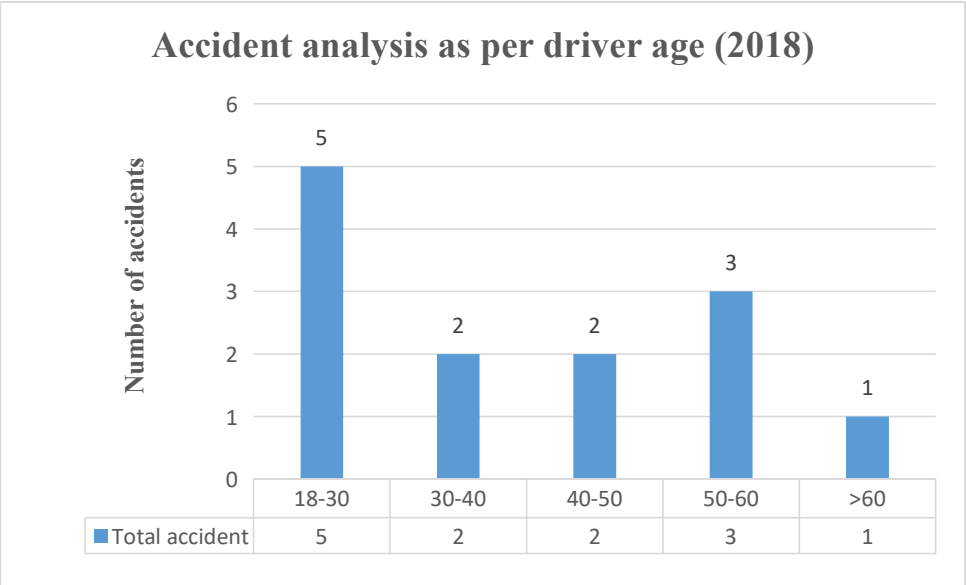

Figure 5.7.8

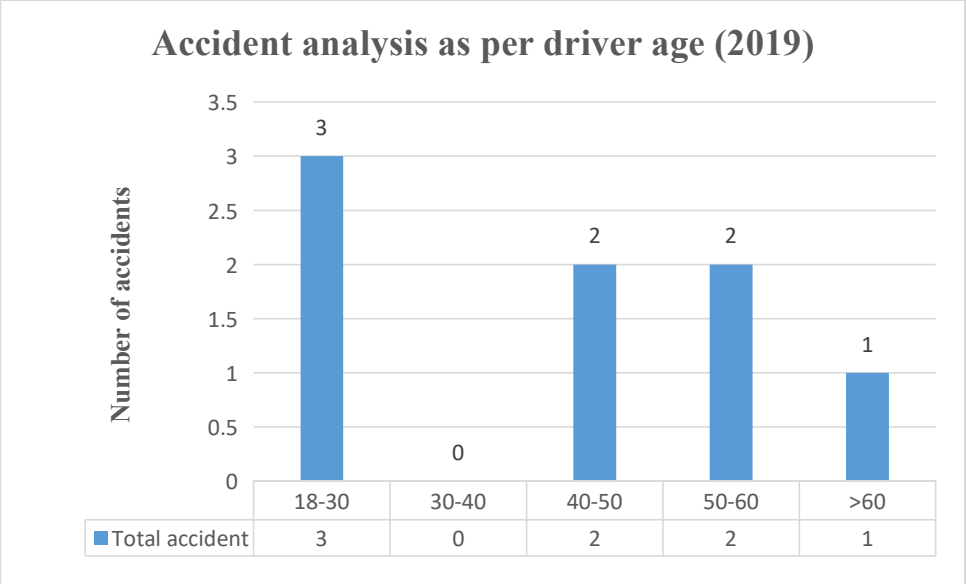

Figure 5.7.9

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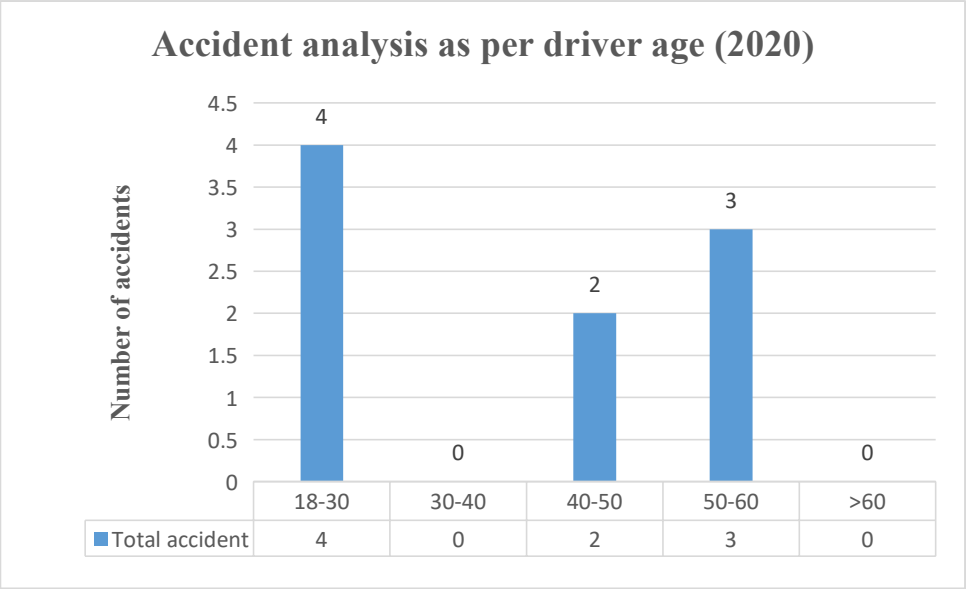

Figure 5.7.10

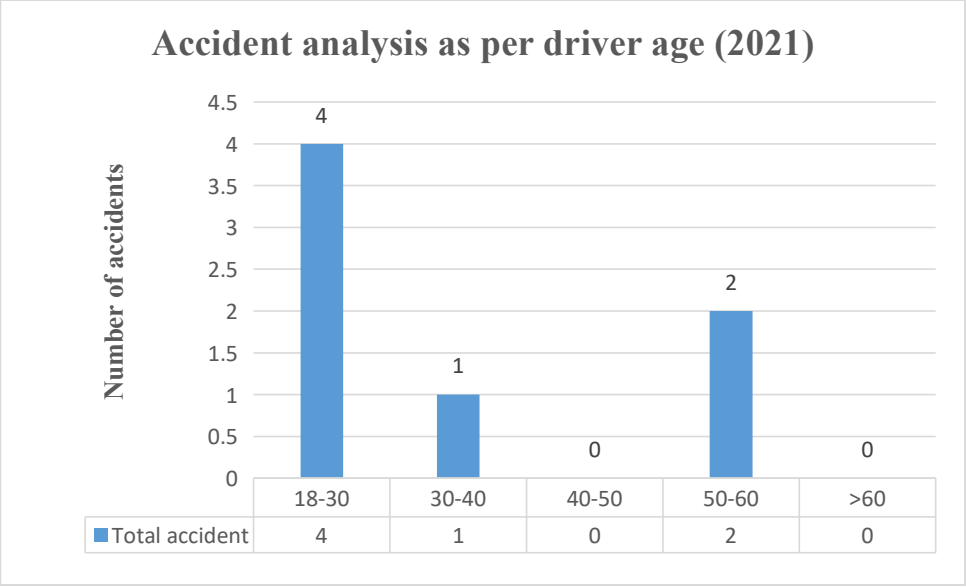

Figure 5.7.11

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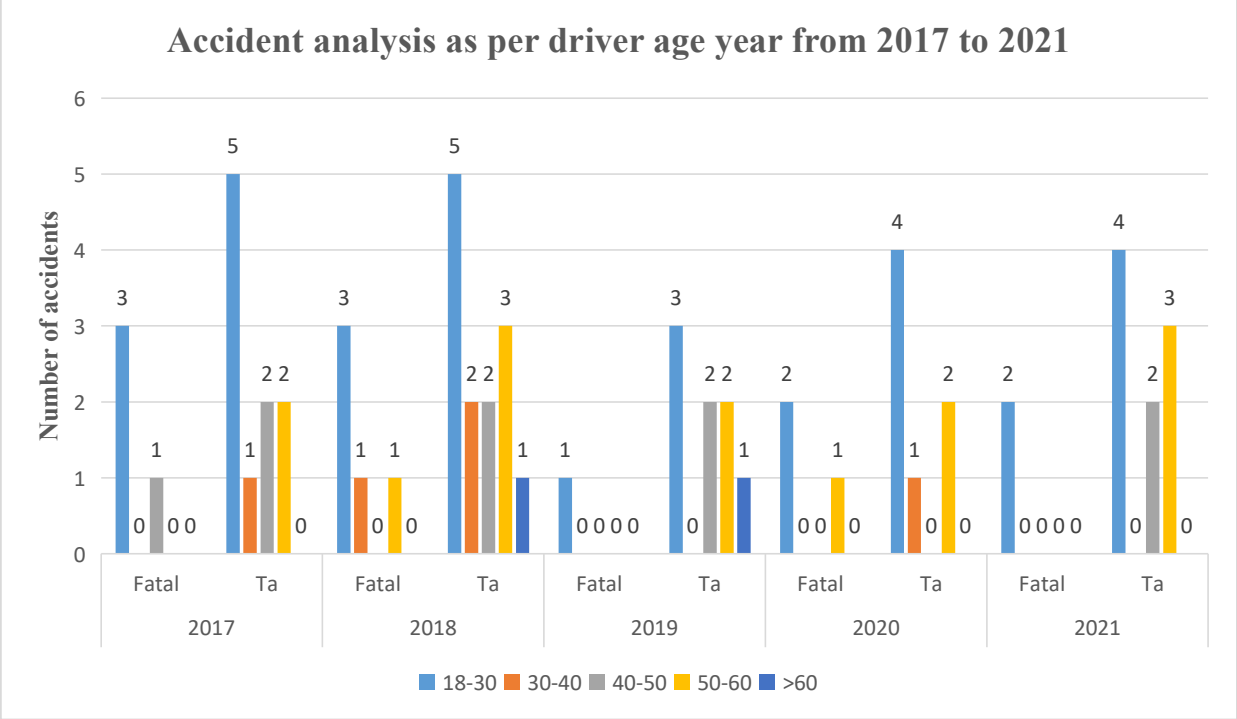

Figure 5.7.12

5.8 The accident data analyze as per driver sex wise distribution

It is clear from Table 5.8.1 and Figure 5.8.2 that males are more involved than female in road traffic accident.

Accident analysis as per driver sex wise distribution from year 2017 to 2021										
year	2017		2018		2019		2020		2021	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
	8	2	12	1	7	1	6	1	8	1
Total	10		13		8		7		9	

Table 5.8.1

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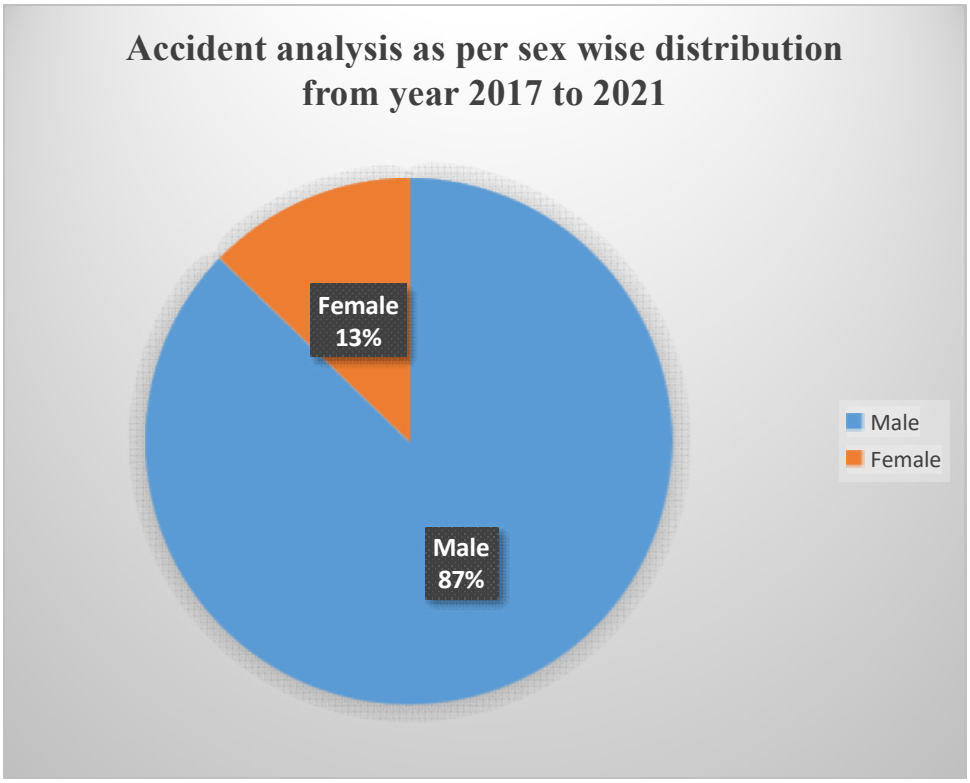

Figure 5.8.2

The total 87% male faces and 13% female faces are involved in year 2017 to 2021. male faces higher then female faces year from 2017 to 2021.

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CHAPTER-6 ACCIDENT PREDICTION MODEL

6.1 DEVELOPMENT OF PREDICTION MODEL BASED ON DRIVER AGE GROUP

The multiple linear regression models are developed for prediction of total accidents as dependent variable (Y) and driver age group as independent variable (X). The accident data are collected year from 2017 to 2021.driver age group is independent variable and the multiple linear regression is carried out.

The Models developed will take the following form:

Y = A + BX

Where y = number of total avg. accidents per year

X = avg. driver age group

A = Coefficient for Independent variable

B = Constant (Estimated parameter)

Y= 4.07 -0.05*X

Model : 1 (For Total Accidents)

MODEL SUMMARY							
Model	**Parameter**	**Estimate**	**R^2**	**DOF**	**F - statistics**		**Comments**
					f	**fcri**	
Model 1	A	4.07	0.93	4	29.01	5.32	Accepted
	B	-0.05					

Table 6.1.1

The fitness of models is proved on the basic statistical test values such as like R^2 and F statistics. The Model 1 developed on base f parameter estimation and different statistics are shown in Table 5.1.1 . It is explained from the table that for model for total accident R^2 value near 1 and (f > fcri). For model of total parameter are found significant and therefore it is statistically good is proved.

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The observed value and expected value of accident data from the accident prediction model are tested for comparability by chi- square test. The Table 6.1.2 , represented the valuation summary of the model. Their validation has also been checked with P-value , F-statistics and Chi-square test.

RESULTS AND VALIDATION OF LINEAR REGRESSION MODEL 2 BASED ON DRIVER AGE GROUP				
AVG. AGES OF DRIVERS	**AVG. NUMBER OF ACCIDENT PER AGE**		**CHI-SQUARE**	**P- VALUE**
	OBSERVED VALUE	**ESTIMATED VALUE**		
20	2.8	0.934	1.88	0.758
35	2.6	1.541		
45	2	1.926		
55	1.4	2.311		
65	0.6	2.688		
TOTAL	**9.4**	**9.4**	**1.88**	**0.758**

Table 6.1.2

6.2 DEVELOPMENT OF PREDICTION MODEL BASED ON TRAFFIC VOLUME (PCU)

The regression models are developed to predict total accidents as dependent variable(Y) and hourly traffic volume (PCU per hour per lane) as independent variable. The linear regression models for prediction development will take the following form:

$Y = A + BX$

Where y = number of total avg. accidents or per year

X = traffic volume in PCU(avg.)

A = Coefficient for Independent variable

B = Constant (Estimated parameter)

Y= 17.124 -0.004*X

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Model : 2 (For Total Accidents)

MODEL SUMMARY							
Model	Parameter	Estimate	R^2	DOF	F - statistics		Comments
					f	fcri	
Mode 2	A	17.124	0.84	3	462.86	5.99	ACCEPTED
	B	-0.004					

Table 6.2.1

The fitness of models is proved on the basic statistical test values such as like R^2 and F statistics. The Model 2 developed on base f parameter estimation and different statistics are shown in Table 6.2.1. It is explained from the table that for model for total accident R^2 value is near 1 and (f > fcri). For model of total parameter are found significant and therefore it is statistically good is proved. The observed value and expected value of accident data from the accident prediction model are tested for comparability by chi-square test. The Table 6.2.2 , represented the valuation summary of the model.

In this chapter various types of accident models have been developed. Their validation has also been checked with P-value , F-statistics and Chi-square test.

RESULTS AND VALIDATION OF LINEAR REGRESSION MODEL 2 BASED ON TRAFFIC VOLUME (PCU)				
TIME	AVG. NUMBER OF ACCIDENT PER AGE		CHI-SQUARE	P- VALUE
	OBSERVED VALUE	ESTIMATED VALUE		
6 am to 11:59am	13.8	9.47	8.55	0.036
12 pm to 5:59pm	7.4	8.95		
6 pm to 11:59pm	11.2	7.74		
12 am to 5:59 am	1.8	8.05		
TOTAL	34.2	34.2	8.55	0.036

Table 6.2.2

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CHAPTER-7 CONCLUTION

During these five years the population and vehicle ownership have raised but the number of total accidents and fatal accidents has remained approximately constant in the Rajkot city in year 2017 to 2021.

Majority of accidents are being observed during high peak hours in morning (i.e.10am to 12pm) and in evening it is in between 5pm to 8pm. This may because of heavy traffic volume in hours.

A total 47 causes of road traffic incidents were recorded in the police database for year 2017 to 2021 within study area. In which 14 people were killed and 27 injured. The majority of those who died due to these accidents were male faces.

The accident data analyzed according the month , most of accident are occur in January and June , and less accident are occur in may and august. The accident data analyzed as per time , the more accident are occur in day time and less accident are occur in night time.

The accident data analyzed according location wise , most of accident are happened at kankot patiyu and kataria chokdi. The data analyzed as per driver age the 18 to 30 age group are more involved than others age group. By accident data analyzed as according to sex wise distribution, the males faces are more involved then female faces.

To develop road accident prediction model each and every parameter related with the accident is considered and a micro level analysis of road accident is performed. After analysis road accident prediction models is developed based on different parameter like Driver age group and Traffic volume (PCU). the models is validate through F test and Chi Square test. The Regression and Anova : single factor data analysis are carried out to identify value of R^2, chi-square value, p-value,f-statistics, fcrt and degree of freedom.

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CHAPTER-8 IMPORTANT WAYS TO AVOID ACCIDENTS

1. Drive in the prescribed speed limits on the various roads. Always remember that **"Speed thrills but kills".**
2. Always put on helmets, seat belts and other safety equipment before driving a bicycle/ motor cycle/vehicle. Always remember that **"Safety saves".**
3. Do not drink and drive. Always remember that "**You cannot hold a pen properly after two pegs, what about the driving wheel?"**
4. Never use mobile phones or ear phones while driving. Always remember **"A mobile call on the road may be the last call of your life".**
5. Know the traffic signs, signals, lights and traffic safety rules before you hit the road. Always remember that **"Road safety rules are best tools to avoid accidents".**
6. Do not drive for long hours in a stretch. Have a proper beaks after every 2 hours of continuous driving. Always remember that **"Man is a man and not a machine".**

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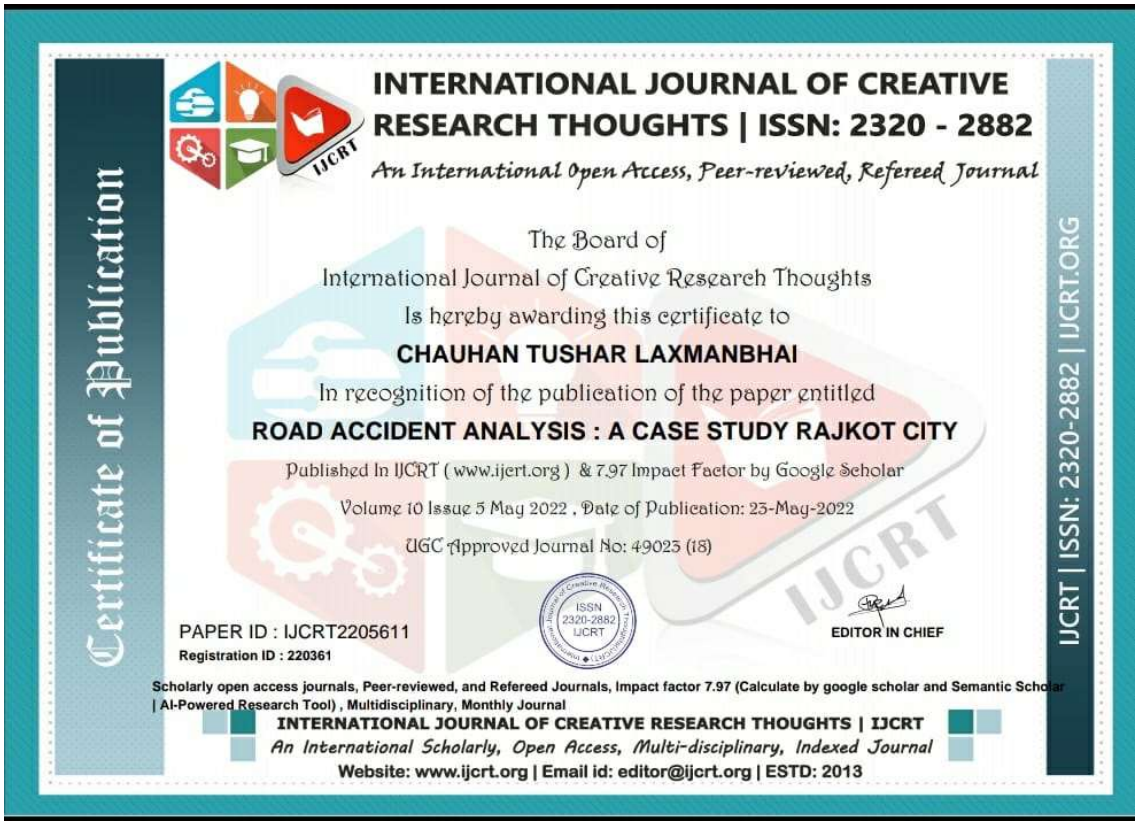

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ANNEXURE 2

REVIEW CARD

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Master of Technology

(Dissertation Review Card)

Name of Student : Chauhan Tushar laxmanbhai

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Student's Mail ID:- chauhant45@gmail.com

Student's Contact No. : 9687739436

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College Code : 0 5 1

Branch Name : Transportation Engi.

Theme of Title : Traffic Engineering

Title of Thesis : Road Accident Analysis And prediction model : A case study Rajrot city.

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Mobile No. :	9874800084

Co-supervisor's Detail	
Name :	
Institute :	
Institute Code :	
Mail Id :	
Mobile No. :	

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ANNEXURE 3

❖ Comments For Internal Review ( ) (Semester 3)

Exam Date : 26/ 11/ 2021

Sr. No.	Comments given by Internal review panel (Please write specific comments)	Modification done based on Comments
1.	Do proper formating	Done
2.	Increase No. of model (prediction)	
3.		

(Guide Sign.)

Particulars	Internal Review Panel	
	Expert 1	Expert 2
Name :	Mauvin B. Jadav	Mr. Ashish Mythatiya
Institute :	AU	Atmiya University
Institute Code :		
Mobile No. :	7874800084	9925629377
Sign :		

Particulars	Internal Guide Details	
	Expert 1	Expert 2
Name :		
Institute :		
Institute Code :		
Mobile No. :		
Sign :		

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ANNEXURE 4

Enrollment No. of Student : 2 0 0 0 4 1 0 0 3

❖ **Comments of Dissertation Phase-1 ( )** **(Semester 3)**

Exam Date : 17 / 12 / 2021

Title : Road Accident Analysis And Prediction Model : A Case Study Rajkot City

1. Appropriateness of title with proposal. (Yes/ No) Yes
2. Whether the selected theme is appropriate according to the title ? (Yes / No) Yes
3. Justify rational of proposed research. (Yes/ No) Yes
4. Clarity of objectives. (Yes/ No) Yes

~3~

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ANNEXURE 5

Enrollment No. of Student: 2 0 0 0 4 1 0 0 3

Exam Date: 17 / 12 / 2021

Sr. No.	Comments given by External Examiners (DP-I): (Please write specific comments)	Modification done based on Comments
1	define scope of work	Done
2	define study area	
3	Add literature survey	
4	Add methodology + chart of work	
5	clear the concept of your work	
		(Internal Guide Sign.)

- Approved ☐
- Approved with suggested recommended changes ☑
- Not Approved ☐

Please tick on any on.
If approved/approved with suggession then put marks ≥ 50 %.

➢ **Details of External Examiners:**

Particulars	Full Name	University / College Name & Code	Mobile No.	Sign.
Expert 1	Mr. Ravindra Solanki	Saurashtra University Rajkot.	96872 00999	
Expert 2				

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ANNEXURE 6

Enrollment No. of Student : 2 0 0 0 4 1 0 0 3

❖ **Comments of Mid Sem Review ( )** **(Semester 4)**

Exam Date : 3 /3 /2022

Sr. No.	**Comments given by External Examiners :** i) The appropriateness of the major highlights of work done; State here itself if work can be approved with some additional changes. ii) Main reasons for approving the work. iii) Main reasons if work is not approved.	Modification done based on Comments
1)	Represent Data in proper graphs	Done
2)	Insufficient traffic volume data	
3)	Do formatting as per guidelines	
4)	Complete it within due dates.	
		Internal Guide Sign.

- *Approved* ☐
- *Approved with suggested recommended changes* ☑
- *Not Approved* ☐

Please tick on any on. If approved/approved with suggession then put marks ≥ 50 %.

➢ ***Details of External Examiners :***

Particulars	*Full Name*	*University / College Name & Code*	*Mobile No.*	*Sign.*
Expert 1	JAY KIRIT KALARIA	FOE-MEFGT-057	9871490878	
Expert 2				

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ANNEXURE 7

Enrollment No. of Student : 2 0 0 0 4 1 0 0 3

❖ **Comments of DP-II Review ( )** **(Semester 4)**

Exam Date : 25 / 05 / 2022

Sr. No.	**Comments given by External Examiners :** i) Main reasons for approving the work. ii) Main reasons if work is not approved.	Modification done based on Comments

- *Approved* ☐
- *Not Approved* ☐

} *Please tick on any one.*
If approved then put marks ≥ 50 %.

➢ ***Details of External Examiners :***

Particulars	*Full Name*	*University / College Name & Code*	*Mobile No.*	*Sign.*
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Expert 2				

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COMPLIANCE REPORT OF REVIEW CARD COMMENT

SR NO.	COMMENTS	COMPLIANCE
	Internal Review	
1	Do proper formatting	Formatting is done
2	INCREASE NO OF MODEL(PREDICTION)	Models are added
	Dissertation Phase-1	
1	Define scope of work	Scope of work are defined
2	Define study area	Study area defined
3	Add literature survey	Literature survey added
4	Add methodology chart of work	Methodology chart of work added
5	Clear the concept of your work	Concept of work are clear
	Mid Semester Review	
1	Present data in proper graph	Graphs are prepared
2	Insufficient traffic volume data	Traffic volume data are added
3	Do formatting as per guidelines	Formatting is done
4	Complete it within due dates	Completed work within due dates

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Skill Training Report

S.B.DOSHI MEDICAL CENTER

Submitted by

Miss Vincy J. Parmar

PG-DMLT, Sem II

To

Department of Microbiology
Faculty of Science

Atmiya University

Yogidham Gurukul, Rajkot

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Department of Microbiology

POST GRADUATE DIPLOMA IN MEDICAL LABORATORY TECHNOLOGY

AU/PGDMLT/2021-22 **Exam Seat No. 210661082**

CERTIFICATE

This is to certify that Skill Training has been successfully completed at **S.B.DOSHI MEDICAL CENTER** by **VINCY J. PARMAR,** students of Postgraduate Diploma in Medical Laboratory Technology, Department of Microbiology, Faculty of Science, Atmiya University, Rajkot as a part of the partial fulfillment for the PG-DMLT during academic year 2021-22.

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Head,
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Head of Department
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Dr. Minaxi Parmar
Assistant Professor
Dept. of Microbiology
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Rajkot

Examiner's Signature:
Date: 04/06/202

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ACKNOWLEDGEMENTS

Atmiya University , who made my transition from A student life to professional life a remarkable one. To all the other trainees who were with me during training period, I would also thank them. Because of them I could have an overview of the work that was going on in their respective We take this opportunity to thank everyone, who made my training possible. All the people that We have worked with, have contributed to our learning process during all these months We aer highly indebted to all the people who have spared their valuable time for my training and help me develop my insight for all the techniques.

During the stay at laboratory superiors and colleagues have helped me grow intellectually as well as professionally and also provided a congenial environment to work with. It has been a great gusto to have known and worked with the team.

S.B.DOSHI MEDICAL CENTER LABORATORY On the first place I would like to record my gratitude to Dr. KAPIL M. RATHOD - my training guide under whose supervision, guidance and advice I have completed my training in a successful way. He showed interest to teach me and enriched my growth in this field.

They have trained me in all the possible techniques, enduring my frequent queries by giving prompt replies to my uncertainties in the technique I thank the HR department of lab.

We Have also indebted to **Dr . Minaxi Parmar** More for all the effort that My heartfelt thanks to Department, thus broadening my knowledge.

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INDEX

Chapter No.	Title	Page No.
01	Introduction to Laboratory	2
02	Departments of the Laboratory	3
03	Instruments	5
04	Internship Details	8
05	Summary	9
06	Learning Outcome	10

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INTRODUCTION TO LABORATORY

- Laboratory is a place that is equipped with different instruments, equipments and chemicals etc. for performing experimental works, research activities and investigate procedures
- Madical laboratory is one part of laboratory.
- Different department in This laboratory blood collection , urine collection, case counter special arrangement of chairs for patients .rest room of patients for any adverse effect. Instrument department or computer department is available.
- In this laboratory, all instrument is available and every month cheak the instrument to proper work or not. All type of testing is available and testing type of reagent kit is avaible.and test is perform in sutaible temperature. all kind of cell seeing in microscopic area, and perfect result and perfect testing is performed. provide all typel facility to the patients.

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DEPARTMENS OF LABORATERY

- A medical laboratory or clinical laboratory is a laboratory where clinical pathology tests are carried out on clinical specimens to obtain information about the health of a patient to aid in diagnosis, treatment and prevention of disease.
- In **S.B.DOSHI MEDICAL CENTER** there are laboratory in pathology department.

- Blood collection
- Hematology laboratory
- Clinical biochemistry laboratory
- Serology & immunology
- Coagulation testing
- Urine analysis
- Parasitology

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BLOOD COLLECTION

Procedure of blood collection:-

There are three popular methods of blood collection.

- Arterial sampling
- Venipuncture sampling
- Fingrestick sampling

BLOOD COLLECTION: COLOURCODE TUBES

- Red-top tubes contain no additives. These tubes are used for test performed on serum sample and DNA.
- When you used the red-top tubes, the sample can be placed for 1-2 hrs. so that the serum and blood clots will be separated. Blood clots can be used for DNA analysis.
- Lavender-top tubes contain EDTA, commonly used clinically for complete blood cell counts.
- This is the way to obtain lymphocytes for DNA extraction, plasma for nutritional analysis, and red blood cells for other assays.
- EDTA is an anticoagulant. It works by calcium chelation and is used clinically and hematology studies. It is well suited to DNA based assays.
- Green-top tubes contains heparin. Heparin is a natural coagulant used in some test.
- Blue-top tubes contain sodium citrate and citric acid. Citrate also works by calcium chelation and in used in coagulation studies and blood banking.
- Black-top tubes contains sodium oxalate.
- Yellow-top tubes contains acid-citrate-dextrose (ACD) solution.
- Gray-top tubes contains a glycolytic inhibitor.

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HEMATOLOGY DEPARTMENT

- A Hematology is a test that measure the proportion of the person's blood that is made up of Red Blood Cells Blood consists of RBCs, WBCs and platelets suspended in a fluid protein called Plasma. The hematocrit is a ratio of the volume of red blood cell to the volume of all these components together, called whole blood. The volume is expressed as a percentage of fraction

➢ CELL BLOOD COUNTER:

In CBC Counter, All blood cell count Like, Hb counter,platlet counter , WBC, RBC,HCT,MCV,MCHC etc..

- SYSMEX XP-100

TEST:

- CBC
- HB
- TC, DC
- BTCT
- ESR
- Platelet

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CLINICAL BIOCHEMISTRY

• This area typically includes automated analysis of blood specimens, including test related to enzymology, toxicology, endocrinology.

□ In the clinical biochemistry lab most of the test performed from the serum. There are many clinical biochemistry test mentioned below :

❖ **TEST :**

- RBS
- FBS
- PPBS
- Blood Urea
- S. Creatinine
- NA+
- K+
- CL-
- Ca++
- Bicarbonate
- Bilirubin
- SGPT
- SGOT
- S. Protein
- Total Protein
- S. Phosphorus

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SEROLOGY & IMMUNOLOGY

- Determine blood group ,this area determines a patients blood type and Rh status.all blood serum test is avaible like creatinie,SGPT,SGOT, Urea ,uric acis ,serum albumin,Lipid profile FBF ,PPBS, direct or indirected bilirubin and any more test is avaible.In serology HIV, IgM Antibody, CRP,dengue ,HBSAG, VDRL,WIDAL,pragnency,TB any etc.. testing is included test

COAGULATION TESTING

- In coagulation testing includes determines various blood clotting times, coagulation factors and platelet function. PT ,APTT Testing.

URIBEANALYSIS

- Test urine for many analysis including microscopically.
- If more percise qualification of urine chemicals is requird the specimen is processed in the clinical biochemistry lab .

PARASITOLOGY

- Is where specimens are examined for parasites. For example stool samples may be examined for evidence of intestinal parasites such as tapeworms or hookworms.

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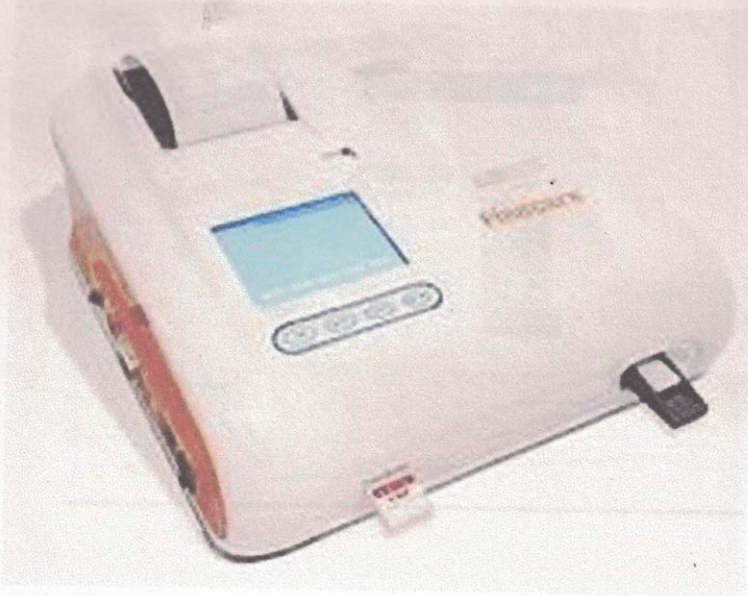

INSTRUMENT : FINE CARE

TEST:

- HBA1C
- TSH
- PSA
- TR10-I
- D-D
- PCT

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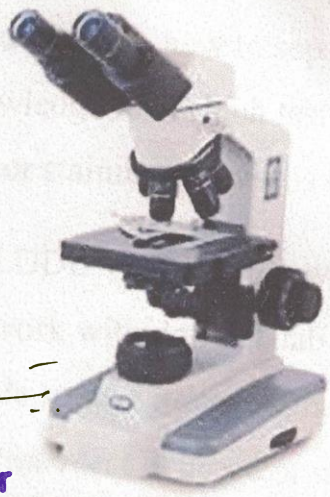
INSTRUMENT : SMARTLYTE

TEST :

- **Na+**
- **K+**
- **Cl**



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INSTRUMENT : MICROSCOPE

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INTERNSHIP DETAIL

- I have complet The internship in **S.B.DOSHI MEDICAL CENTER**.And this laboratory is runs by **S.B.DOSHI MEDICAL CENTER**
- My internship time is 1 month.start the unternship at 11 April and completed at 11 May.my lab timing is 9:00 am to 2:00 pm. **Miss Kalpana Udani** is our laboratory incharge and **Nishit Sheth** is co-ordinator of laboratory.

SUMMARE

- We know that time is very precious andas time is changing everything changes to cope with new things. During this time I got an apportunity of getting practical knowledge about the laboratory system.
- In this laboratory introduction of may instrument , all type of reagent kit, and how to perform in blood .urine test, and getting knowledge for how to operate instrument.
- During this time,We have done our many test like Biochemistry test, blood test .serology test and many other test introduction for blood collection in patients. how to separate serum or plasma in to blood and getting knowledge for which test performed in serum or plasma. Smear preparation or staining process is done during this time.
- We CONCLUDE That , during work in this laboratory we experience that how to work with doctors, lab technicians and staff. Also learned that how to operate some automated machines, how to work with this machine how to performed test in blood or urine .and how to communication with patients.
- We have wonder full experience to work in this laboratory.

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LEARNING OUTCOME

- We complete the internship and get use full knowledge for how to work in laboratory. how to perform test from blood or urine.
- Developed communication skill, how to communication to patient.
- Getting correct information about instrument.
- Getting knowledge for how to operate for some automated machines, and how to work with this machine
- Introduction of many test like urine analysis, sputum analysis, stool analysis, and other all blood test.
- We getting knowledge for how can we run the laboratory when we are alone.

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શ્રી વર્ધમાન ચેરિટેબલ ટ્રસ્ટ - સંચાલિત
એસ. બી. દોશી મેડીકલ સેન્ટર

'શ્રી વર્ધ-પ્રેમ-ધીર-સંકુલ' ત્રીજા માળે, ૫ વૈશાલીનગર, રૈયા રોડ, સીટી સેન્ટર / વેસ્ટ સાઈડ શો-રૂમની સામે, રાજકોટ-૩૬૦૦૦૭.

Date :-11/04/2022

Certificate for internship

TO WHOM IT MAY CONCERN

This is certify that **Miss.Parmar Vincy** student of Atmiya university in rajkot has completed her internship in our Pathology Department under the guidance of Miss.**kalpna udani** – Assistant Manager. The periode of training was from 11st April,2022 to 11stMay,2022.

During her internship period we found her to be sincere and hardworking and dedicated student with professional attitude to learn new things. She is good in nature and character is well. Her performance expectations and was able to complete the internship successfully on time.

We wish all the best for her future endeavors.

For,

SHREE VARDHMAN CHARETABAL TRUST

S.B.DOSHI MEDICAL CENTER

RAJKOT 360007

Warm regards,
Lab incharge

MISS KALPNA UDANI

S.B. DOSHI MEDICAL CENTER
Dr. Kapil Rathod
M.D. Medicine
G-30391
RAJKOT

DR.KAPIL M.RATHOD
(CONSULTANT PHYSICIAN)

શ્રી વર્ધમાન ચેરિટેબલ ટ્રસ્ટ
એસ.બી. દોશી મેડીકલ
& વૈશાલીનગર સેન્ટર
ત્રીજો માળ, શ્રી વર્ધ-પ્રેમ-ધીર સંકુલ,
૫ વૈશાલી-
સીટી સેન્ટર / વેસ્ટ
રાજકોટ - ૩૬૦૦૦૭.

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Sample Evaluated projects report / field work submitted by the students.

AY 2020-21

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ATMIYA

Sarvoday Kelavani Samaj Managed

ATMIYA University-Rajkot

DEPARTMENT OF CHEMISTRY

B.Sc. Chemistry

Semester-V & VI

Student Training Through Industrial Visit Report

STTIV Report 2020-21

NAME:-FACHARA DHRUV HITESHBHAI

ENROLLMENT NO:-1807071032

❖ FORTUNE POLY PLAST

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ATMIYA UNIVERSITY

॥सुहृदं सर्वभूतानाम्॥

STTIV Report

This is to certify that

FACHARA DHRUV HITESHBHAI of

T.Y.B.SC.-Chemistry Sem.-VI

Enrolment no.: 180701032 Division: A

Has received training through industrial visit

FORTUNE POLY LAST

During academic year 2020 -2021

Exam Number: 180701032 Date of Examination: _____

Examiner

Head

Department of Chemistry

Head of Department
Department of Chemistry
Faculty of Science
Atmiya University
Rajkot

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Atmiya University
Rajkot

Fortune
Poly Plast

This is certifying that Mr Dhruv Hitesh Bhai student of T.Y. B.Sc.chemistry from Atmiya University has undergone his industrial visit of fortune polyplast on date 29 January 2021 during this period he performed all the activity assigned to his by company and shown keep interest during visit of the company.

we wish every success in his future endeavours.

Fortune Poly Plast.
Partner.

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Survey No 368, Polt NO. 1,2,3, Jai Bharat Industrial,
At. : Ravki. Tal. : Lodhika, Dist.: Rajkot - 360 004.
Mo.: 96627 30045

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❖ ACKNOWLEDGEMENT

We have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. We would like to extend my sincere thanks to all of them.

I am highly indebted to Mr. Bharatbhai Pokiya, Managing Director of FORTUNE POLY PLAST and our respected Principle Dr. K D Ladva sir, Hod. Dr. P B Nariya sir and Assi. Professor Nikhil Shavaniya for their guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the project.

I would like to express my gratitude towards my parents & member of FORTUNE POLY PLAST .for their kind co-operation and encouragement which help me in completion of this project.

I would like to express my special gratitude and thanks to industry persons for giving me such attention and time.

My thanks and appreciations also go to my colleague in developing the project and people who have willingly helped me out with their abilities I have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. I would like to extend my sincere thanks to all of them.

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❖ SELF DECLARATION

I hereby declare that the project report entitled "**FORTUNE POLY PLAST**" submitted by me to ATMIYA UNIVERSITY, Rajkot in partial fulfillment of the requirement for the Course: core-18 "Group project/Industrial training /Instrumental training". Course Code: 18BCHCC606 of the degree of B.Sc. in chemistry department is a record bonafide project work carried out by me under guidance of our coordinator Mr. Nikhil Shavaniya.

Date: 09/08/2021

Place: Rajkot

Signature of Student

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❖ PREFACE

As a part of B.Sc.in order to gain practical knowledge in the field of chemistry. We are required to make a report on "FORTUNE POLY PLAST". The basic objective behind this project is to get knowledge of PVC polymer.

In this project we have included various concepts, raw, materials, chemicals of PVC and whole process of making PVC pipe.

Doing this projects helped us to in enhance our knowledge regarding the work. Through this project we come to know about importance of team work and role of devotion towards the work.

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❖ INDEX

Sr.no.	Content	Page no.
1	Company Profile	7
2	Introduction of polymer	9
3	Classification of polymer	10
4	Introduction of PVC	14
5	History of PVC	16
6	Properties of PVC	18
7	UPVC	19
8	CPVC	20
9	Deference between UPVC and CPVC	21
10	Raw material	22
11	Manufacturing	28
12	Product	37
13	Quality Check	39
14	Future plan And Conclusion	42

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❖ COMPANY PROFILE

In Rajkot district many polymer companies are available. Basically they are produce pipes and pipes fittings items of plastic. Many are manufactured tap and shower from PVC.

FORTUNE POLY PLAST is mainly manufacture pipe of UPVC and pipe fittings items from PVC They have two main manufacturing plant of UPVC pipe machine and one manufacturing plant of PVC pipe fittings items

Company is progressing in this field since 2015 .Owner of FORTUNE POLY PLAST are very kind with us They support a lots in this project to us .They give information about their company and their future plans.

➢ HISTORY OF FORTUNE POLY PLAST

Owners Bharatbhai, Nileshbhai and Pratikbhai are working in some other polymer company and they are very smart in their work so they are planning of their own manufacturing plant. So they are start this unit on rant and start of this unit with loans funds and their progress start with this. Now they are owned there unit lands and they swift in their own lands and manufacturing company

This company is progressing more and more in this field. They do their brand name in Saurashtra many big .The manager of fortune pipe Rutvikbhai Pokiya is very young but their dignity and sharp mind about business is very good he always visit some new technology in Indian industries so they always do something new in this field and always visit out states because of purpose of marketing and developing.

Company is very supportive in environmental so they make garden in side of their company and they plants tree in this garden. In this company workers are from UP and Bihar state. Operators are from Gujarat also. Workers are very happy with this company and their owners to work with them.

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❖ INTRODUCTION OF POLYMER

A polymer is a large molecule or a macromolecule which essentially is a combination of many subunits. The term polymer in Greek means 'many parts'. Polymers can be found all around us. From the strand of our DNA which is a naturally occurring biopolymer to polypropylene which is used throughout the world as plastic.

Polymers may be naturally found in plants and animals (natural polymers) or may be man-made (synthetic polymers). Different polymers have a number of unique physical and chemical properties due to which they find usage in everyday life. Polymers are all created by the process of polymerization wherein their constituent elements called monomers, are reacted together to form polymer chains, i.e. 3-dimensional networks forming the polymer bonds.

The type of polymerization mechanism used depends on the type of functional groups attached to the reactants. In the biological context, almost all macromolecules are either completely polymeric or are made up of large polymeric chains.

Polymer, any of a class of natural or synthetic substances composed of very large molecules, called macro molecules that are multiples of simpler chemical units called monomers. Polymers make up many of the materials in living organisms, including, for example, proteins, cellulose, and nucleic acids. Moreover, they constitute the basis of such minerals as diamond, quartz, and feldspar and such man-made materials as concrete, glass, paper, plastics, and rubbers.

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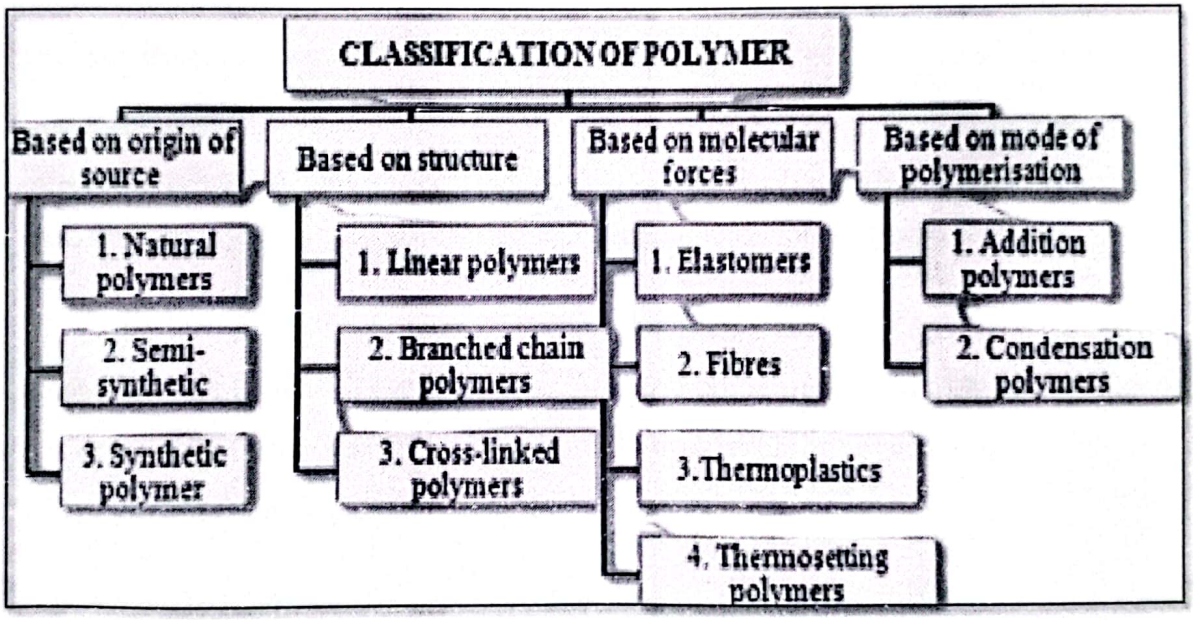
❖CLASSIFICATION OF POLYMERS

Polymers cannot be classified under one category because of their complex structures, different behaviors and vast applications. We can, therefore, classify polymers based on the following considerations.

Classification of Polymers based on the Source of Availability .There are three types of classification under this category, namely, Natural, Synthetic, and Semi-synthetic Polymers.



➢ Classification Based on Origin:

1.Natural Polymers:

They occur naturally and are found in plants and animals. For example proteins, starch, cellulose, and rubber. To add up, we also have biodegradable polymers which are called biopolymers.

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2. Semi-synthetic Polymers:

They are derived from naturally occurring polymers and undergo further chemical modification. For example, cellulose nitrate, cellulose acetate.

3. Synthetic Polymers:

These are man-made polymers. Plastic is the most common and widely used synthetic polymer. It is used in industries and various dairy products. For example, nylon-6, 6, polyether's etc.

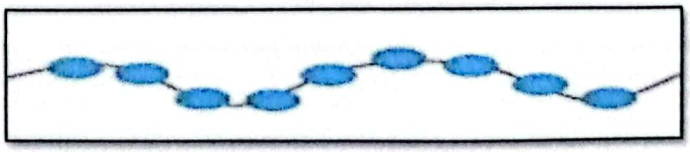
➢ Classification based on Polymerization reaction:

1. Addition Polymers: Polymers formed by the repeated addition of monomers by possessing the double or triple bonds. If the addition is of the same species they are called homopolymers and if the addition is of different monomers they are called copolymers. Examples are polythene and Buna-s respectively.

2. Condensation polymers: These polymers are formed by repeated condensation of tri or bifunctional monomeric units. In this reaction elimination of some small molecules like water and hydrogen chloride etc. will take place. Terylene and Nylon 6,6are examples.

➢ Classification of Polymers based on the Structure :

1. Linear Polymer:



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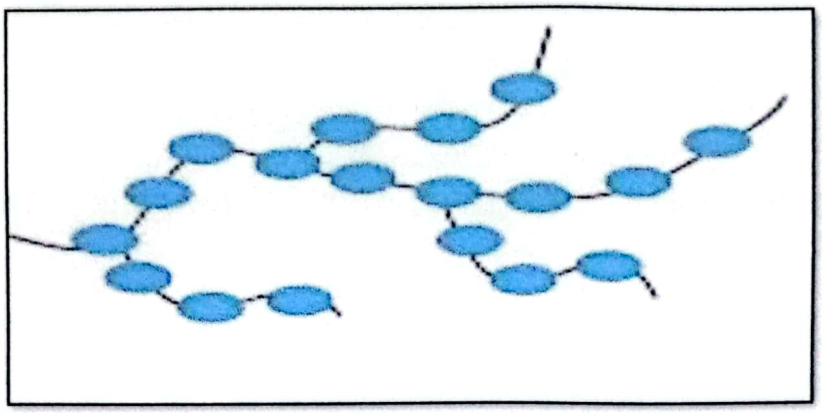
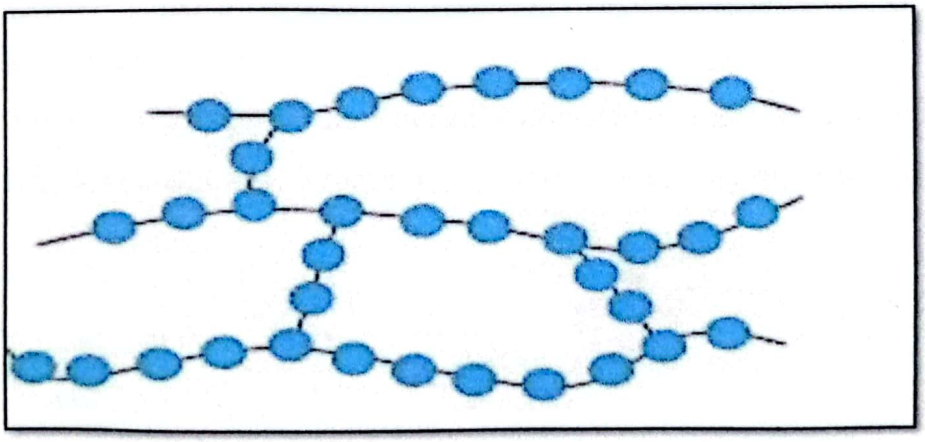
The structure of polymers containing long and straight chains fall into this category. PVC, i.e. poly-vinyl chloride is largely used for making pipes and electric cables is an example of a linear polymer.

2.Branched-chain Polymers:



When linear chains of a polymer form branches, then, such polymers are categorized as branched chain polymers. For example, Low-density polythene.

3.Cross-linked Polymers:



They are composed of bifunctional and trifunctional monomers. They have a stronger covalent bond in comparison to other linear polymers. Bakelite and melamine are examples in this category.

❖ Classification Based on Molecular Forces:

1. Elastomers:

These are rubber-like solids weak interaction forces are present. For example, Rubber.

2. Fibers:

Strong, tough, high tensile strength and strong forces of interaction are present. For example, nylon -6, 6.

3. Thermoplastics:

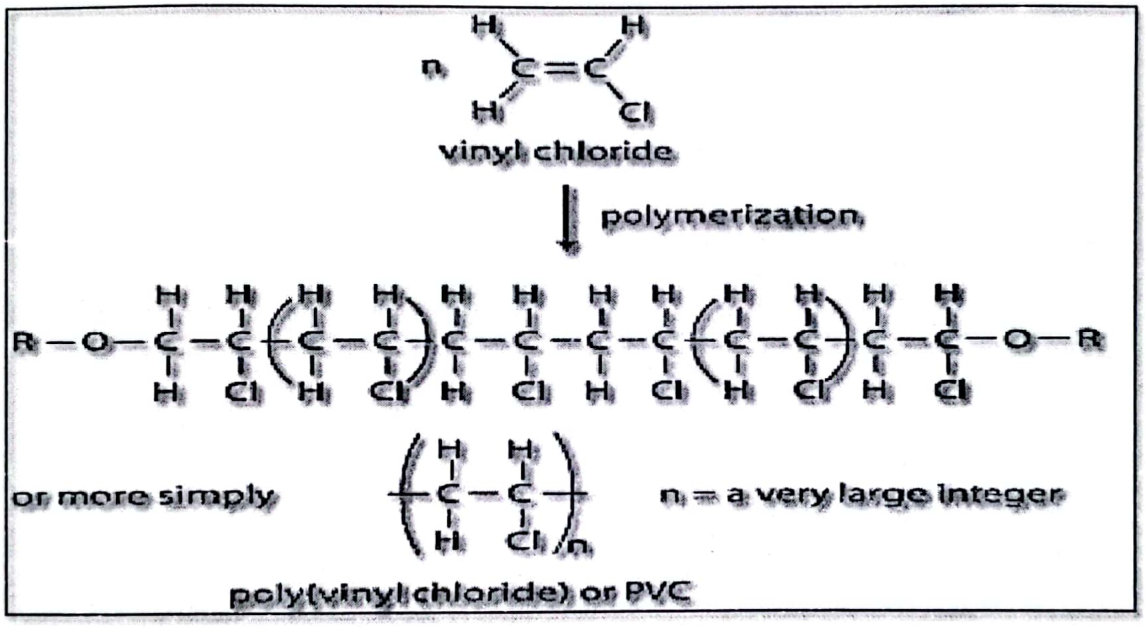
These have intermediate forces of attraction. For example, polyvinyl chloride.

4.Thermosetting polymers:

These polymers greatly improve the material's mechanical properties. It provides enhanced chemical and heat resistance. For example, Phenolic, epoxies, and silicones.

❖ INTRODUCTION OF PVC:

PVC polyvinylchloride a synthetic resin made from the polymerization of vinyl chloride. Second only to polyethylene among the plastics in production and consumption, PVC is used in an enormous range of domestic and industrial products, from raincoats and shower curtains to window frames and indoor plumbing. A lightweight, rigid plastic in its pure form, it is also manufactured in a flexible "plasticized" form.



Vinyl chloride is an organic halogen compound that has important industrial applications. When treated with certain catalysts, vinyl chloride monomers undergo polymerization and form the larger compound known as polyvinyl chloride, or PVC. PVC is used in the manufacture of numerous products, including packaging films and water pipes.

Vinyl chloride (CH_2=CHCl), also known as Chloroethylene, is most often obtained by reacting ethylene with oxygen and hydrogen chloride over

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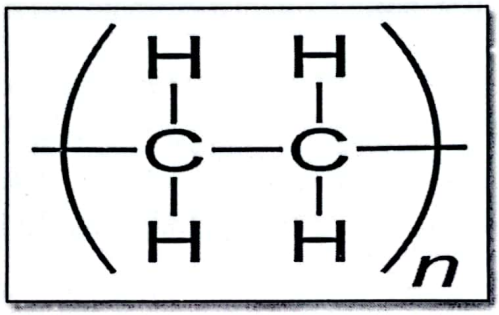
a copper catalyst. It is a toxic and carcinogenic gas that is handled under special protective procedures.

PVC is made by subjecting vinyl chloride to highly reactive compounds known as free-radical initiators. Under the action of the initiators, the double bond in the vinyl chloride monomers (single-unit molecules) is opened, and one of the resultant single bonds is used to link together thousands of vinyl chloride monomers to form the repeating units of polymers (large, multiple-unit molecules). The chemical structure of the vinyl chloride repeating units is:



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❖ HISTORY OF PVC:

PVC was prepared by the French chemist Henri Victor Regnault in 1835 and then by the German chemist Eugen Baumann in 1872, but it was not patented until 1912, when another German chemist, Friedrich Heinrich August Klatte, used sunlight to initiate the polymerization of vinyl chloride.

Commercial application of the plastic was at first limited by its extreme rigidity; however, in 1926, while trying to dehydrohalogenate PVC in a high-boiling solvent in order to obtain an unsaturated polymer that might bond rubber to metal, Waldo Lunsbury Semon, working for the B.F. Goodrich Company in the United States, produced what is now called plasticized PVC. The discovery of this flexible, inert product was responsible for the commercial success of the polymer. Under the trademark Koroseal, Goodrich made the plastic into shock-absorber seals, electric-wire insulation, and coated cloth products.

One of the best-known applications of the plastic was initiated in 1930, when the Union Carbide and Carbon Corporation (later the Union Carbide Corporation) introduced Vinylite, a copolymer of vinyl chloride and vinyl acetate that became the standard material of long-playing phonograph records.

Pure PVC finds application in the construction trades, where its rigidity, strength, and flame resistance are useful in pipes, conduits, siding, window frames, and door frames.

It is also blow-molded into clear, transparent bottles. Because of its rigidity, it must be extruded or molded above 100 °C (212 °F) a temperature high enough to initiate chemical decomposition

Decomposition can be reduced by the addition of stabilizers, which are mainly compounds of metals such as cadmium, zinc, tin, or lead.

Know about the evolution of tinsel from a source of lead poisoning to the modern tinsel made of polyvinyl chloride (PVC).

In order to arrive at a product that remains flexible, especially at low temperatures, most PVC is heated and mixed with plasticizers, which are sometimes added in concentrations as high as 50 percent. The most commonly used plasticizer is the compound di-2-ethylhexyl phthalate (DEHP), also known as dioctyl phthalate (DOP). Plasticized PVC is familiar to consumers as floor tile, garden hose, imitation leather upholstery, and shower curtains.

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Very fine particles of PVC can be dispersed in plasticizer in excess of the amount used to make plasticized PVC (e.g., 50 percent or more), and this suspension can be heated until the polymer particles dissolve. The resultant fluid, called a plastisol, will remain liquid even after cooling but will solidify into a gel upon reheating. Plastisols can be made into products by being spread on fabric or cast into molds. Flexible gloves can be made by dipping a hand-shaped form into plastisol, and hollow objects such as overshoes can be made by casting plastisol into a mold, pouring off the excess, and solidifying the material remaining on the walls of the mold.

PVC has been an occasional object of controversy since a link between vinyl chloride monomer and cancer was established in 1973. Environmentalists and health advocates raised concerns over the possible ill effects of exposure to substances such as residual vinyl chloride monomer, hydrogen chloride, organometallic stabilizers, and phthalate plasticizers. Industry officials maintain that these substances are scrupulously controlled and are released from PVC in trace amounts that have not been proved harmful.

Rigid PVC is typically made into durable structural products such as window casings and home siding, which are not frequently recycled. PVC bottles and containers, however, can be recycled into products such as drainage pipe and traffic cones.

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❖ PROPERTIES OF PVC:

PVC is a very versatile and cost-effective material. Its main properties and benefits include:

- **Electrical Properties**: PVC is a good insulation material, thanks to its good dielectric strength.

- **Durability**: PVC is resistant to weathering, chemical rotting, corrosion, shock and abrasion. It is therefore the preferred choice for many long-life and outdoor products.
- **Flame Retardancy**: Because of its high chlorine content, PVC products are self- extinguishing. Its oxidation index is ≥45. Antimony trioxide has been used extensively, usually in combination with phosphate ester plasticizers, giving excellent fire performance and mechanical properties.

- **Cost/Performance Ratio**: PVC has good physical as well as mechanical properties and provides excellent cost-performance advantages. It has long life span and need low maintenance.

- **Mechanical Properties**: PVC is abrasion-resistant, lightweight and tough.

- **Chemical Resistance:** PVC is resistant to all inorganic chemicals. It has very good resistance against diluted acids, diluted alkalis and aliphatic hydrocarbons. Attacked by ketones; some grades swollen or attacked by chlorinated and aromatic hydrocarbons, esters, some aromatic ethers and amines, and nitro- compounds.

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❖ What is UPVC?

UPVC is the term that stands for unplasticized polyvinyl chloride. PVC or polyvinyl chloride is a polymer material that can be heated and molded to get desired products such as pipes. PVC pipes are strong and very hard. Therefore, manufacturers tend to add plasticizers to PVC in order to reduce rigidity.

However, UPVC is the unplasticized PVC in which no plasticizer is included. Hence it is very rigid.

UPVC pipes are less bendable and are hard to work with due to their rigidity. A UPVC pipe is nearly rigid as an iron pipe. However, it is easy to cut with power tools. UPVC pipes are durable and fire-resistant. They are also recyclable.

UPVC can be used as a substitute for wood in construction sites. It is also used instead of cast iron for heavy-duty plumbing. Since it is incredibly resistant to chemical erosion, UPVC is a good choice for the production of plastic pipes. In addition, UPVC pipes can handle a wide range of temperatures. Therefore, a product obtained from UPVC material such as window frames do not change the shape depending on the weather condition. But at higher temperatures, UPVC can be reshaped.

❖ What is CPVC?

CPVC or chlorinated polyvinyl chloride is a thermoplastic polymer. It is produced by the chlorination of PVC polymer. This chlorination is done to get the properties such as more flexibility and ability to withstand high temperatures.

The production process includes the chlorination of PVC via free radical chlorination. This reaction is initiated by using UV energy, which can decompose chlorine gas into radicals. These radicals then react with PVC and replace a portion of hydrogen atoms with chlorine atoms. Various additives are also introduced to the polymer material in order to make it easy to process.

CPVC can withstand very high temperatures (about 90oC). It is bendable, can be welded, and exhibit fire-retardant properties. This means it can slow or stop the spread of fire. CPVC is resistant to many acids, bases, alcohols, hydrocarbons, etc. But it is not resistant to chlorinated hydrocarbons. CPVC pipes can carry high-temperature.

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❖ DIFFERENCE BETWEEN UPVC AND CPVC:

➢ **Mechanical:**

CPVC possesses greater mechanical strength as compared to UPVC. Its characteristics can be preserved at higher temperatures whereas UPVC is best when used at temperatures ranging from 0 degrees Celsius to 65 degrees Celsius. However, UPVC is tough and rigid in nature and is made of a transparent and hard-wearing material.

➢ **Chemical:**

CPVC and UPVC both, have great resistance to chemicals and corrosive fluids. Both of these are non-resistant to esters, ketones and chlorinated solvents. The only point of difference here is that CPVC pipe continues to possess these properties even at temperatures as high as 95 degrees Celsius. On the other hand, UPVC pipe changes its properties once the temperature scale exceeds 65 degrees Celsius.

➢ **Installation:**

Both CPVC pipes and UPVC pipes are easy to accommodate and light to move around. When it comes to flexibility, CPVC ranks slightly higher than UPVC.

➢ **Application:**

UPVC being low maintenance in nature is most commonly used in the building industry. It finds its application for water supply and drainage, buildings, chemicals processing, etc. CPVC being flexible, is used for the transportation of drinkable water and is widely used for water plumbing.

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❖ RAW MATERIALS

➢ Resin:

A resin is a material often used in the production of plastics and rubbers. PVC resin is a white powder commonly used to produce thermoplastics.

Other members of the vinyl family can be used for similar applications, but PVC tends to be the most popular member of that family. It is believed to be superior to other options because it can be produced in numerous forms and used to create a wide array of items for many industries. Products made with PVC resin include blood bags, windows, and pipes.

Production of PVC resin generally relies heavily on the use of chlorine and crude oil. There are four manufacturing processes commonly used in its production. They are the suspension method, the mass method, the emulsion/dispersion method, and the solution method.

PVC resin alone is a raw material. It can be made into products with a wide range of properties from soft and flexible to light and rigid. The outcome is often determined by additives. Other ingredients must typically be added to convert this resin into a finished product. These can include heat stabilizers, lubricants, and fillers. One of the most common types of additives to be blended with PVC is plasticizers, such as butyl glycolate, epoxy resins, and dialkyl azelates.

There are many benefits in plasticized PVC. Since it is a thermoplastic, meaning it can be melted down and reformed, PVC is often produced into sheets that will be reworked later. These are normally hard.

When plasticizers are added, the material tends to become much more flexible and pliable than it otherwise would be. The chemical resistance, stress resistance, and puncture resistance can also be increased. PVC in the plasticized form is extremely popular.

PVC resin generally has a high level of chemical resistance. This may not be seen, however, when the material is exposed to organic chemicals. PVC is also strong and resistant to water and abrasion. This material is very popular in the construction industry. It can be used to produce many items needed in the building process. Those items are often lightweight, long lasting and maintenance-free.

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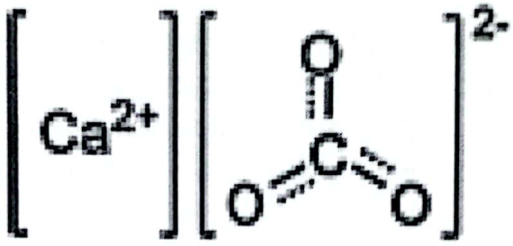
One weakness of PVC resin is ultraviolet exposure. The negative effects can often be reduced by additives such as plasticizers. In most cases, however, it is recommended to avoid this type of exposure.

- **Calcium carbonate:**



Calcium Carbonate ($CaCO_3$) is one of the most popular mineral fillers used in the plastic industry. It is widely available around the world, easy to grind or reduce to a specific particle size, compatible with a wide range of polymer resins and economical.

As an additive in plastic compounds, $CaCO_3$ helps decrease surface energy and provides opacity and surface gloss, which improves surface finish. In addition, when the particle size is carefully controlled, $CaCO_3$ helps increase both impact strength and flexural modulus (stiffness).

Calcium carbonate may be used with a myriad of thermoplastic resins. Polypropylene compounds are often filled with calcium carbonate to increase rigidity, an important requirement for operations at high temperatures. In PVC, calcium carbonate is used with flexible compounds such as tubing, wire and cable insulation, latex gloves, trash bags and in rigid compounds such as extruded pipes, conduits and window profiles. Calcium Carbonate ($CaCO_3$) is used in PVC Applications.

Polyvinyl Chloride (PVC) is a versatile polymer well suited for a variety of pipe applications ranging from large sewer piping to residential drain waste vent (DWV) piping, as well as smaller potable water piping and electrical conduit. Applications such as DWV are not pressure rated, which reduces the impact resistance required to function in the application. Others, such as residential potable water, carry ratings appropriate to their intended application. More recently, chlorinated PVC (CPVC) has been approved in some municipalities for use in hot water piping because of its superior high-temperature properties versus PVC.

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Both calcium carbonates and coated calcium carbonates contribute to the ultimate performance properties of this wide variety of piping applications. Product choice depends on the specific application and the property requirements of that.

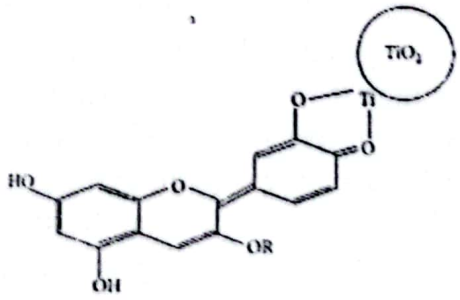
Application: flexibility, surface-treated carbonates are designed to give good dispersion along with excellent incorporation in the polymer matrix.

Calcium carbonate improves the base properties of polyvinyl chloride by adding stiffness to the polymer matrix and improving impact resistance as particle sizes become smaller. Calcium carbonate also improves compounding performance by helping disperse various ingredients into the PVC powder blend and improves processing by making polymer flow more homogeneous.

The relationship between a calcium carbonate's particle size and the impact strength of the finished rigid PVC part also applies to extruded pipe and injection-moulded fittings. The object is to produce an acceptable part at the lowest possible cost. This is achieved by minimizing the level of ingredients that add cost to the PVC formulation, such as impact modifier.

The ideal is to eliminate the use of impact modifier. This can be achieved in larger diameter pipes using a formulation containing a 2-3 micron calcium carbonate. The impact specification is usually more difficult to meet in a small diameter pipe, thus a finer calcium carbonate must be used usually in the range of 1-2 microns. In applications that require an impact modifier, the amount of modifier can be minimized by using a very fine micron coated $CaCO_3$. This approach is especially useful in demanding applications such as pipe fitting formulations and large diameter corrugated drainpipe.

- **Titanium dioxide:**



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The polymer industry is the second largest user of titanium dioxide. As for the application of Titanium Dioxide in polymer products, besides its high covering power, high lightening power, and other pigment performance, it can also enhance the heat resistance, light resistance and weather resistance of plastic products, protecting plastic products from invasion of UV Rays, improving the mechanical capacity and electrical performance of products.

Since the films of products are much thicker than the coatings of oil paints and printing inks, they do not require high pigment volume concentration, plus it has high covering power and tinting strength, so the average amount used is usually 3% – 5%.

It is used in almost all thermosetting and thermoplastic polymer, such as Polyolefin (mainly low-density polyethylene), polystyrene, ABS, polyvinyl chloride, etc. It can mix not only with dry resin powder, but also with liquid containing plasticizer. Another way of application is to process titanium dioxide into colour master batch first, and then take it into use.

The particle sizes of most titanium dioxides for plastic are small. Generally, the particle size of titanium dioxide for coating is 0.2~0.4μm, while the particle size of titanium dioxide for plastic is 0.15~0.3μm.

➢ PVC stabiliser:

PVC Stabilisers are added either directly into PVC or in combination to prevent oxidation, chain scission, uncontrolled recombination, and cross-linking reactions caused by photo oxidation. Essentially, they protect PVC from the harmful effects of extreme temperature and ultraviolet radiations. PVC Stabilisers are of different types like Heat Stabilisers which are mainly used in Construction projects. Antioxidants are PVC Stabilisers that prevent oxidation of PVC from taking place due to atmospheric oxygen. Hindered amine light stabilizers are PVC Stabilizers that scavenge radicals produced by weathering. The next type of PVC Stabilisers are UV absorbers. They dissipate energy absorbed by UV rays. Antiozonants are PVC Stabilisers that prevent degradation of materials cause by Ozone gas present in the atmosphere. Lastly, PVC Stabilisers are available in the form of Organosulfur Compounds that thermally stabilize polymers.

❖ Usage:

PVC Stabilisers are mainly used in the manufacture of Pipes and Fittings, Window Profiles, Rigid and semi-rigid films, wires and cables, coatings, and

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flooring etc. PVC Stabilisers are available in the form of Heat and UV Stabilisers, Flame Retardants, Smoke Suppressants, Plasticizers, Processing Aids, Impact Modifiers, Thermal Modifiers, Pigments, and Fillers that are added to PVC for strengthening purposes.

The applications of a PVC Stabiliser are in all places where PVC is used. PVC is widely used in construction material, medical devices, children's toys, protective housing for cables and wires, manufacture of credit cards etc. PVC is also used in rubber seals, vinyl fabrics, and automotive parts. Impact Modifier/Processing Aid PVC Stabilisers provide softness and flexibility that PVC does not normally ha stearic acid.

➢ Stearic acid:

In the plastics industry, stearic acid is widely used in the manufacture of PVC plastic pipes, sheets, profiles, and films. It is a PVC heat stabilizer with excellent lubricity and good light and heat stability. In plastic PVC pipe, stearic acid helps to prevent "coking" during processing. The stearate salts of zinc, calcium, cadmium, and lead are used to soften PVC.

➢ Optical Bright more:

We all know that rigid PVC is mainly used in PVC pipes and fittings and profiles, for pipes the general use temperature is not more than 40 degrees, often used in water supply (non-drinking water), drainage pipes, rain Water pipes.

In production, in order to improve the whiteness of pipe, many manufacturers will add fluorescent brightener, because there are many types of fluorescent brightener, performance characteristics are also very different, today to talk to you about the characteristics of hard PVC special fluorescent brightener.

Fluorescent brightener, also known as optical brightener, is a kind of compounds that can absorb ultraviolet light and emit blue or blue-purple visible light.

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Many industrial products, such as textiles, paper, plastics, etc., often have a yellow hue that is not visually desirable. Using the principle that blue and yellow are complementary colours, adding fluorescent whitening agent can remove yellow and make the treated objects appear white.

The special fluorescent brightener for rigid PVC, which is often used, only needs to be fully mixed when PVC is mixed.

Because the amount of fluorescent brightener is very small, generally about 2/10000 (1 ton of material plus 200g), so it is very important to ensure good dispersibility.

In the process of hard extrusion, the general fillers of PVC products are calcium carbonate and barium sulphate.

Injection moulding products require good liquidity and toughness, generally suitable for the use of titanium dioxide and calcium carbonate.

The filling amount of hard products within 10 phr has little effect on the performance of the products. In recent years, in order to reduce the cost, people add too much filling, which is disadvantageous to the performance of the products.

Some inorganic fillers were added to PVC to reduce the cost, improve some physical and mechanical properties (such as hardness), and increase electrical insulation and flame resistance.

In recent years, the whitening problem of rigid PVC plastics has been perplexing many manufacturers, and the real economy is becoming more and more difficult to manage. Only by adding special fluorescent whitening agent for rigid PVC can our products be whiter and brighter, and can we occupy a larger market. Otherwise, it will soon be eliminated by the market.

At present, many manufacturers in the market are in the hard PVC special fluorescent brightener, it can be soluble in alkane, fat, mineral oil, paraffin and most solvents, very high weather resistance, heat resistance, sun resistance, whitening, brightening, remarkable performance and so on.

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❖ MANUFACRTURING PROCESS

PVC pipes are manufactured by extrusion of raw material PVC, and generally follow the same steps of typical pipe extrusion operations:

- Feeding of raw material pellets / powder into the PVC twin screw extruder
- Melting and heating in multiple extruder zones
- Extruding through a die to shape into a pipe
- Cooling of the shaped pipe
- Cutting of PVC pipes to the desired length

However, despite having a similar manufacturing procedure to most plastic piping, PVC pipes have intrinsic characteristics that pose additional challenges to pipe manufacturers both in terms of production, as well as positioning their products on the market.

In general we used two process mainly first one is extrusion for pipe and second process is injection moulding for our other product.

➢ Extrusion:

Pipes are first and foremost produced through an extrusion process. The raw material is faded into the extruder via a hopper and a gravimetric or volumetric control system. Inside the extruder barrel the material is heated up to the melting point around 200°C by electricity and the friction in the screw system.

The melted material is pushed through a cavity, called a die-head and thereby formed into a pipe. The pipe is then calibrated to correct size in a vacuum box and thereafter cooled by water in spray boxes. Extrusion is a continuous process and pipes can in principle be produced in infinity lengths. In the end of the production line pipes are cut into lengths and socketed or coiled according to the intended use.

The process described above is the for producing the so-called solid wall pipes consisting of one layer of a homogeneous material.

Next to the process for solid wall pipes other variants of production processes are used, e.g. for structured wall pipe. Structured wall pipes have an optimized design to achieve the physical, mechanical and performance requirements, using less materials at the same. Twin wall is a typical structure for pipe wall construction. Another variant is the so-called co-extruded pipes where the layers can be made of different materials. A typically a 3-layer coextruded sewer pipe consists of an outer skin and an inner skin of new (virgin) material where the middle layer is

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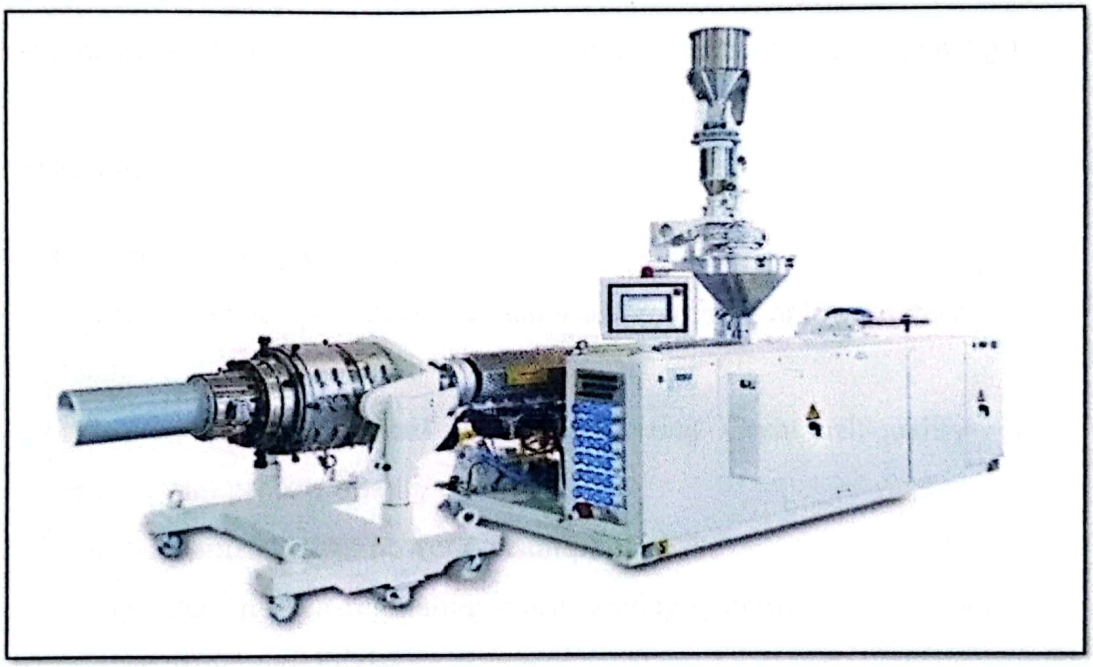
post-consumer recycled material. In this way the discoloration of the recycled material in the middle layer can be hidden inside the pipe.

Multilayer pipes for plumbing are a construction of PE or PEX with an aluminum layer inside the pipe wall. The aluminum has two purposes: To improve the longitudinal stiffness and to act as an oxygen barrier. The barrier is important in cases where the pipes are used for heating applications. The barrier can also be made with a polymer called EVOH.

Pipes can be connected in a variety of ways to form reliable and leak-free pipe systems. They can be connected by either welding, a push fit joint with rubber seal or by a solvent cement system.

❖ **Pipe Manufacturing Machine:**



- Brand-Kabra
- Output-150-170 Kg/Hour
- Model-2-52-25V
- Extruder Drive-25 (Kw-AC)
- L and D Ratio-251

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KET's wide model range of extrusion lines for UPVC, CPVC, HDPE, PPR pipes are preferred choice of processors in many countries.

KET's glorious journey as Plastic Extrusion Machine manufacture commenced 5 decades ago. It still feels energetic while introducing innovative solution to pipe makers around the world. Kabra has been consistently following and promoting a tradition of customer support.

Twin Screw Extruders are crucial for the efficient extrusion of quality PVC pipes. A wide range of products are made on these extruders. They are offered with Screw diameters 52 mm to 168 mm to give output ranges from 120 to 2,000 kg/hr.

Features and Benefits:

- Battenfeld-cincinnati technology
- Special screw design - Increased material throughput at lower screw speeds
- Low shear stress on material- Gentle plasticizing- Great melt quality
- Superior end product quality
- Higher outputs at lower power consumption.
- Maintenance free self-regulating screw cooling system.
- Stronger thrust gear boxes.
- Synchronization of high rated AC drives.
- Enhanced protection and Panel Cooler for drive panels.
- Available with Optima and NX 32 Panel

Optional:

Coated Screw Barrels | Spiral hopper loaders | Energy meter

Applications: Agriculture, Plumbing, Boring, Column Pipe

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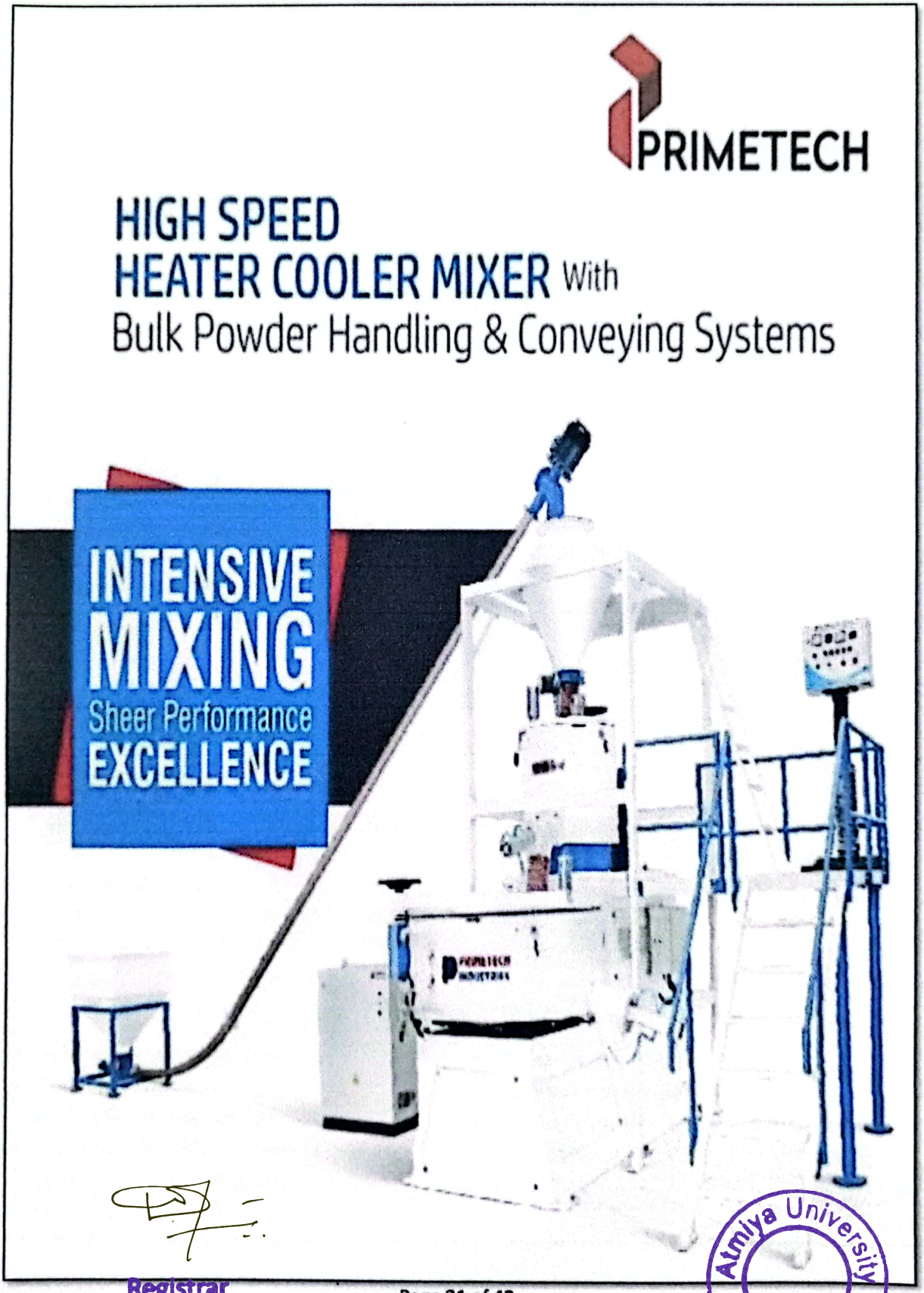
➢ **Mixer For PVC Resin:**



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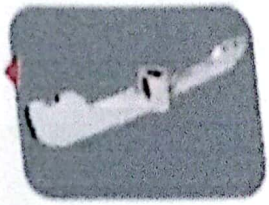
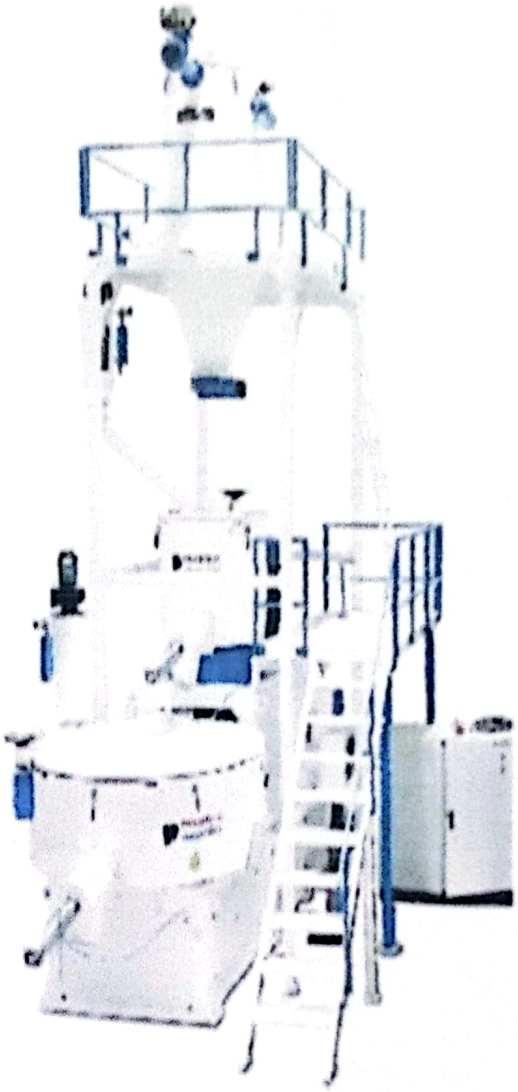
COOLING VESSEL

Large bottom radius with mirror finished contact surface enabling gentle treatment of material due to large surface mixing and low speed.

MIXING TOOL

Process enhancing and self cleaning





DISCHARGE VALVE

Piston type valve with complete electro- pneumatic operation for Easy and smooth discharge of a material.

CONTROL PANEL

Panel construction and wiring as per international standards of panel design

PERFORMANCE FEATURE

- High heat transfer co-efficient
- Short cooling cycle
- Excellent dispersion with efficient cooling
- Robust, easily serviced and maintained construction
- Corrosion and abrasion resistance
- Easy and perfect cleaning
- Self cleaning, easy fitting and removal
- Intensive cooling of mixed material
- Long life and low noise level
- Twin jacket for cooling with forced circulation of cooling water

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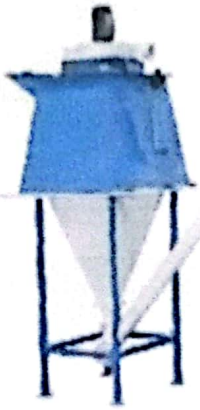
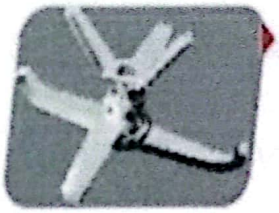
MIXING VESSEL AND DEFLECTOR

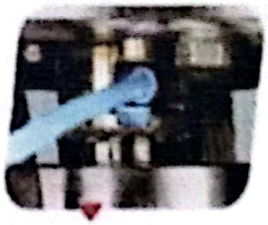
Internal surfaces in contact with material are made of stainless steel and Double steel jacketed. Contact surface are uniquely mirror polished for free flowing of material with deflector influencing the flow of material.





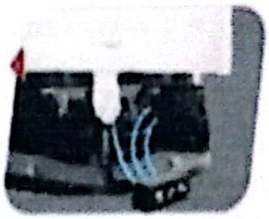
MIXING TOOL

Made from high carbon stainless steel with suitable heat treatment process in order to enhance its wear resistance properties.



CENTRALIZED LUBRICATION PORT

For easy service & maintenence of the machine



PROVEN PNEUMA-SEAL TECHNOLOGY

Prevents powder infiltration Into bearing and convincingly Increasing the bearing life period.

PERFORMANCE FEATURE

- Heater Mixer with good heating performance
- Suitable for plastic, minerals, chemical and colorant
- Short heating times
- Heat induced by friction
- Homogenizing in minimum of time
- Very robust & easy service construction of mixing vessel & tool
- Twin jacketed mixing vessel
- Fast and complete discharge of mixed material
- Improved tool life
- Long service life and less noise level
- Excellent dispersion and optimum adaptability to each type and size of mixing batch

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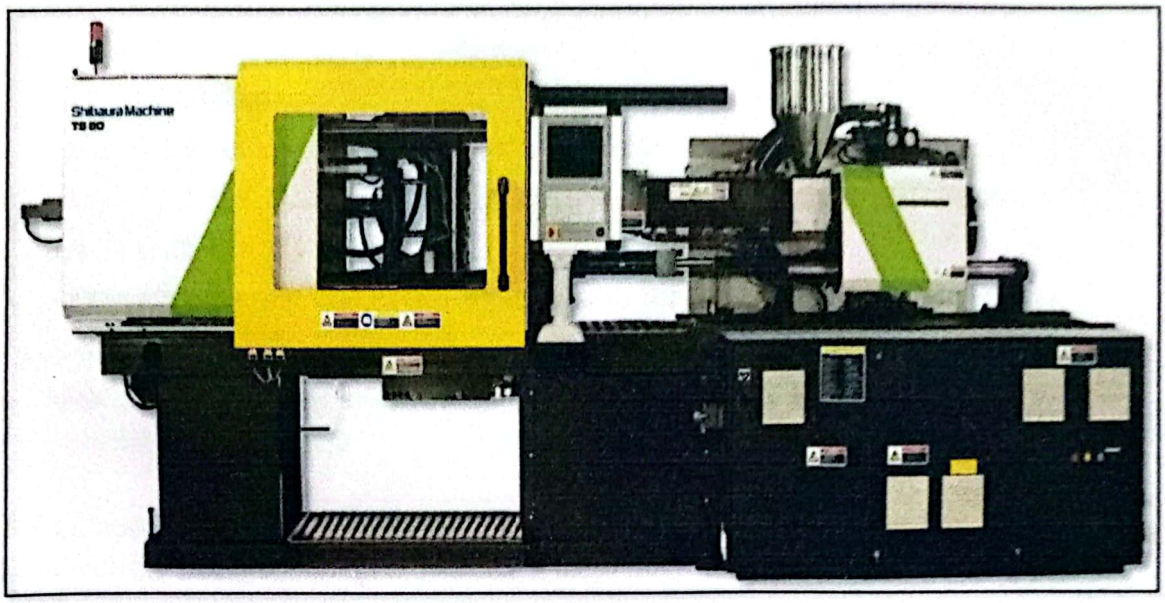
➢ Injection Moulding:



(moulding machine for pipe fittings)

Shibaura Machine India Private Limited, is among the leading high-end plastics injection moulding machines and auxiliary equipment manufacturers in India. SMI is a wholly owned company of Shibaura Machine Company of Japan.

Shibaura Machine TS Series offers five-point twin toggle clamping mechanism, robust injection unit, closed loop servo hydraulics and user friendly LNC6 control system

The entry and mid-level hydraulic machines in clamping force ranging from 400kN to 13000kN are manufactured at our state-of-the-art factory in India and caters to application segments in packaging, electrical, automotive, white-goods, writing instruments, construction etc.

Clamping Unit Feature:

- Computer optimized kinematics of toggle re-produces high precise control over acceleration and breaking profiles of moving platen movement.

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- Precise control of mold sensing force by optimized tuning of servo pump system for low pressure control duly supported by optimized hydraulic circuit ensuring.
- Less foot print due to optimum use of stroke amplification
- Graphite impregnated bushes for toggles ensuring efficient lubrication and low maintenance
- Automated centralized lubrication system for toggles
- Anti-friction roller bearings for moving platen
- Mechanical drop bar is given to provide more safety for operator.
- Injection unit features .

TS Series comes with robust construction of injection units and modular concept in the selection of injection unit offering a high degree of flexibility.

- Injection unit movement on anti-friction bushes
- Well-supported barrel assembly for easy alignment
- Hopper throat temperature control
- Larger cooling water channels to minimize effect of scale formation
- Torque free nozzle sealing force
- High kneading DBG profile screw –produces excellent melt homogeneity with low shear heat
- Fast response rotating locking ring design
- Melt temperature near to set point of barrel temperature
- Consistent cavity & peak pressure

➢ Drive unit Feature:

Lower power consumption through Reliable combination of servo pump, drive and servo motor.

- Backlash free coupling for efficient transmission of power
- Optimized drive parameters for dynamic response and longer life
- Pressure and speed stability leading to consistent performance
- Optimized P-Q characteristics (Combined efficiency of pump and servo motor)
- Option of Servo / Electronically controlled VDP (ECVDP) suitable for various applications

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- High pressure filter with automatic monitoring of clogging with advance warning and stoppage

➢ Control Unit Features:

TS Series is offered with highly advanced all new controller with a host of new features

- Touch sensitive
- Transparent
- User friendly
- Precise
- Fast
- T net enabled

Generally, fittings such as joints, elbows or T-pieces are produced by injection moulding. Also production of storm water boxes uses the injection moulding process.

In injection-moulding, the plastic material is fed from a hopper into the melting section of the injection-moulding machine. After melting via electric heating and friction in the screw system, the material is transported forward and homogenized before being injected into the mould to form the shape of the desired product. After cooling the mould is opened and the product is ejected.

The Challenges of PVC Pipe Manufacturing

Increased Extruder Friction .Due to the nature of PVC plastic, PVC extruders are subjected to high amounts of friction and stress. This means that to guarantee a long service life, PVC pipe production lines require the use of specialized extruders that utilize a twin screw extruder configuration, as well as featuring robust construction materials that can withstand the harsh PVC extruder operating conditions.

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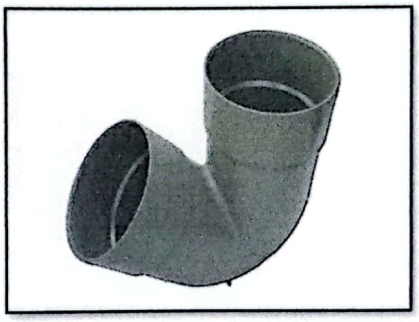
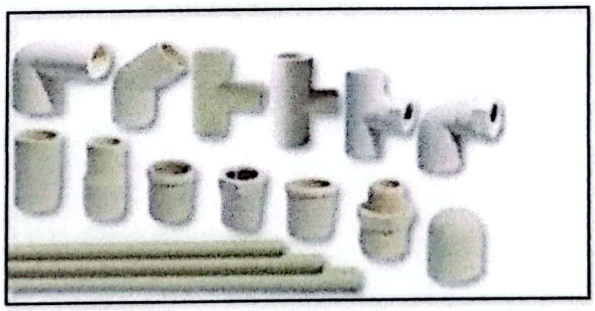
❖ PRODUCT

PVC pipes come in various sizes and diameters, and for each size exists a variety of fittings. Therefore it is highly desirable for PVC pipe manufacturers to present the market with a comprehensive range of products. FORTUNE supports PVC pipe producers with a wide variety of ready-made PVC pipe fittings, available in various types and sizes, helping you bring your products to market with a complete family of PVC piping products.

It has good UV resistance and barrier properties but a limited operational temperature range, and unless modified it becomes brittle at 5 °C with an upper continuous use temperature of 50 °C.



0.75 inch elbow use for agricultural



CPVC pipe and fitting

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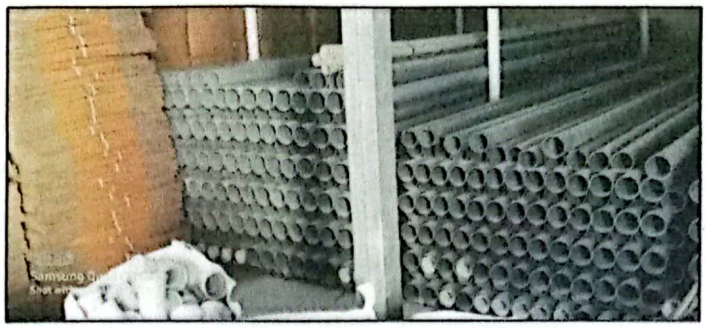

PVC Pipe

PVC Pipe fitting

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❖ QUALITY CHECK

In the case of the plastic pipes and fittings, all of them are subjected to tests to determine that they are within the parameters determined by the normative and the special regulations published by the CTC 001 (Technical Certification Committee).

Firstly, it should know that the tests are done in all stages of the production process. Since the moment it is received the raw material up to it is sent the plastic pipe to the client.

These tests are done in the manufacturer's premises. They are non-destructive testing that are done to samples chosen at random and each X determined time.

❖ **Types of most common tests and controls:**

- Resistance to traction and ultimate elongation
- Heat resistance
- Aspect
- Dimensional stability
- Dimensional control
- Density
- Tightness of the joining of the joins
- Gelation
- Resistance to the internal pressure
- Resistance to the impact
- Annual rigidity
- Softening temperature

➢ Resistance to traction and ultimate elongation

This first test is done by subjecting to a cut test tube, to an elongation up to the break. This traction is done with a dynamometer and at a speed of controlled elongation.

In the moment that the test tube breaks, it is written down both the effort in the break and the percentual elongation. These data are compared to its original size and if the parameters are met, it will have been met the first test.

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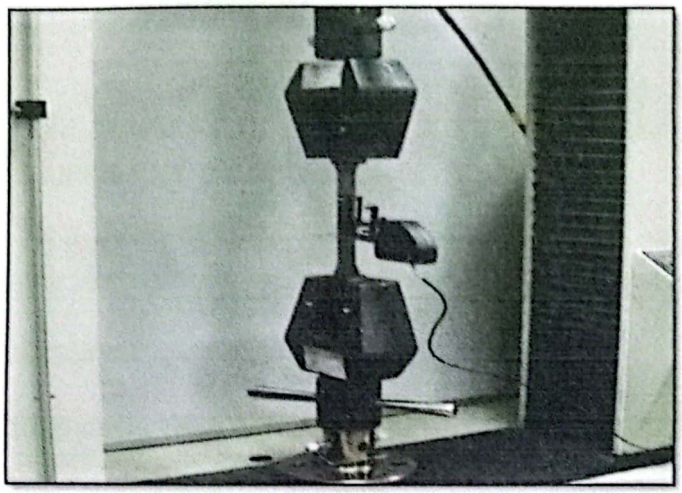


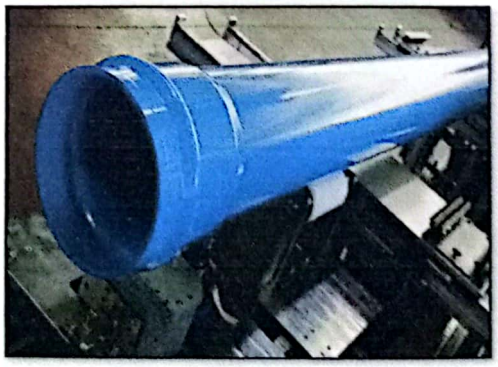
➢ Heat resistance

As its name indicates, this test is done by subjecting at high temperature (150°C), during a determined time. This test is done on the fittings of the welding to determine the effectiveness of the lines of the welding and that there are no internal defects.

➢ Aspect

Maybe this is the simplest test of all of them; it is simple verified the inside and the outside, the aspect of the pipe to make sure the lack of bubbles, pores…

The simplest one, but which is not less important, as a pore, subjected to a great quantity of water under pressure can produce leaks.



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➢ Dimensional stability

This test consists in cutting a piece of a pipe and marking on it two lines at a determined distance. Once they are marked, it is introduced the piece of pipe in water at 150ºC during a determined time.

After this time, it is removed the pipe and it is measures the distance between the two lines and it is written down the difference (positive or negative) in %.

➢ Dimensional control

This test is done periodically during the whole manufacturing process.

It consists to supervise the measure of the pipes and fittings by controlling the following parameters.

- Wall thickness (at least control 6 points)
- Thickness in the cup
- Length of the cup
- Medium external diameter
- Ovulation
- Length of the cut pipe

➢ Density

It is supervised the density of the raw material and the determined pipe. This test is done by following the Archimedes' method (it has a precision of 0.0001 gr.)

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❖ FUTURE PLAN

Future plans of FORTUNE POLY PLAST are they are still working in this polymer field and they are importing and developing some new technology in this plant and production will be increasing more and more. They are already booking of new machinery of pipe fittings items. And their basic planning is more manufacture of PVC items.

Company is selling their products in Gujrat and other states also. In India Company is transporting their products in Kerala, UP, MP, Sikkim, and mostly in South India. Company also thought about exporting their products out of India. But they have already busy with these states so that's why company is developing more manufacture plants in their unit.

➢ CONCLUSION

We conduct a research on PVC pipe and other pipe fitting product manufacturing Process and via this research we have been able to envision ourselves with ideas regarding the scope and challenges of business opportunities in Rajkot. We believe that it will really help us get our dreams come true in the future.

Through this project we have gained a lot of experience in finding out more about the subject matter and the entrepreneurship concept as well as financial and business concepts. Moreover we have gained the knowledge of the process and how this subject actually helps is to be an entrepreneur. After the project .we realise that setting u a new business requires a lot of thought and hard work.

In this project report we all are notice that polymer industry are very interesting for the daily uses. If we have not use polymer product than our life has many problem to face. Company are very developing and supporting to the environment they are using the recycle plant and they has also maintain the one small garden in their own land and they plant the tree in this garden. There are 35 workers are working with FORTUNE POLY PLAST.

Last but not the least, we would also like to thank all the friends, family members and our teachers who were always supporting and there when needed.

THE END

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ATMIYA UNIVERSITY

For the award of the degree of

Bachelor of Computer Application

Semester – VI (2020-2021)

Project Report on

SellnBy

Submitted by

Yesha Swami S.

Submitted to

Department of Computer Application & Information Technology

Atmiya University

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SellnBy

The Joy Of Getting Your Best!

A PROJECT SUBMITTED TO

Atmiya University

Department of Computer Application & Information Technology

RAJKOT

Submitted in partial fulfillment of the requirements for the degree of

"Bachelor of Computer Application"

Sem-6

(Year 2020-2021)

Submitted By:-

Swami Yesha S.

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Guided By:-

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Dr. Ripal Ranpara

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ATMIYA UNIVERSITY
(Established under the Gujarat Private University Act 11, 2018)
Yogidham Gurukul, Kalawad Road, Rajkot - 360005, Gujarat (INDIA)

Date: 15-03-2024

CERTIFICATE

This is to certify that,

Ms. Swami Yesha

of Bachelor of Computer Application

Semester VI

Has satisfactorily completed the project on

SellnBy
The Joy Of Getting Your Best!

For, Department of Computer Application,

ATMIYA University, Rajkot.

Signature
Dr. Ripal Ranpara
(Project Guide)

Registrar
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(Head of Department)
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Acknowledgement

It is great pleasure to present this report on the project named "SellnBy" undertaken by me and my partner as part of my BCA curriculum.

It is a pleasure that we find ourselves penning down these lines to express our sincere thanks to the people who helped us along the way in completing our project. We find inadequate words to express our sincere gratitude towards them. First and foremost we would like to express our gratitude towards our training guide Dr.Ripal Ranpara and Mr. Malay Solanki for placing complete faith and confidence in our ability to carry out this project and for providing us their time, inspiration, encouragement, help, valuable guidance. They took personal interest in spite of numerous commitments and busy schedule to help us complete this project.

Abstract

Online reselling website is in the process of interconnecting all the buyers and to develop a custom-made software which covers function like reselling management. The system not only takes care of registration but also on the Internet where customers can browse the catalog and select products of interest. User can select many products and those products stored in cart. At checkout time, the items in the shopping cart will be presented as an order. At that time, more information will be needed to complete the transaction. Usually, the customer will be asked to fill the basic details or select a billing address, a shipping address, a shipping option, and payment information such as credit card number.

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Serial No	Description		Page No
1.	**Introduction**		
	1.1	Project Summary	4
	1.2	Purpose	4
	2.3	Scope	5
	2.4	Report Outline	5
2.	**Literature Overview**		**8**
3.	**Project Management**		
	3.1	Project Development Approach	12
	3.2	Project Plan	13
4.	**System Requirements Specification**		
	4.1	User Characteristics	15
	4.2	Hardware and Software Requirements	15
5.	**System Analysis**		
	5.1	Technical Feasibility	17
	5.2	Economical Feasibility	17
	5.3	Operational Feasibility	18
	5.4	Functions Of System	18
	5.5	Use Case Diagram	19
	5.6	E-R Diagram	20
	5.7	Activity Diagram	22
	5.8	Data Flow Diagram	24
6.	**System Design**		
	6.1	Database Schema Design	27
7.	**Implementation**		**31**
8.	**Conclusion and Future work**		**47**

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Chapter 1: Introduction

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1.Introduction

Project Summary

Project Name	:	SellnBy
Devloped By	:	Swami Yesha
Front-End Language	:	HTML, CSS, JS
Backend Language	:	PHP
Database	:	PhpMyAdmin

Purpose

A reseller is a type of channel partner that acts as an intermediary between companies that make, distribute or provide IT products or services and end customers, which may be businesses or consumers. A key reseller role has been order fulfillment: The customer goes to a reseller to simplify the ordering process and offload procurement and order processing tasks.

Working with a reseller can also streamline product sourcing. A business that needs to purchase multiple technology components can make those purchases through a single reseller versus approaching multiple manufacturers or service providers directly. Competitive pricing may also attract customers to resellers.

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Scope

Reselling systems are designed to help organizations manage their sales processes more efficiently and effectively. The scope of a Reselling system can vary depending on the needs of the organization, but typically includes the following:

1. **Higher Earnings:**

The supporters show a view to believe that the persons working in the selling field have physical and mental qualities. This is the reason that they have been provided with higher remuneration. In addition to regular salary they are paid with commission on the basis of increased volume of sales. Their incomes are in direct proportion to the time & energy.

2. **Personal Satisfaction:**

Everyone needs psychic income too. Selling provides personal satisfaction also. Salesman earns his satisfaction through customer satisfaction by solving customer problems.

3. **Security:**

Certain people believe that reselling job is involving risk and uncertainty. ==========

4. **Freedom and Guidance:**

Salesman has his own control on his timings of selling duties. He has freedom in functioning and decision making upto certain limits. He has freedom to deal with his customers in his selling territory and the products that he deals with. He himself is the administrator and guide for his functions in the field.

5. **Development of Personality and Responsibility:**

Selling develops various challenges before a salesman. In a changing situation, he has to deal with different people. This will help in his mental development and maturity of personality. In addition to this, he becomes self-disciplined and responsible as he gets the knowledge for self-decision-making and initiatives.

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Report Outline

Definition: I have selected a project definition, which will serve as the basis for my project, outlining the scope, objectives, and expected outcomes.

Research: Following the selection of my project definition, I conducted research to identify and define the various scopes and components of the project, including its goals, tasks, timelines, and resource requirements.

Diagrams: After conducting extensive research on my project, I created various diagrams to visually represent the details, processes, and flow of the project. These diagrams will help me to better understand the project and communicate its various aspects to others.

Choosing Technology: Following the completion of my research and the creation of project diagrams, I evaluated various technology options and selected the one that is most suitable for developing my project.

Developing: Once I finalized the technology for my project, I commenced the development process, implementing various features and functionalities based on the project's requirements. During the development process, I conducted various testing rounds to ensure that the project was functioning as intended, and made necessary changes to improve its overall performance and functionality.

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Chapter 2:
Literature Overview

2. Literature Overview

What is HTML

HTML (Hypertext Markup Language) is a markup language used to create and structure content for the web. It is a standard language used to create web pages and is used to define the structure and layout of web documents.

HTML consists of a series of elements, which are represented by tags. These tags define the content and structure of the document. For example, the <head> tag is used to define the head section of the document, which typically includes information such as the title and meta data. The <body> tag is used to define the body section of the document, which includes the main content of the web page.

HTML documents are created using a text editor or a specialized HTML editor. The document is then saved with an .html file extension and uploaded to a web server. When a user visits a web page, their browser retrieves the HTML document from the server and renders it as a web page.

HTML also allows for the inclusion of other resources, such as images, videos, and stylesheets. These resources are typically linked to the HTML document using a special tag called the <link> tag.

HTML is constantly evolving, with new versions being released periodically. The current version of HTML is HTML5, which includes new features such as improved support for multimedia, new semantic tags for better accessibility and search engine optimization, and improved support for mobile devices.

What is CSS

CSS (Cascading Style Sheets) is a style sheet language used to describe the presentation and layout of HTML (Hypertext Markup Language) documents. It provides a way to separate the content of a web page from its visual presentation, which makes it easier to maintain and update the design of a website.

With CSS, you can define the styles for different HTML elements, such as the font size and color of text, the background color of a page, the positioning and size of

images, and the layout of page elements. CSS also allows for more complex designs, such as creating responsive layouts that adjust to different screen sizes and devices.

CSS works by defining styles in a separate file or within the HTML document itself using special tags called selectors. These selectors target specific HTML elements and define the style properties that should be applied to them.

CSS is an essential tool for web designers and developers, and it is often used in conjunction with other technologies such as HTML and JavaScript to create engaging and dynamic web pages.

What is JS

JavaScript is a programming language used to create interactive and dynamic web pages and web applications. It is a client-side scripting language, which means it is executed on the client's computer rather than the server, and can be used to add interactivity, functionality, and behavior to web pages.

JavaScript is often used in conjunction with HTML and CSS to create interactive elements such as pop-ups, forms, and menus, as well as to validate and manipulate user input. It can also be used to create animations, perform calculations, and communicate with server-side scripts.

What is PHP

PHP stands for Hypertext Preprocessor, which is a server-side scripting language used for web development. PHP is particularly well-suited for creating dynamic web pages and web applications that interact with databases and other server-side technologies.

- Open-source: PHP is an open-source language, which means it is free to use, modify, and distribute.
- Easy to learn: PHP is relatively easy to learn and has a simple and intuitive syntax that is similar to C and Java.
- Cross-platform compatibility: PHP is a platform-independent language, which means it can be used on a wide range of operating systems, including Windows, Linux, and macOS.

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What is PhpMyAdmin

PhpMyAdmin is a free and open-source web-based application used to manage MySQL databases. It is written in PHP and provides an intuitive web interface for managing MySQL databases, tables, fields, and data.

With PhpMyAdmin, you can perform tasks such as creating and deleting databases, creating and modifying tables, inserting, updating and deleting data, importing and exporting data, and managing user accounts and permissions.

PhpMyAdmin is used by web developers and system administrators who work with MySQL databases. It is particularly useful for managing large databases and complex database structures, as it provides an easy-to-use graphical interface for managing database tasks.

PhpMyAdmin is compatible with many web servers and operating systems, and it is available in many languages. It is widely used and is a popular tool in the web development community.

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Chapter 3:
Project Management

3. Project Management

Project Development Approach

- **Define the project scope**: Start by defining the scope of the project. What are the objectives of the project? What are the deliverables? Who are the sellers? What are the reselling?
- **Conduct a needs assessment**: Before developing the reselling project, you need to assess the needs of the organization. Identify the current sales processes, the gaps in the process, and the requirements for a new system.
- **Define the requirements**: Once you have assessed the needs, define the requirements for the reselling project. What are the functionalities that the system should have? What are the user requirements?
- **Develop a project plan**: Develop a project plan that includes the reselling. Identify the risks and develop contingency plans.
- **Choose a technology platform**: Choose a technology platform that suits the requirements of the reselling project. This could be a cloud-based solution or an on-premise solution.
- **Develop the system:** Once you have the project plan and technology platform in place, start developing the system. Follow the software development life cycle (SDLC) process.
- **Test the system**: Once the development is complete, test the system to ensure that it meets the requirements. Identify any defects and fix them.
- **Deploy the system**: Once testing is complete, deploy the system in a phased manner. Train the users on the new system.
- **Monitor and maintain**: Monitor the system after deployment to ensure that it is functioning as expected. Maintain the system by providing updates and fixing any issues.

By following these steps, you can successfully plan and develop a reselling project.

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Project Plan

Your project plan is essential to the success of any project. Without one, your project may be susceptible to common project management issues such as missed deadlines, scope creep and cost overrun. While writing a project plan is somewhat labor intensive up front, the effort will pay dividends throughout the project life cycle.

- Define your project's stakeholders, scope, quality baseline, deliverables, milestones, success criteria and requirements. Create a project charter, work breakdown structure (WBS) and a statement of work (SOW).
- Identify risks and assign deliverables to your team members, who will perform the tasks required and monitor the risks associated with them.
- Organize your project team (customers, stakeholders, teams, ad hoc members, and so on), and define their roles and responsibilities.
- List the necessary project resources, such as personnel, equipment, salaries, and materials, then estimate their cost.
- Develop change management procedures and forms.
- Create a communication plan, schedule, budget and other guiding documents for the project.

Each of the steps to write a project plan explained above correspond to the 5 project phases, which we will outline in the next section.

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Chapter 4: System Requirement Specification

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4. System Requirements Specification

User Characteristics

- **Admin** : Admin can do this functionalities, just like Add/Edit/Remove Sellers, Products, Users.
- **Users** : They can Add/Remove Products. Buyers can't Add new products and can't modify other product Details where Admin can do it.

Hardware and Software Requirements

- **Operating System** : Software can run on any os Such as Windows,Linux etc.
- **Web Server** : Software that is installed on a computer and is used to host websites is known as a web server. Apache is a common web server application.
- **Web Development Language** : Websites are typically designed using languages such as HTML, CSS, JS. Also it can developed using server side language like PHP.
- **Database** : It require server side database connectivity to store all software data. Commenly most used database is PHPMYADMIN.
- **Internet :** Software can accessed over the internet, So better internet connectivity is required.
- **Storage :** 256 GB HDD
- **RAM :** 4 GB

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Chapter 5:
System Analysis

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5. System Analysis

Technical Feasibility

The technical feasibility of a Reselling project depends on the availability of the required hardware, software, and technical resources.

Hardware requirements for a Reselling project may include computers, mobile devices, networking equipment, and servers. The hardware should be able to handle the required processing power and storage capacity to support the Reselling software and other applications.

Software requirements may include a Reselling software application, as well as supporting software such as a database management system, a customer relationship management (CRM) system, and communication tools. The software should be compatible with the hardware and should be able to support the required features and functionality of the Sales Management project.

Economical Feasibility

The economical feasibility of a Reselling project refers to whether theproject can be completed within a reasonable budget and whether it can provide a sufficient return on investment (ROI).

To determine the economical feasibility of a Reselling project, a cost-benefit analysis should be conducted. This analysis involves estimating the costs associated with implementing and operating the Reselling project and comparing them to the expected benefits and savings that the project will provide.

The costs of a Reselling project may include the costs of hardware, software, and technical resources, as well as the costs of training, implementation, and ongoing maintenance and support.

The benefits of Reselling project may include increased sales revenue, improved customer retention, streamlined sales processes, and reduced operational costs. These benefits can be quantified and estimated based on historical data or industry benchmarks.

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Operational Feasibility

The operational feasibility of a Reselling project refers to whether the project can be successfully implemented and integrated into the existing business operations and processes.

To assess the operational feasibility of a Reselling project, the following factors should be considered:

- **User Acceptance**: Will the users be able to use the system effectively and efficiently? Will they be willing to adopt the new system?
- **Business Processes**: Will the new Reselling system integrate seamlessly with existing business processes, or will it require significant changes to be made?
- **Technical Compatibility**: Will the Reselling system be compatible with existing hardware and software systems?
- **Scalability**: Will the Reselling system be able to scale up or down as needed, based on changes in the business environment or users volume?
- **Data Accuracy**: Will the Reselling system provide accurate and reliable data to support decision-making and reporting?
- **Security**: Will the Reselling system be secure and protect sensitive data such as customer information and users data?

By considering these factors and addressing any operational challenges early on in the project, the Reselling system can be designed and implemented in a way that is operationally feasible and beneficial for the reseller.

Functions of System

- Seller Data Management
- User – Profile Management
- Creation of Demand
- Establishing contact with the buyers
- Negotiations

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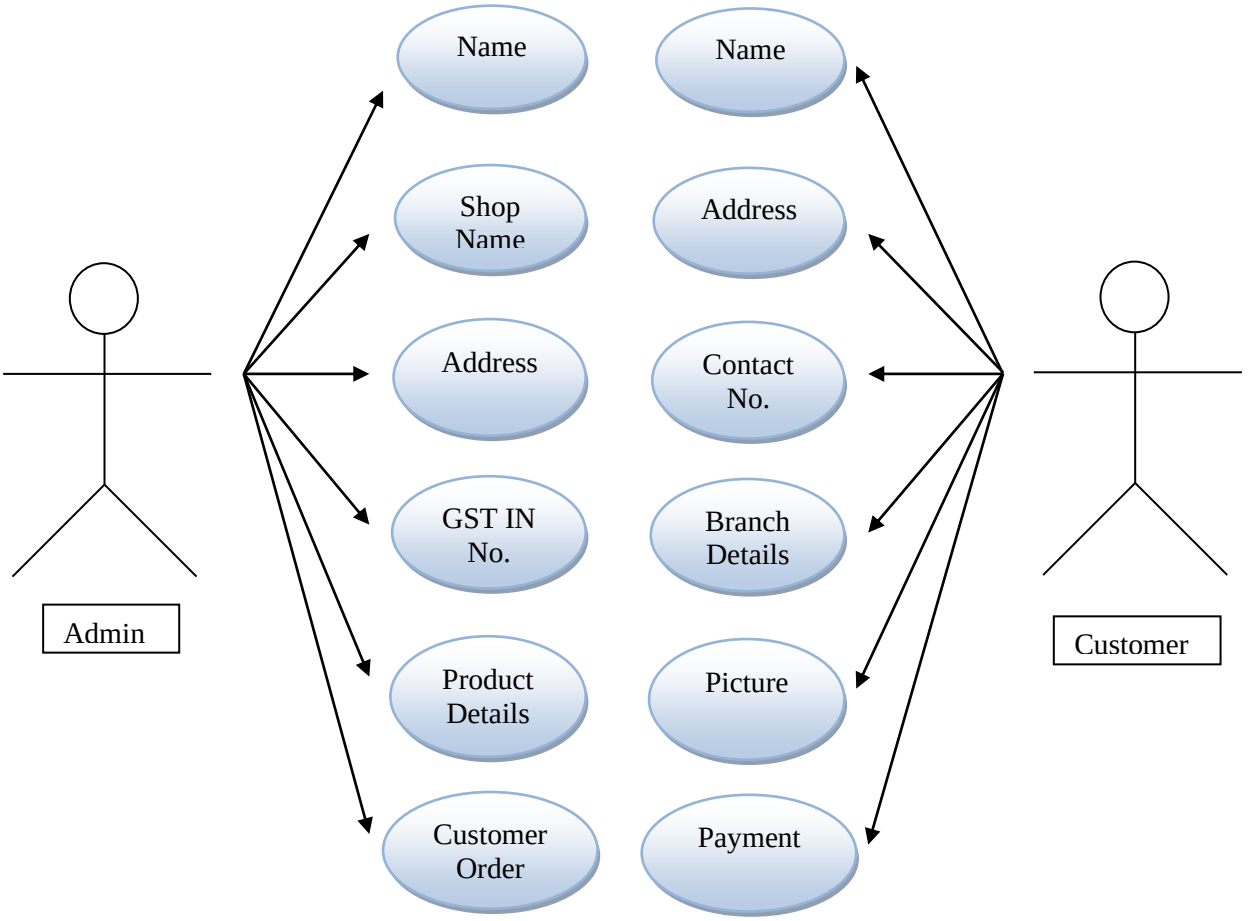
Use – Case Diagram

A Use-Case Diagram is a graphical representation of the interactions between a system and its actors, which can be individuals or other systems. It is commonly used in software engineering to model the behavior of a system or software application.

In a Use-Case Diagram, each use case represents a specific functionality or behavior that the system can perform. The actors are represented by stick figures and are external entities that interact with the system. Each actor is associated with one or more use cases that represent their interactions with the system.



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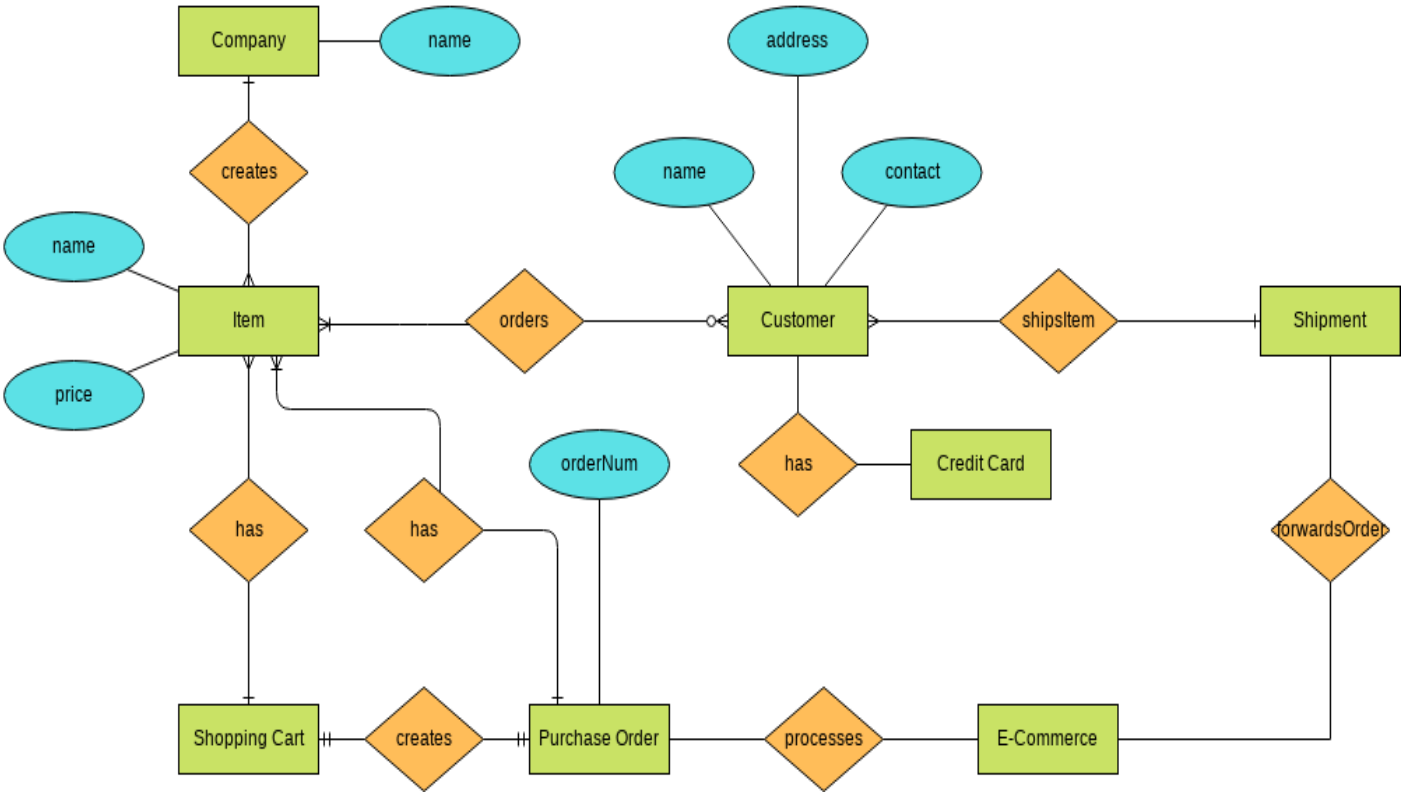
E-R Diagram

ER diagram, short for Entity-Relationship diagram, is a graphical representation of entities and their relationships to each other within a system or organization. It is commonly used in database design to model the relationships between tables.

In an ER diagram, entities are represented as rectangles, and relationships are represented as diamonds. Entities are the objects or concepts within the system, such as customers, orders, products, or employees. Relationships represent how the entities are connected to each other, such as one-to-one, one-to-many, or many-to-many relationships.

ER diagrams are useful in database design as they help to visualize the structure of a database and ensure that all relationships between entities are properly defined. They also help to identify potential issues with the design before the database is implemented.

In addition to entities and relationships, an ER diagram may also include attributes, which are characteristics or properties of an entity. For example, a customer entity might have attributes such as name, address, and email address. Attributes are typically represented as ovals connected to the entity rectangle by a line.



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Activity Diagram

An activity diagram is a type of UML (Unified Modeling Language) diagram that represents a process, workflow, or use case in a visual way. It is used to model the steps, actions, and decisions involved in a process or activity, and to illustrate the flow of control between different elements of the process.

In an activity diagram, each step or action is represented by a node, which can take different shapes depending on the type of action it represents. Nodes can be connected by arrows, which indicate the flow of control between them. Control flows can be conditional, indicating that certain conditions need to be met before the next step can be executed, or they can be parallel, indicating that multiple steps can be executed simultaneously.

Activity diagrams can be used for a variety of purposes, such as documenting business processes, designing software applications, or modeling complex workflows. They are particularly useful for identifying potential bottlenecks, redundancies, or inefficiencies in a process, and for helping stakeholders to understand the sequence of actions involved in achieving a particular goal or objective. Overall, activity diagrams provide a visual representation of a process or workflow, making it easier to analyze, understand, and improve.

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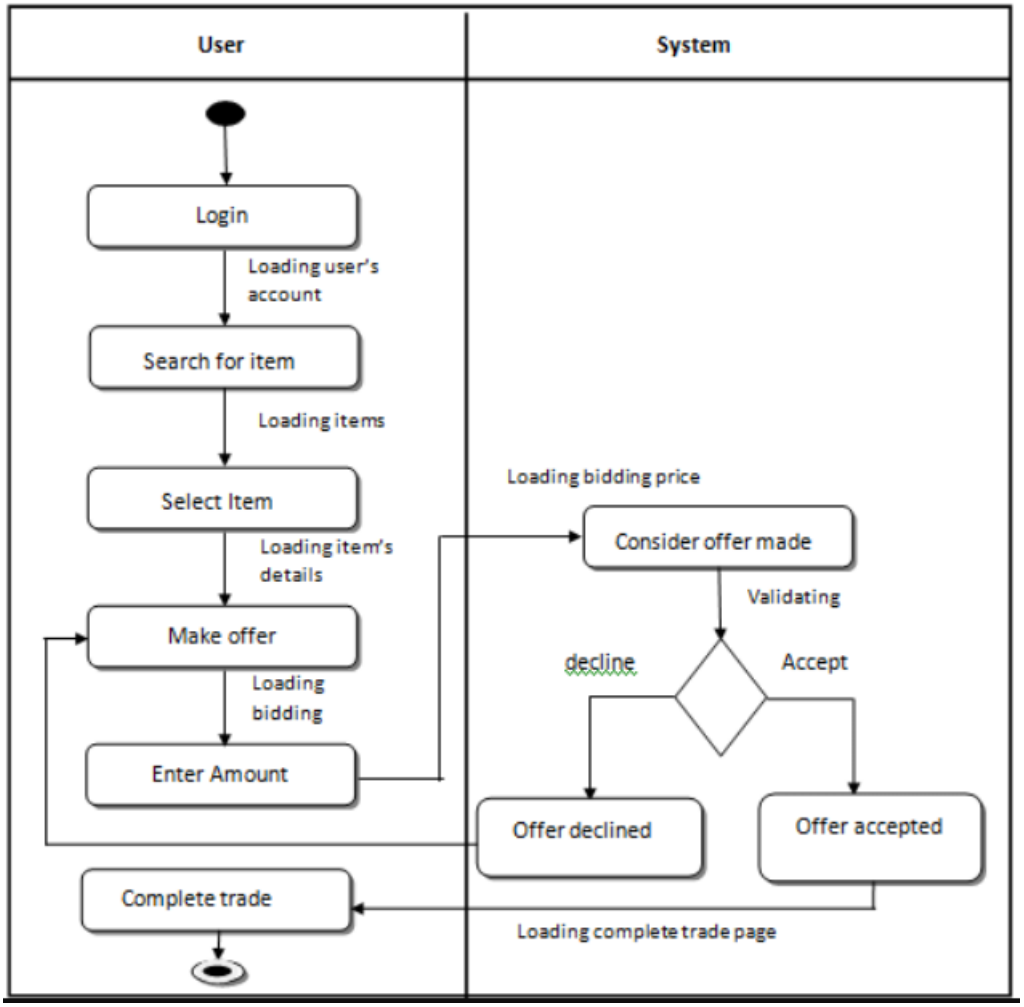

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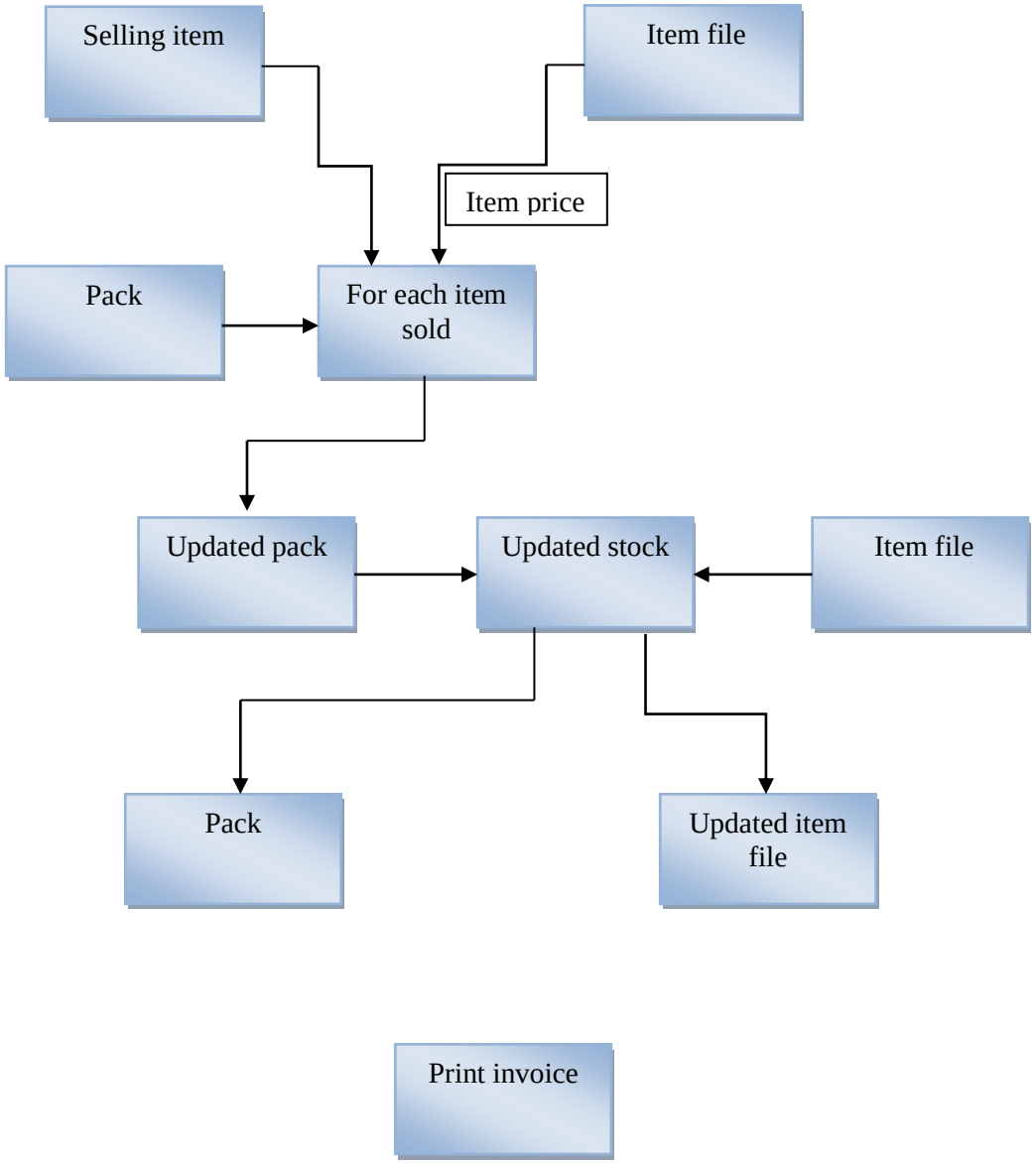
DFD

DFD stands for Data Flow Diagram, which is a graphical representation of the flow of data through a system. It is a visual tool used to model, analyze, and design information systems, showing the inputs, processes, outputs, and storage of data in a system.

In a DFD, data is represented by arrows, which show the flow of data between different entities in the system. Entities can be people, organizations, or other systems that interact with the system being modeled. Processes are represented by circles or rectangles, and show how data is transformed within the system. Data stores are represented by rectangles, and show where data is stored within the system.

DFDs are commonly used in system analysis and design, where they help to clarify the structure and behavior of a system, and identify areas for improvement. They can be used to model different levels of detail, from a high-level overview of the entire system to a detailed analysis of specific processes or interactions. Overall, DFDs provide a clear and concise way to represent the flow of data through a system, making it easier to understand and analyze.



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Chapter 6:
System Design

6. System Design

Database Schema Design

--DataTables—

	Table	Action	Rows	Type	Collation	Size	Overhead
☐	admin	Browse Structure Search Insert Empty Drop	0	InnoDB	utf8mb4_general_ci	16.0 KiB	-
☐	category	Browse Structure Search Insert Empty Drop	0	InnoDB	utf8mb4_general_ci	16.0 KiB	-
☐	order	Browse Structure Search Insert Empty Drop	0	InnoDB	utf8mb4_general_ci	16.0 KiB	-
☐	products	Browse Structure Search Insert Empty Drop	0	InnoDB	utf8mb4_general_ci	16.0 KiB	-
☐	seller	Browse Structure Search Insert Empty Drop	1	InnoDB	latin1_swedish_ci	16.0 KiB	-
☐	users	Browse Structure Search Insert Empty Drop	0	InnoDB	utf8mb4_general_ci	16.0 KiB	-
	6 tables	Sum	1	InnoDB	utf8mb4_general_ci	96.0 KiB	0 B

--Admin —

	id	Dealer_Name	Business_Name	Contact_No	Email	Address
☐ Edit Copy Delete	13	Rajkumar Singhania	RK Enterprise	9926645444	contact@rk.com	Borivali East, Mumbai
☐ Edit Copy Delete	14	Dilipbhai Arora	Amar Retailer	8989012345	diliparora@gmail.com	South Bopal, Ahmedabad
☐ Edit Copy Delete	15	Mr. Pradip Setti	KK Enterprise	9998877766	pradip@gmail.com	Malviya Nagar, Jaipur
☐ Edit Copy Delete	16	Jaykumar Patel	Umiya Enterprise	9355545455	jay@gmail.com	Cubbon Park, Banglore
☐ Edit Copy Delete	17	Mr.Vikas Shah	Vikas Enterprise	8686644453	vikas@gmail.com	Waghodia Road, Vadodara

Check all *With selected:* Edit Copy Delete Export

Show all | Number of rows: 25 Filter rows: Search this table Sort by key: None

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--Category—

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Chapter 7: Implementation

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7. Implementation

Admin Side

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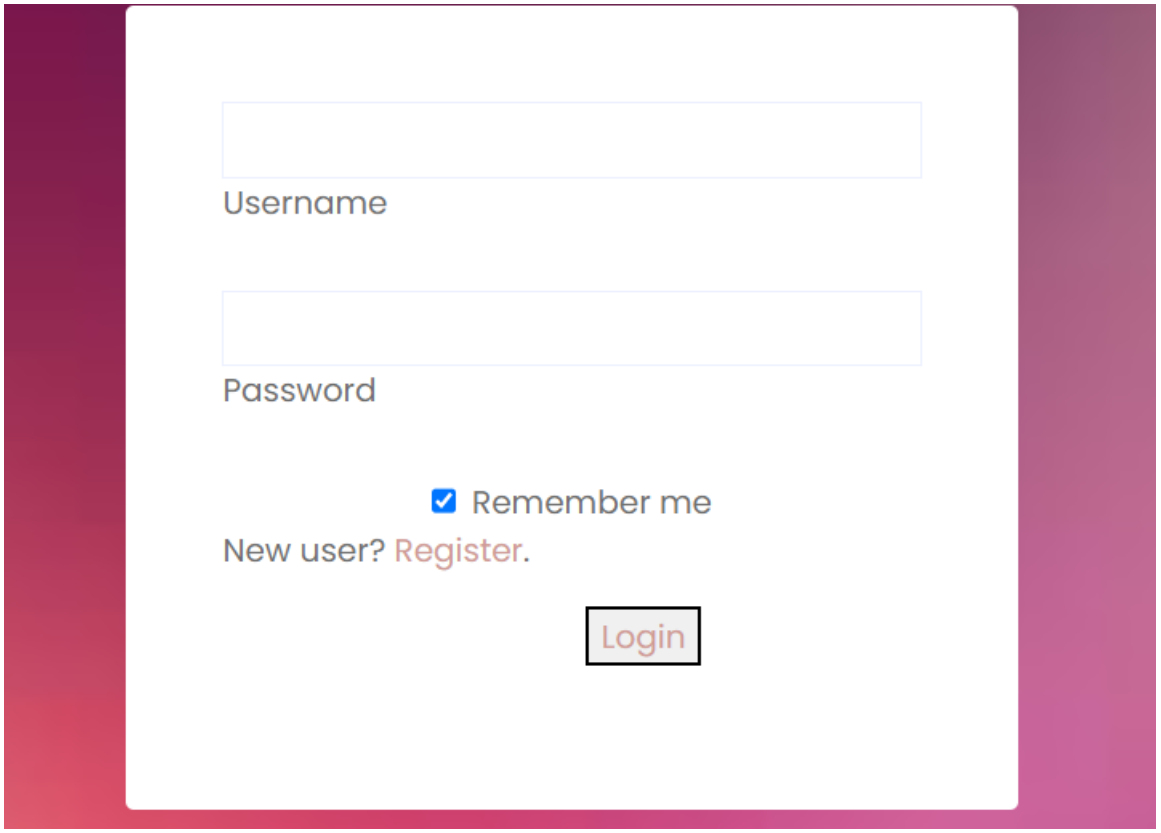

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Chapter 8: Conclusion & Future Work

8. Conclusion and Future Work

- In conclusion, the SellnBy project in PHP has been a success in achieving its objectives of developing a comprehensive reselling system for the reseller. The project involved a thorough analysis of the system requirements, followed by a detailed design and implementation process that has resulted in a user- friendly system that meets the needs of the organization.

- The literature review provided a solid foundation for the project, outlining the key concepts and theories related to reselling, while the project management methodology ensured that the project was delivered on time and within budget. The system requirement specification provided a clear roadmap for the project, while the system analysis phase ensured that the system was tailored to the specific needs of the organization.

- The system design phase involved the creation of a detailed plan for the system's architecture and functionality, which was then implemented through the use of PHP programming language. The final system is both reliable and efficient, providing users with a user-friendly interface and the ability to manage their sales processes with ease.

- In future work, there is potential for further improvements and refinements to the system. For instance, the addition of new features such as reporting and analytics could provide users with even more insights into their sales performance. Additionally, ongoing maintenance and support will be required to ensure the system continues to meet the needs of the organization as its sales management processes evolve.

- Overall, the SellnBy project has been a valuable contribution to the organization, providing a solid foundation for reselling and offering the potential for further improvements and enhancements in the future.

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A Dissertation thesis entitled

"SYNTHESIS, CHARACTRIZATION AND PHYSICO-CHEMICAL PARAMETERS STUDIES OF BENZODIAZEPINE DERIVATIVE"

Submitted in partial fulfillment of the requirements

For the award of the degree of

Master of Science

IN

INDUSTRIAL CHEMISTRY

Submitted By

MR. YAGNIK P. SOLANKI [ENROLLMENT NO. 190722017]
MR. DHARMIK V. SUDANI [ENROLLMENT NO. 190722018]

Under the guidance of

ER. DHAVAL A. TANK
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FACULTY OF SCIENCE (FoS)
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Rajkot

2020-2021

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Dedicated to

My Family & Department of Industrial Chemistry

Without their love, support and constant encouragement this would not have been possible.

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Yogidham Gurukul, Kalawad Road,
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CERTIFICATE

This is to certify that the dissertation thesis entitled **"Synthesis, Characterization and Physico-Chemical Parameters Studies of Benzodiazepine Derivative"** submitted by **Mr. SOLANKI YAGNIK PARBATBHAI (Enroll. 190722017),** A Post Graduate student of Faculty of Science, Department of Industrial Chemistry, Semester-IV, Atmiya University, Rajkot, as a part of the degree of Master of Science (M.Sc.) in Industrial Chemistry during academic year 2020-2021.

D. A. Tank

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D. A. Tank

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DECLARATION

We undersigned, hereby declare that the work assimilated in the dissertation thesis entitled **"Synthesis, Characterization and Physico-Chemical Parameters Studies of Benzodiazepine Derivatives"** has been carried out by us at Faculty of Science, Department of Industrial Chemistry, Atmiya University, Rajkot, Gujarat, India, under the supervision and Guidance of **Er. Dhaval A. Tank, Assistant Professor, Faculty of Science, Department of Industrial Chemistry, Atmiya University, Rajkot, Gujarat, India.**

To the best of our knowledge and belief, the work included in this thesis is quite original and has not submitted to any other Institution or University for the award of any degree either in this or any other form.

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We wish to express our sincere gratitude and honour to our Research supervisor **Er. Dhaval A. Tank, Assistant Professor, Faculty of Science, Department of Industrial Chemistry, Atmiya University, Rajkot,** for their inspiring, splendid and authentic guidance, moral support and constant encouragement throughout our research work. Their passion and dedication towards research has stimulated, provoked and facilitated us to complete this endeavour. We could not have imagined having a better Research Supervisor and mentor for our M. Sc study. Their role will always remain fundamental in shaping our future.

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CONTENTS

ABSTRACT: 9

LITERATURE REVIEW: ……..10

CHAPTER-1:GENERAL INTRODUCTION 17

CHAPTER-2: SYNTHESIS OF 20

1,3-Dihydro-4-(2-hydroxyphenyl)-2H-1,5-benzodiazepin-2-one..... 20

Section-2.1: Reaction Scheme 20

Section-2.2: Method..... 22

CHAPTER-3: PHYSICO-CHEMICAL PARAMETERS 23

Section-3.1: Solubility 23

Section-3.2: Density..... 60

Section-3.2: Viscosity..... 69

CONCLUSION……..85

REFERENCE……..86

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ABSTRACT:

Benzodiazepines are widely used drugs for several indications. This study provides, on the other hand, a global vision of the family starting for their fortuitous discovery, the synthesis of their derivatives, their mechanism of action widely known nowadays, the actual classification according to the chemical structure and pharmacokinetic properties, and their uses and indications, the traditional and the new ones. On the other hand, the study is focused in the mainly problems of benzodiazepines, dependence and tolerance, many times led by a misuse of the patient, wrong prescriptions, or extended treatments. A withdrawal program is proposed that includes the important factors or criteria to success, with a slow and gradual reduction of these drugs, avoiding relapse or severe adverse effects. New lines of research related to benzodiazepines are taken into account, which not only include the new therapeutic uses but also the adverse effects in short and long term.

BZDs have proven to be excellent drugs for the known pharmacological properties they present, as: Action-Clinical uses, Anxiolytic- Anxiety and panic/phobias, alcohol withdrawal, Hypnotic- Insomnia, Muscle relaxant- Muscle spasms, spasticity caused by CNS pathologies, Anticonvulsive- Attacks caused by drug intoxications, some forms of epilepsy, Amnesic- Intraoperatively or pre-surgery medication.

The variation of the dose changes the effects: a hypnotic BZD administered in low doses produces anxiety-relieving effects, whereas a BZD marketed as an antianxiety drug at higher doses induces sleep.

Adverse effects:

In general, BZD are well-tolerated drugs if the use and administration are correct. In most of the cases, adverse reactions are a prolongation of the pharmacological action that affects the CNS.

Frequent: somnolence (50% of the patients experienced it during the first days of treatment), sedation, ataxia (in the older times), fatigue, and anterograde amnesia (recent facts).

Occasionally: dizziness, headache, depression, confusion, and dysphasia.

Exceptionally: urticaria, pruritus, and visual and/or audition alterations.

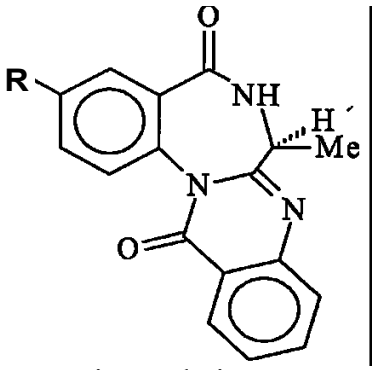
LITERATURE REVIEW:

Benzodiazepine structural motifs are found in numerous pharmaceutical agents with a wide range of biological applications and hence recently they have gained considerable attention by chemists.

Benzodiazepines are a class of compounds that have selective activity against a diverse array of biological targets. Their basic structure comprises a benzene ring fused to a seven-membered ring heterocycle, which contains two nitrogen atoms within the ring. The names of the benzodiazepines are derived from the location of the nitrogen atoms within the heterocycle ring.

Benzodiazepines (BZDs), as a class of antianxiety, hypnotic, d muscle relaxing agents, have replaced traditional barbiturates. Benzodiazepines are more effective in alleviating anxiety and stress and they have fewer and less severe side effects. Consequently, BZDs continue to be used to treat such conditions as phobic and panic disorders, as well as depression and migraines. In additions to trating anxiety, BZDs are often prescribed for treating insomnia, alcohol withdrawl and more recently, epilepsy.

I, 5-benzodiazepiiles are being investigated for their central nervous system depressant properties. Additionally, many benzodiazepine alkaloids found in nature, such as Circumdatin (1) and Circumdatin (2).

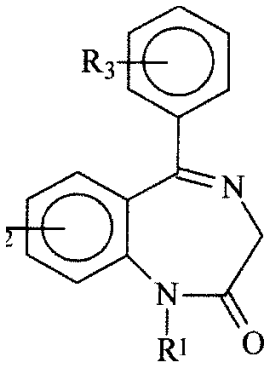


Circumdatin

1 =R=H

2=R=OH

As structural analogues of benzodiazepines derivatives (3) represent a significant class of neurologically active agents.



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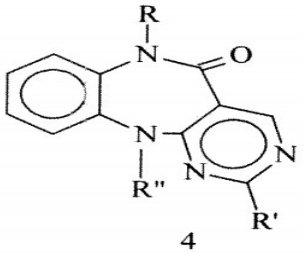
5H-pyrimido [4, 5-b]- [l,5]benzodiazepin-5-ones (4) and pyrazolo[3,4-b]-

[l, 5] benzodiazepin-4-ones (5 and 6) as well as tetracyclic derivatives 7 are reported as analogues of nevirapine and its very active tetracyclic derivatives, respectively.

Compounds 4, 5, 6 and 7 display effect against the HIV-I multiplication in acutelyinfected MT-4 cells and the HIV-I rRT in enzyme assays.



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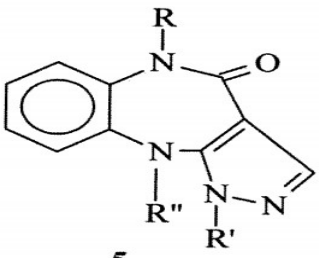

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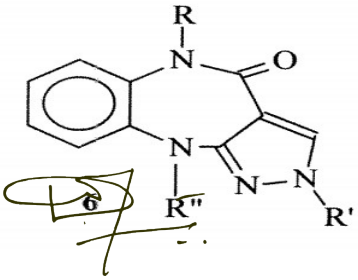

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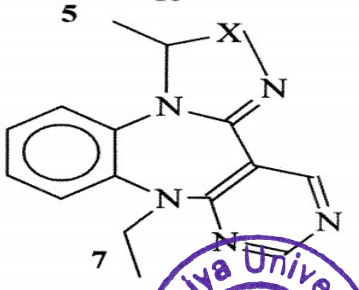

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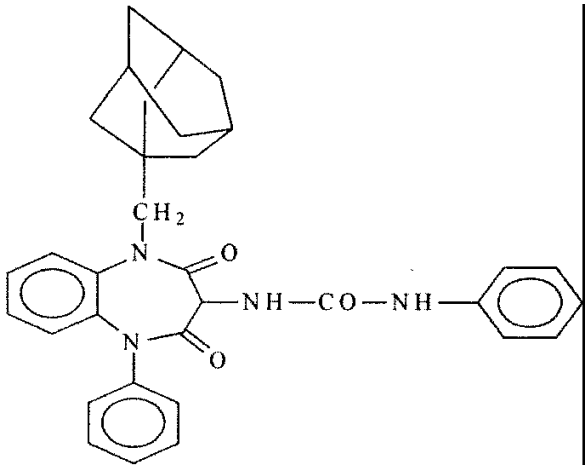
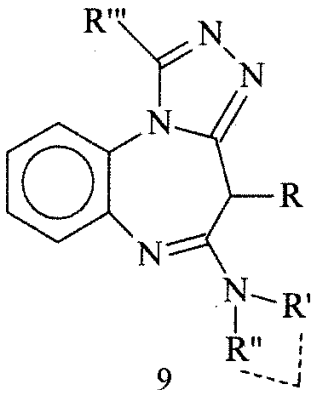
l-alkyl-5-aryl-l, 5-benzodiazepines bearing either arylureido14-16 or (aryloxycarbonyl) amino groups at the C-3 position 8 have been reported as CCK.2 antagonists. Brain neurotransmitter cholecystokinin (CCK.2)4.



8

A new class of 4H-[l, 2, 4] triazolo (4, 3-a] [I, 5] benzodiazepine derivatives 9, Displayanalgesic and anti-inflammatory activities.



9

The psychotropic activity of some 4H-[l,2,4]triazolo[4,3-a] [l,4]benzodiazepine derivatives is well known. Estazolam **10,**

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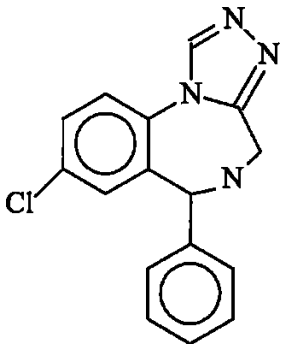
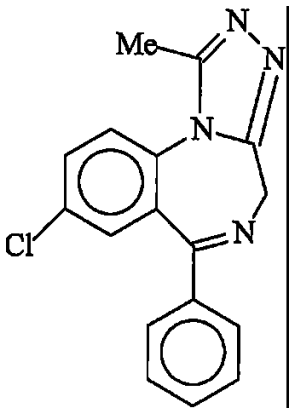
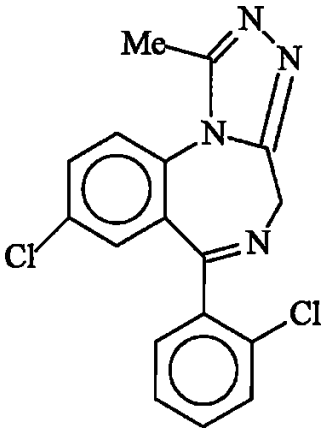


10

Alprazolam 11 and triazolam **12** are presently available for clinical use as hypnotics or tranquilizers.





11 12

Analogous tricyclic derivatives were also prepared starting from the 1, 5-benzodiazepine system in order to obtain new compounds provided with central nervous system (CNS) activity.

For instance, the 4H- [1, 2, 4] triazole [4, 3-a][l, 5]benzodiazepine derivatives **13, 14** were actually active as anticonvulsants.

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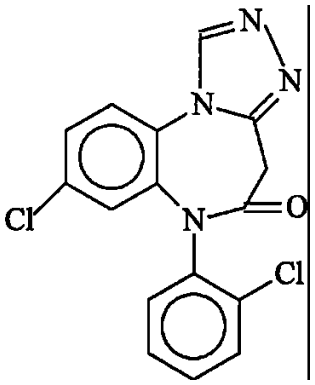

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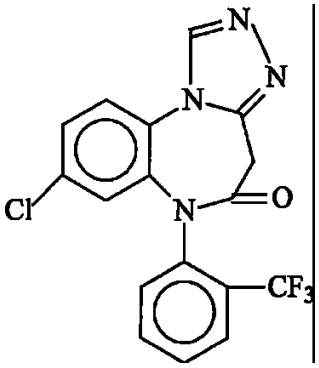
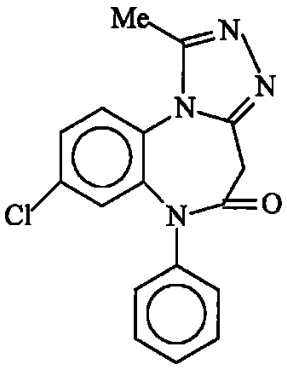


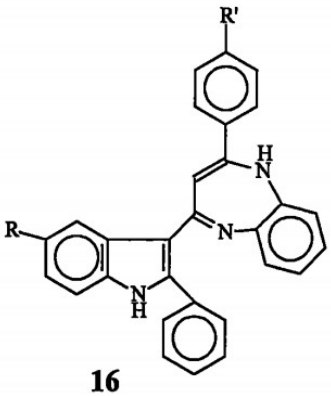
M

Molecule **15** showed CNS depressant properties.



15

7-substitutedphenyl-5-(5'-substituted-2'-phenylindol3'-yl) 1-4-benzo[b]diazepines **16** showed good analgesic and anti-inflammatory activity.



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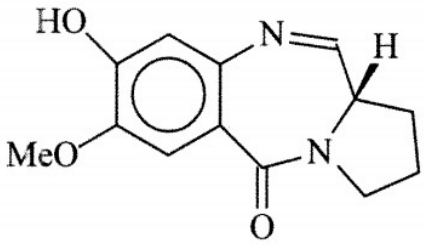
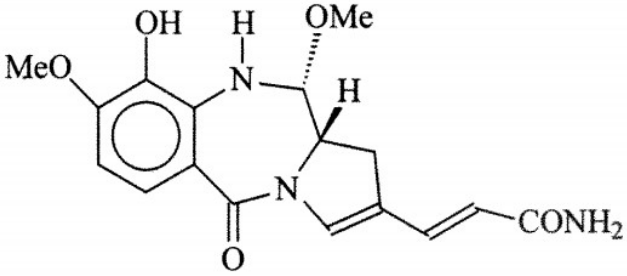
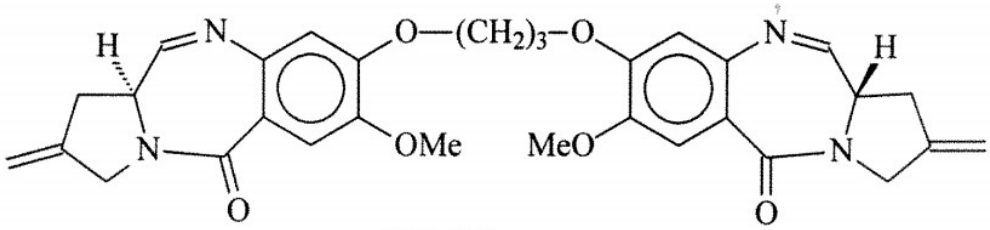
The pyrrolo[2,l-c][l,4]benzodiazepines(PBDs) are a group of potent ,naturally occurring, antitumor antibiotics produced by various streptomyces species. A number naturally occurring and synthetic compounds based on this PBD ring system, such asanthramycin, mchicamycin, abbeyeymycin, DC-81 and its dimmers have shown varying degree of DNA binding affinity and anticancer activity.



DC-81



Anthramycin



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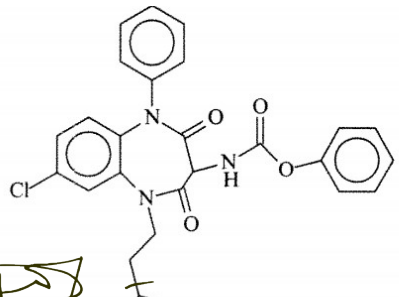
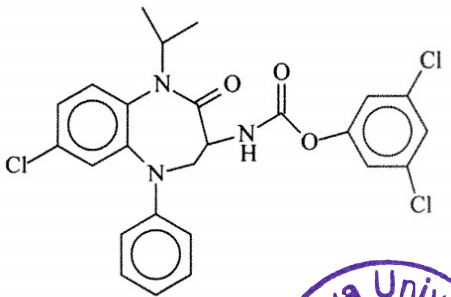
The 1,5-benzodiazepines core is indeed a privileged scaffold found compounds active against a variety of target types including peptide hormones (such as CCK), Interleukin converting enzymes (ICE) and potassium blockers.



Cholecystokinin A (CCK) Antagonist



IK Blockers

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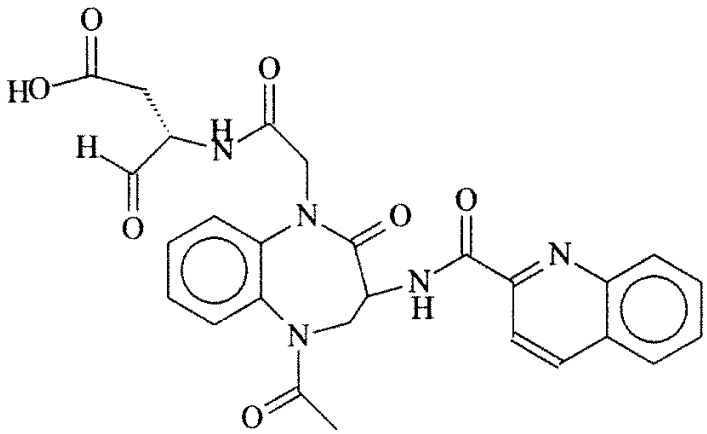
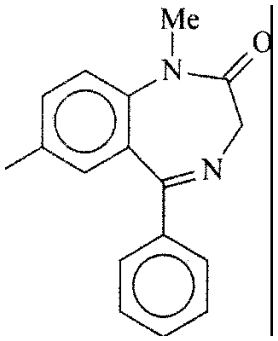
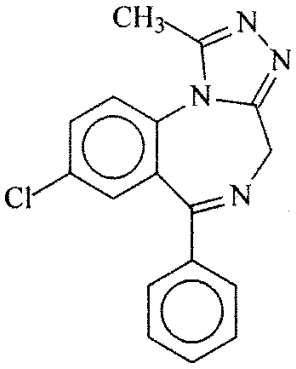


Interleukin converting enzymes

Whereas 1, 4-benzodiazepines -2, 5-diones are anticonvulsant and potent inhibitors of platelet aggregation. Drugs currently in use in the treatment of anxiety, panic, schizophrenia, and sleep disorders contain the 1, 4-benzodiazepine core (Valium and Xanax).



Valium



Xanax

2, 3-Benzodiazepines have been evaluated for their anticonvulsant, anti epileptic and anti seizure properties.

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CHAPTER-1

GENERAL INTRODUCTION:

Benzodiazepines, also known as benzos, belong to class of psychoactive drugs whose main chemical structure is the fusion of a benzene ring and a diazepine ring. The first such drug, chlordiazepoxide, was discovered accidentally by Leo Sternbach in 1955, and was made available in 1960 by Hoffmann–La Roche, which, since 1963, has also marketed the benzodiazepine diazepam (Valium).[1] In 1977 benzodiazepines were globally the most prescribed medications.[2] They are in the family of drugs commonly known as minor tranquilizers.[3]

Benzodiazepines enhance the effect of theneurotransmittergamma-aminobutyric acid(GABA) at the $GABA_A$ receptor, resulting in sedative, hypnotic (sleep-inducing), anxiolytic (anti-anxiety), anticonvulsant, and muscle relaxant properties. High doses of many shorter-acting benzodiazepines may also cause anterograde amnesia.[4] These properties make benzodiazepines useful in treating anxiety, insomnia, seizures, muscle spasms, alcohol withdrawal and as a premedication for medical or dental procedures.[5] Benzodiazepines are categorized as either short, intermediary, or long-acting. Short- and intermediate-acting benzodiazepines are preferred for the treatment of insomnia; longer-acting benzodiazepines are recommended for the treatment of anxiety.[6]

Benzodiazepines are generally viewed as safe and effective for short-term use, although cognitive impairment and paradoxical effects such as aggression or behavioral disinhibition occasionally occur. A minority of people can have paradoxical reactions such as worsened agitation or panic.[7] Benzodiazepines are also associated with increased risk of suicide.[8] Long-term use is controversial because of concerns about decreasing effectiveness, physical dependence, withdrawal, and an increased risk of dementia and cancer.[9][10][11][12] In the long-term, stopping benzodiazepines often leads to improved physical and mental health.[13][14] The elderly are at an increased risk of both short and long-term adverse effects,[13][15] and as a result, all benzodiazepines are listed in the Beers List of inappropriate medications for older adults.[16] There is controversy concerning the safety of benzodiazepines in pregnancy. While they are not major teratogens, uncertainty remains as to whether they cause cleft palate in a small number of

babies and whether neurobehavioral effects occur as a result of prenatal exposure;[17] they are known to cause withdrawal symptoms in the newborn.

Benzodiazepines can be taken in overdoses and can cause dangerous deep unconsciousness. However, they are less toxic than their predecessors, the barbiturates, and death rarely results when a benzodiazepine is the only drug taken. When combined with other central nervous system (CNS) depressants such as alcoholic drinks and opioids, the potential for toxicity and fatal overdose increases.[18][19] Benzodiazepines are commonly misused and taken in combination with other drugs of abuse.[20][21][22]

Medicinal uses of Benzodiazepine:

Most are administered orally; however, they can also be given intravenously, intramuscularly, or rectally.[23] In general, benzodiazepines are well tolerated and are safe and effective drugs in the short term for a wide range of conditions.[24][25] Tolerance can develop to their effects and there is also a risk of dependence, and upon discontinuation a withdrawal syndrome may occur. These factors, combined with other possible secondary effects after prolonged use such as psychomotor, cognitive, or memory impairments, limit their long-term applicability.[26][27]The effects of long-term use or misuse include the tendency to cause or worsen cognitive deficits, depression, and anxiety. The College of Physicians and Surgeons of British Columbia recommends discontinuing the usage of benzodiazepines in those on opioids and those who have used them long term.[28] Benzodiazepines can have serious adverse health outcomes, and these findings support clinical and regulatory efforts to reduce usage, especially in combination with non-benzodiazepine receptor agonists.[29]

Physico-chemical, acoustical and solubility of drugs are useful in field of pharmaceutical sciences to examine their functions and performance [30]. Physical and acoustical properties like density, viscosity and ultrasound velocity of solution of pharmaceutical molecules in polar and non-polar solvents provide valuable information about solute-solvent interaction.[31] This information is useful for drug formulation, drug dosages, synthesis and predicting the absorption and transport of drugs in biological tissues.[32] Apart from this other the study of ultrasound velocity and related parameters for drug-solvent interactions are important to understand the behavior of bio-molecules and physico-chemical nature of solutions.[33]

These parameters are useful in a number of areas such as medical, sedimentology, food processing, paper industry and biotechnology. Ultrasonic methods have been successfully used to monitor polymer processing, chemical reactions, film formation, glue processing or crystallization in polymers.

Today, the use of ultrasonic for non-destructive evaluation of system is widespread. The ultrasonic parameters such as velocity, attenuation, compressibility, acoustic impedence and scattering gives a clear picture of structural changes in biological substances. In the recent years, the use of ultrasound has greatly increased because of the advantage it offers to synthetic chemistry. It includes time consumption in reaction, saving energy, higher yield, milder condition and higher purity of the product. Density and viscosity measurements are helpful in study of ion-solvent interactions in aqueous and non-aqueous solutions.

Nowadays, the uses of ultrasound for non-destructive evaluation of system are widespread. The ultrasonic parameters such as velocity, compressibility, acoustical impedance gives clear picture of structural of structural changes in biology substances. In recent years, the usage of ultrasound as increased because of advantages it gives to synthetic chemistry. It includes time consumption in reaction, saving energy, higher yield, milder conditions and higher purity of product. Ultrasound velocity measurements are helpful in the study of ion-solvent interactions in aqueous and non-aqueous solutions in recent years.

Acoustical parameters are employed in various fields in investigating various organic liquids, polymers along with their mixtures, drugs etc. It plays an important role in understanding physico-chemical behavior of liquids. Knowledge of ultrasound velocity and related acoustical parameter provides information about molecular interaction and hence nature and strength of these interactions are useful in solution processing technology. The study on changes in acoustical properties of solution has been found to be an excellent qualitative and quantitative way to bring out the information about molecular structure and inter molecular forces present in liquid mixtures.[34]

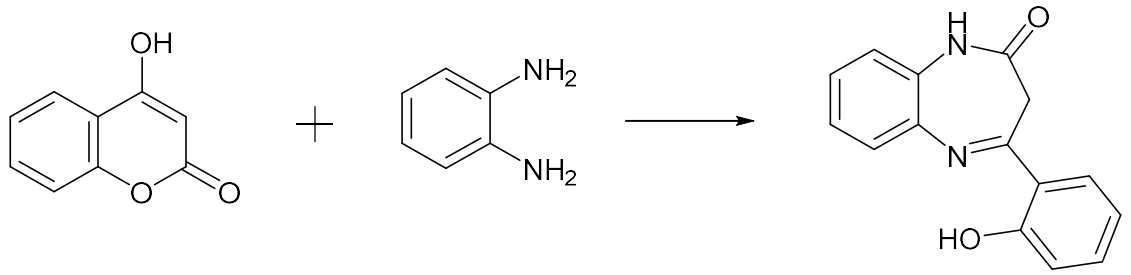
Accuracy and precision in solubility, density and viscosity measurements allow one to calculate many interesting thermodynamicand thermo-acoustical properties of industrial and environmental concerns with high degree of reliability.[35-37]

CHAPTER-2

SYNTHESIS OF

1,3-Dihydro-4-(2-hydroxyphenyl)-2H-1,5-benzodiazepin-2-one:

Section-2.1: Reaction Scheme



4-hydroxy-2*H*-chromen-2-one
Chemical Formula: $C_9H_6O_3$
Molecular Weight: 162.14

benzene-1,2-diamine
Chemical Formula: $C_6H_8N_2$
Molecular Weight: 108.14

4-(2-hydroxyphenyl)-1,3-dihydro-2*H*-benzo[*b*][1,4]diazepin-2-one
Chemical Formula: $C_{15}H_{12}N_2O_2$
Molecular Weight: 252.27

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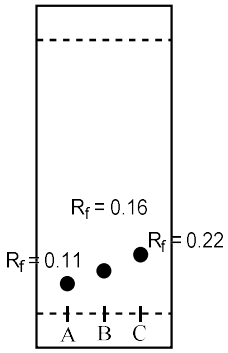
TLC:



Where,

A = 4-hydroxy coumarin

B = O-phenylene diamine

C = 1,3-Dihydro-4-(2-hydroxyphenyl)-2H-1,5-benzodiazepin-2-one

Solvent system:

Hexane: Ethyl acetate (8:2)

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Section-2.2: Method

- Here we are synthesizing a drug named1,3-Dihydro-4-(2-hydroxyphenyl)-2H-1,5-benzodiazepin-2-one.
- The method for the synthesis of this drug as follows:
- Take 1.62 gram 4-hydroxy coumarin and 1.62gram O-phenylene diamine in a 10mL RBF.
- Further add required amount of toluene solvent.
- Then reflux the reaction mixture for 5 hours at 110°C (±5°C) temperature with constant magnetic stirring.
- After 5 hours of reflux the reaction mixture was checked by taking TLC.
- For removing the impurities, wash the product with appropriate amount of methanol which removes the impurities.
- After removing impurities, pure product is obtained which can be seen fromthe given TLC.[38]

CHAPTER-3

PHYSICO-CHEMICALPARAMETERS:

Section-3.1: Solubility

- Solubility is one of vital physico-chemical properties of pharmaceutical compounds. Major drug with high level of biological activity often fail in investigation to form new drug because of low solubility. Further solution crystallization is an important step for industrial purification process, which control product quality such as purity and yield. Hence it is necessary to determine physico-chemical data such as solubility in difference solvents to select the proper solvent.[39]

Method:

- **Procedure for the preparation of unknown solutions:**

- Accurately weigh 0.05 gm drug with help of electronic weight balance and transfer it into 7 different vials containing rice needles.
- Then add 3 mL of solvent in these vials.
- The solvents required are water, methanol, ethanol, 1,4-dioxane, DMF, DCM and chloroform.
- Put these vials in water bath for constant stirring at 30°C temperature and 300 rpm for 24 hours.
- Monitor the temperature using thermometer.
- After 24 hours, centrifuge the vials for 20 min at 400 rpm. These will result into settle down the particles.
- Post centrifugation, keep the vials undisturbed for 24 hrs

❖ **Procedure for the preparation of standard solutions:**

- Accurately weigh 10 mg of drug and carefully add into 10 mL volumetric flask and make a concentration of 1mg/1mL with the help of specific solvent. Label it as main stock solution.
- With the help of syringe take 2mL of main stock solution and add into 50mL volumetric flask.
- Make up to 50mL using specific solvent.

Consider theλmax value at 344 nm in each solvent:

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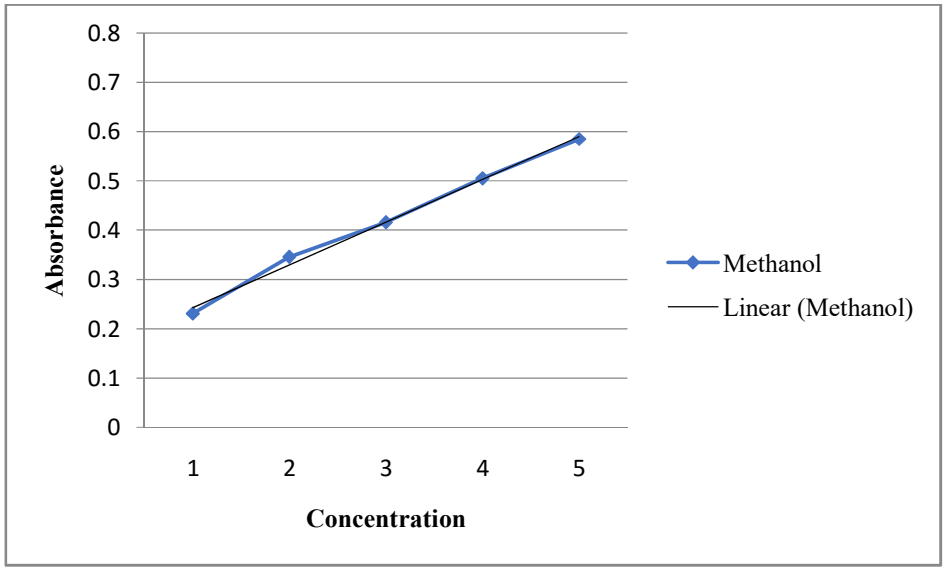
Methanol:

Conc.	Absorption	Absorption	Absorption	RSD
	Try 1	Try 2	Try 3	
1mg/100mL	0.231	0.233	0.232	0.43%
2mg/100mL	0.346	0.345	0.345	0.17%
3mg/100mL	0.416	0.416	0.412	0.56%
4mg/100mL	0.582	0.580	0.581	0.17%
Unknown	0.505	0.502	0.503	0.30%

Try-1:



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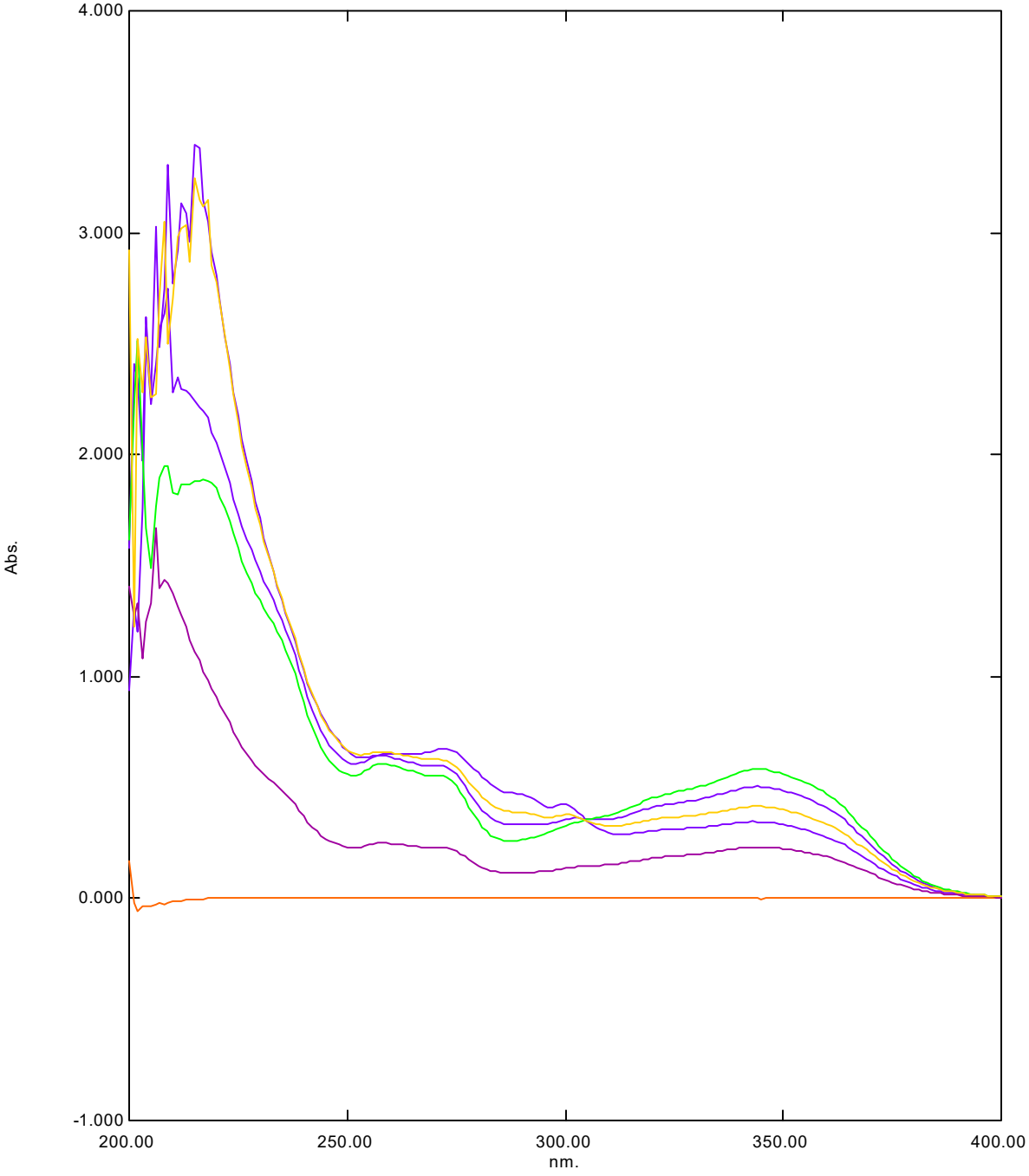

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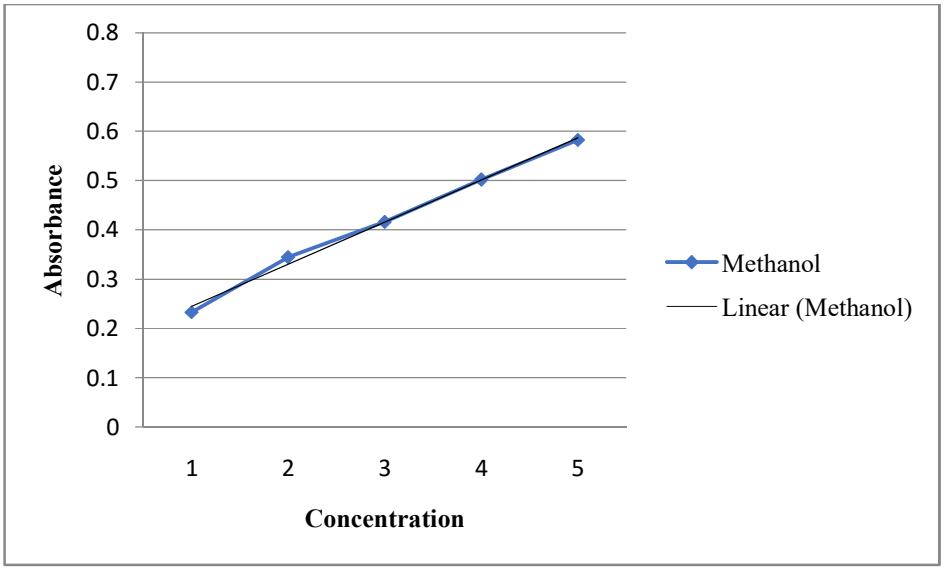

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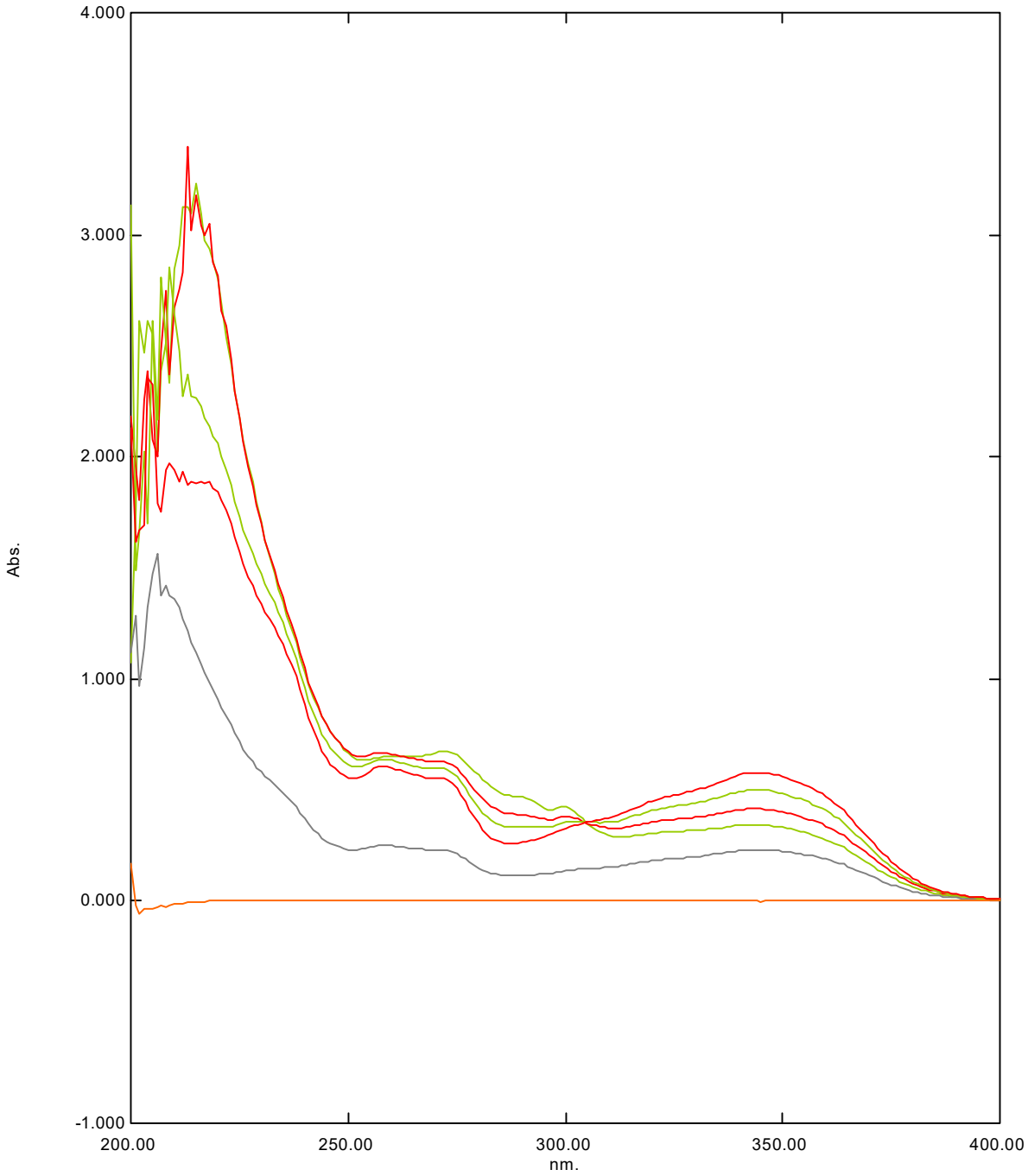

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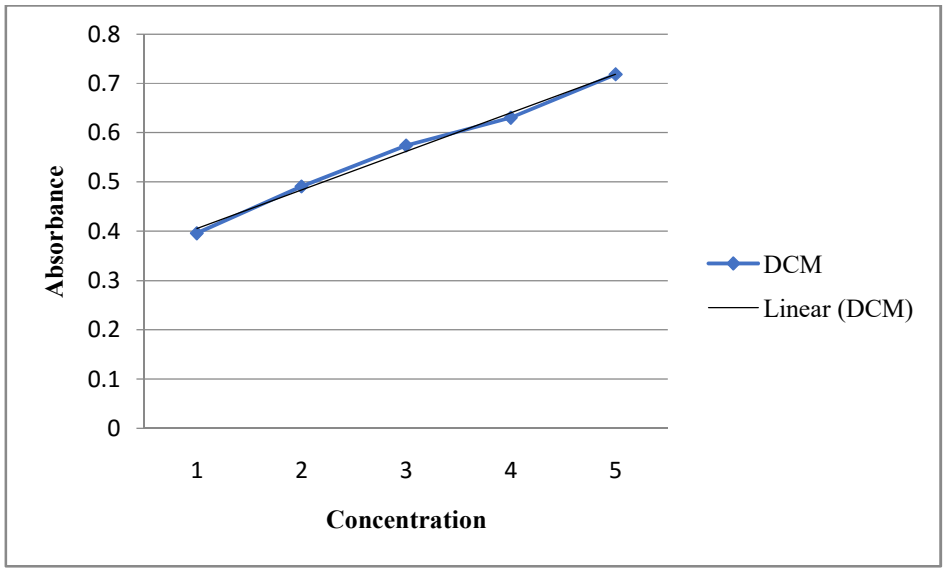
DCM:

Conc.	Absorption	Absorption	Absorption	RSD
	Try 1	Try 2	Try 3	
1mg/100mL	0.396	0.397	0.399	0.39%
2mg/100mL	0.491	0.488	0.489	0.12%
3mg/100mL	0.574	0.571	0.571	0.10%
4mg/100mL	0.718	0.716	0.717	0.08%
Unknown	0.630	0.629	0.629	0.09%

Try-1:



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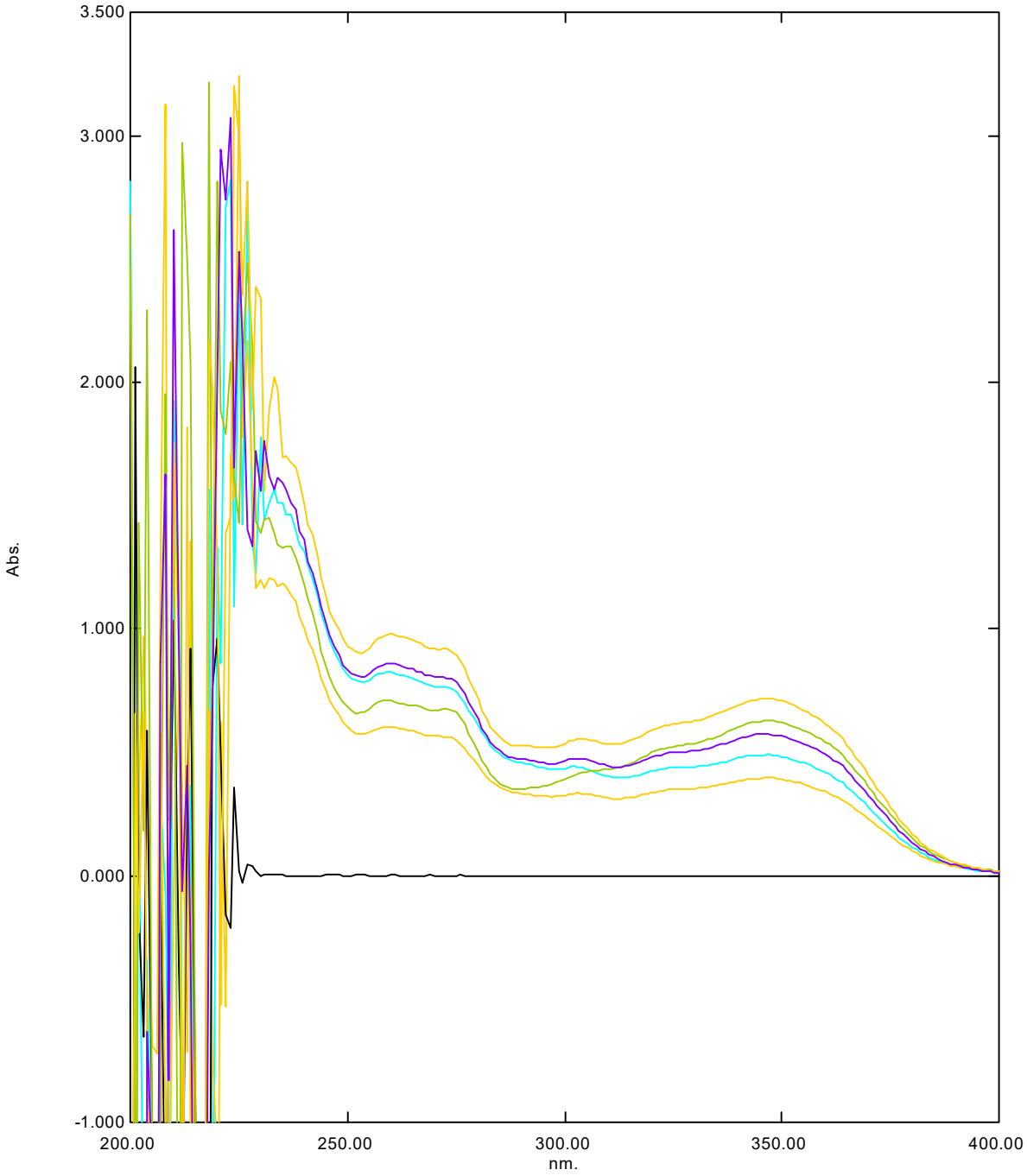

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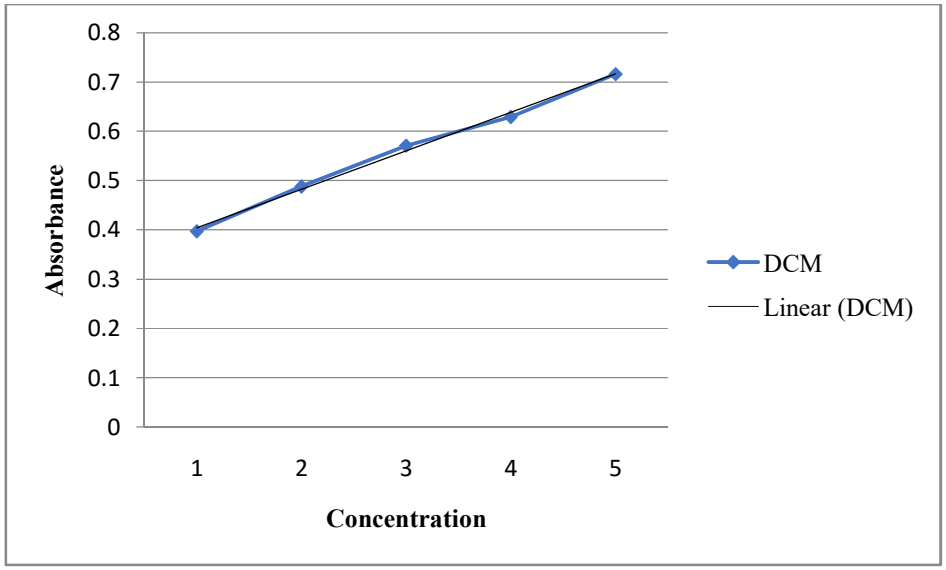

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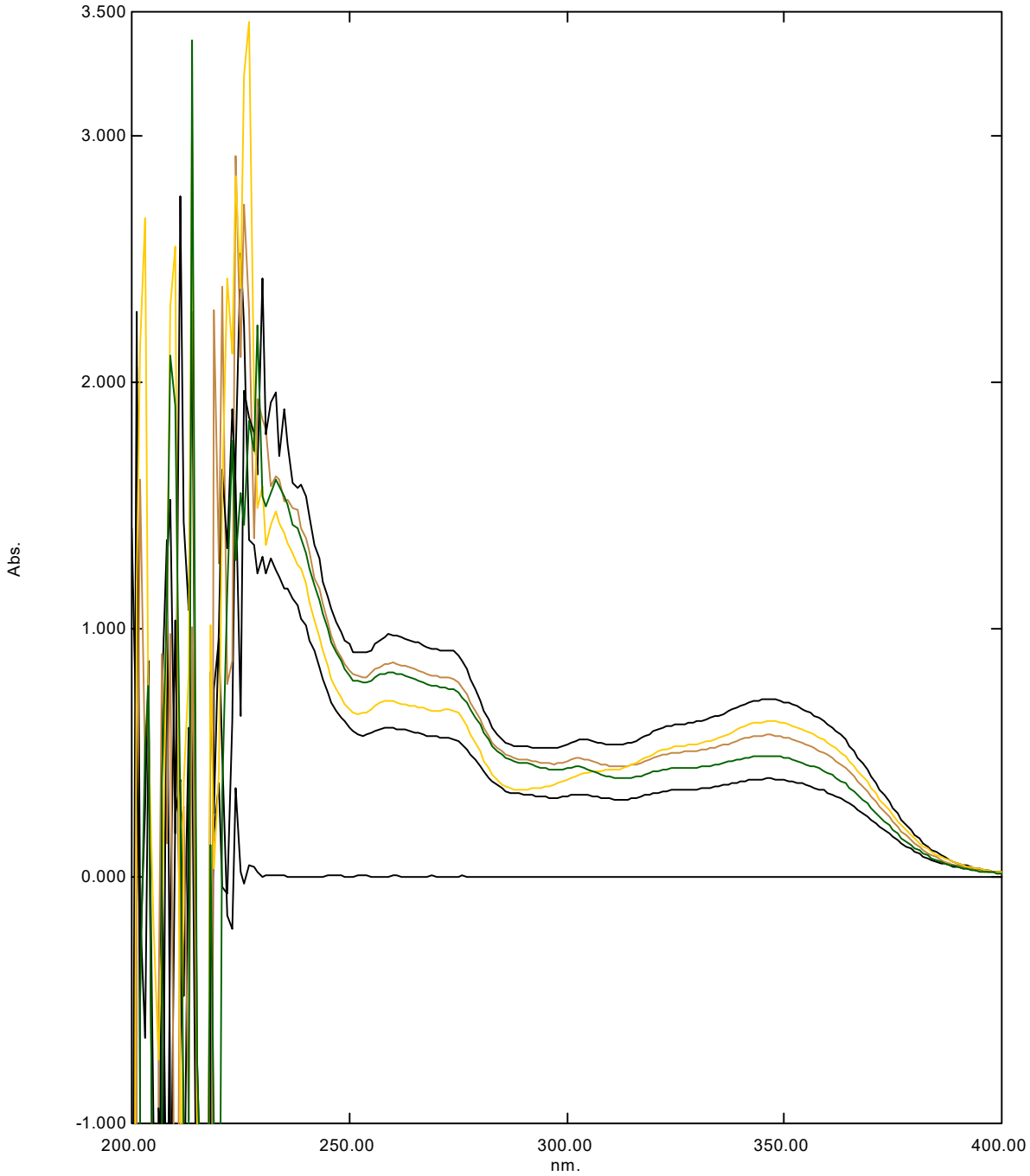

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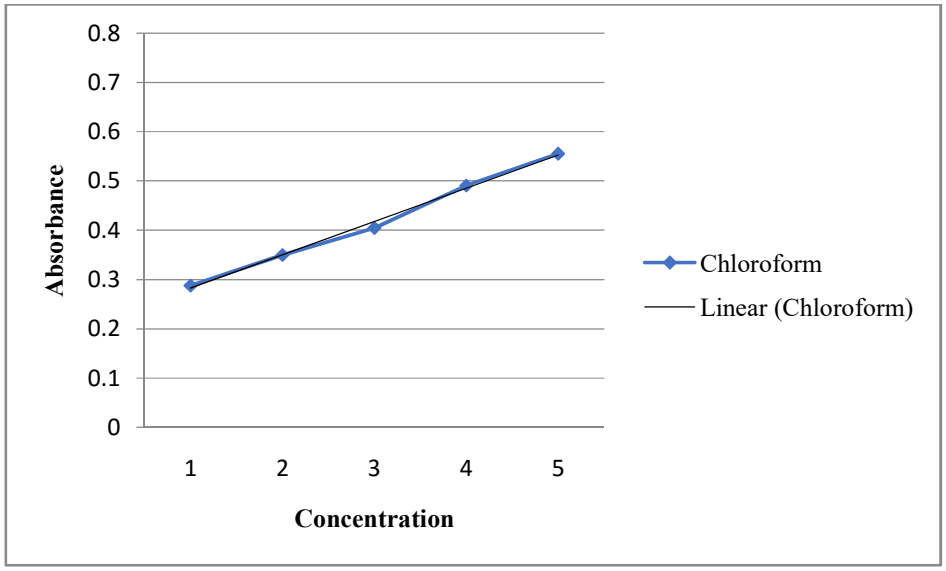
Chloroform:

Conc.	Absorption	Absorption	Absorption	RSD
	Try 1	Try 2	Try 3	
1mg/100mL	0.288	0.289	0.288	0.52%
2mg/100mL	0.350	0.351	0.353	0.33%
3mg/100mL	0.405	0.407	0.409	0.14%
4mg/100mL	0.555	0.552	0.552	0.21%
Unknown	0.491	0.491	0.492	0.35%

Try-1:



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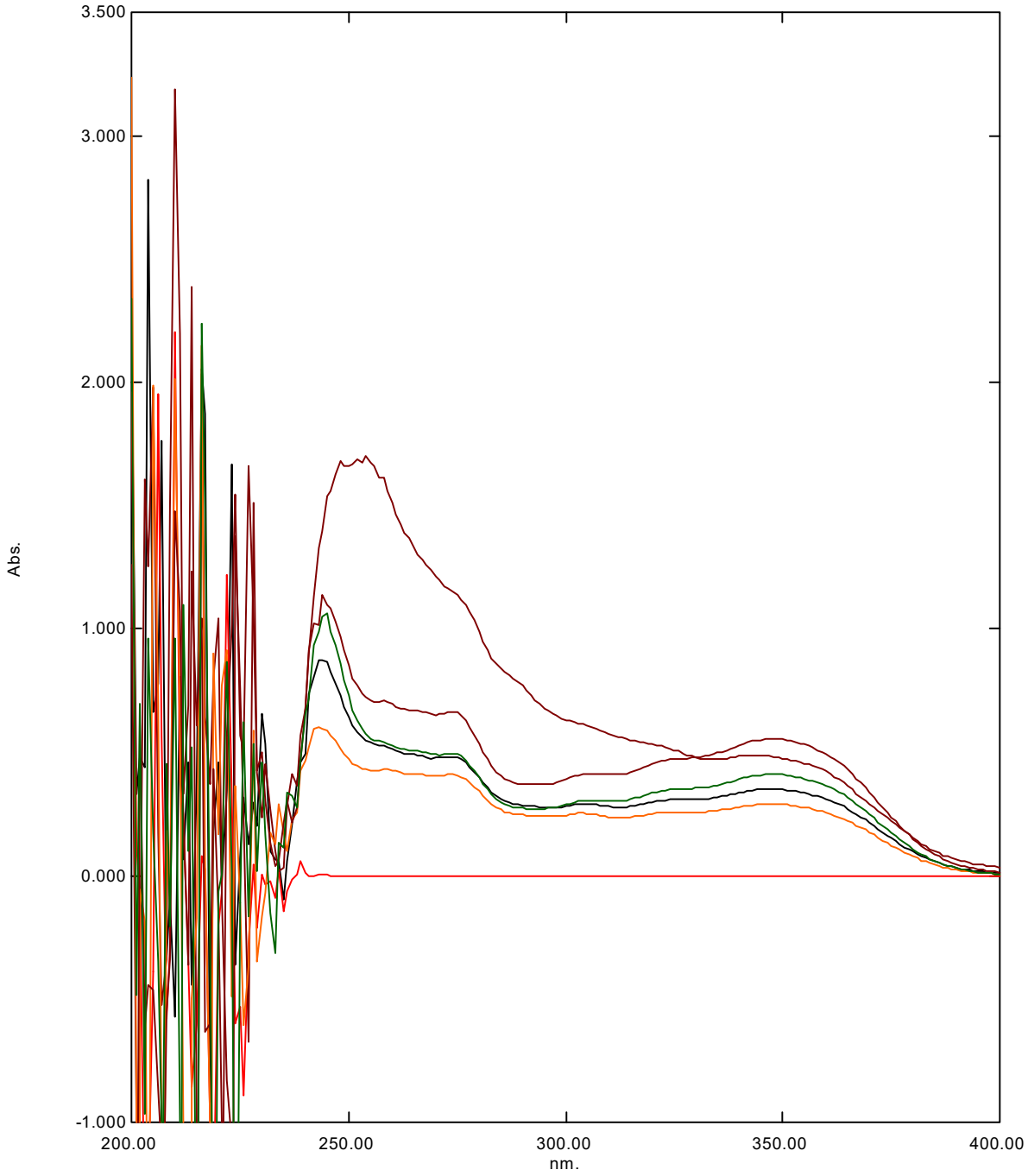

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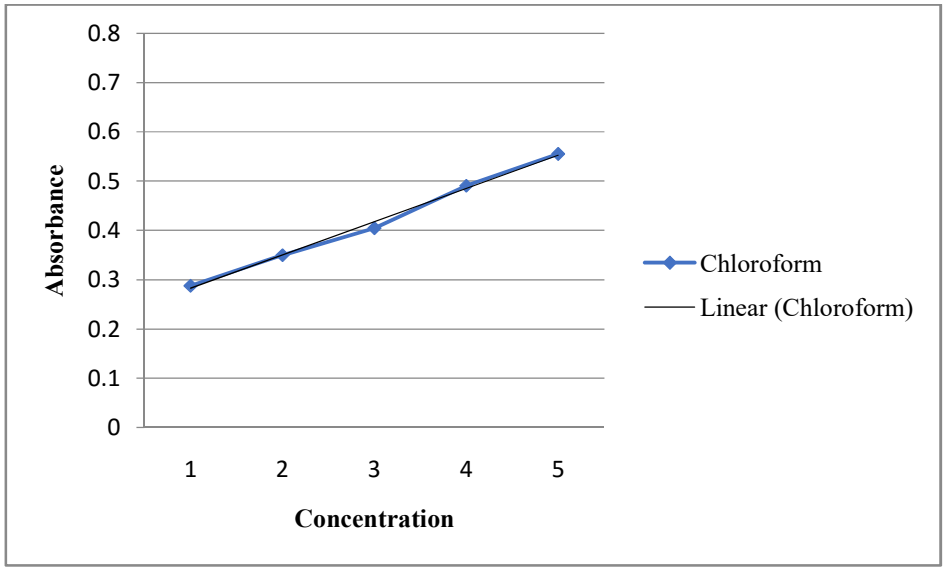

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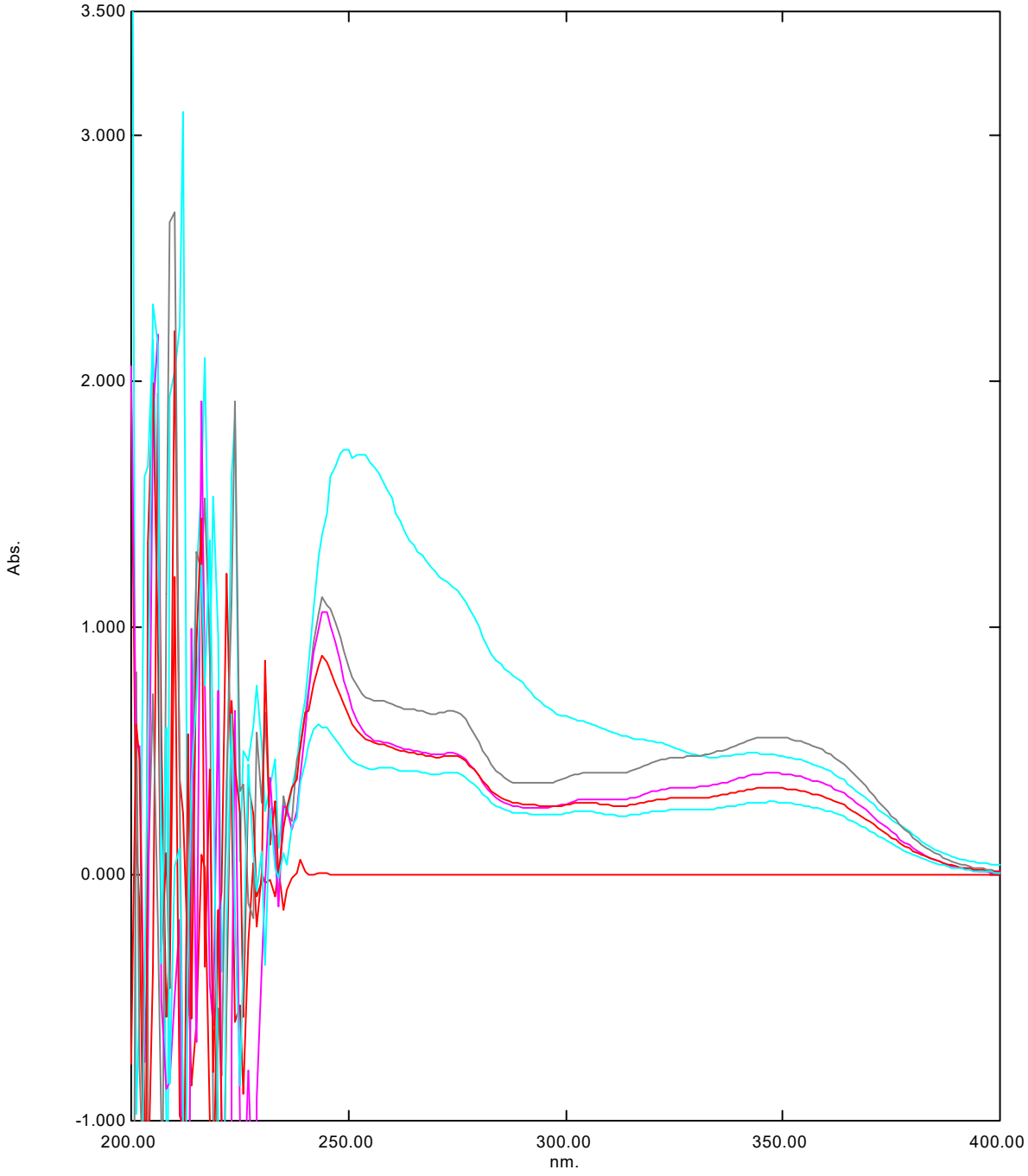

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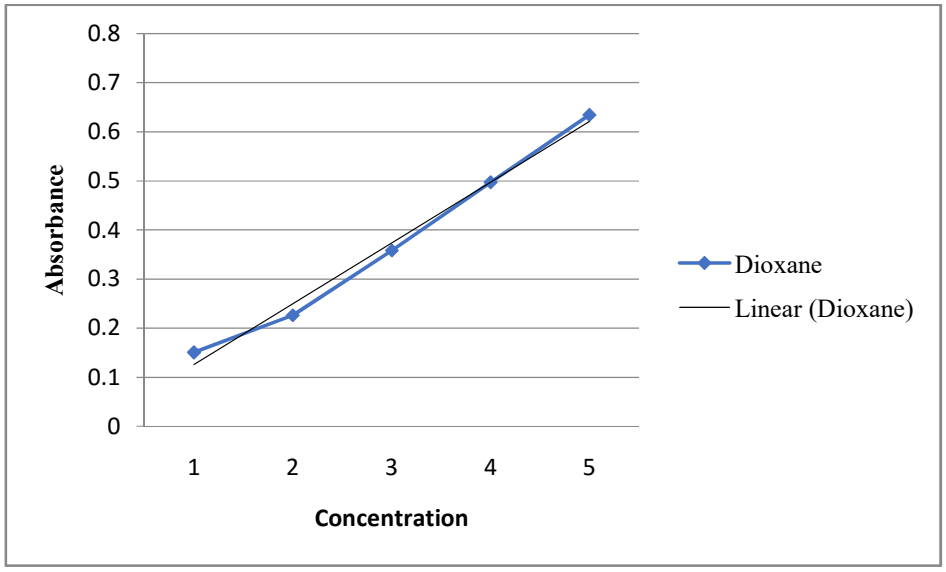
Dioxane:

Conc.	Absorption	Absorption	Absorption	RSD
	Try 1	Try 2	Try 3	
1mg/100mL	0.150	0.150	0.149	0.00%
2mg/100mL	0.358	0.359	0.357	0.16%
3mg/100mL	0.497	0.498	0.497	0.12%
4mg/100mL	0.634	0.633	0.631	0.09%
Unknown	0.226	0.223	0.221	1.02%

Try-1:



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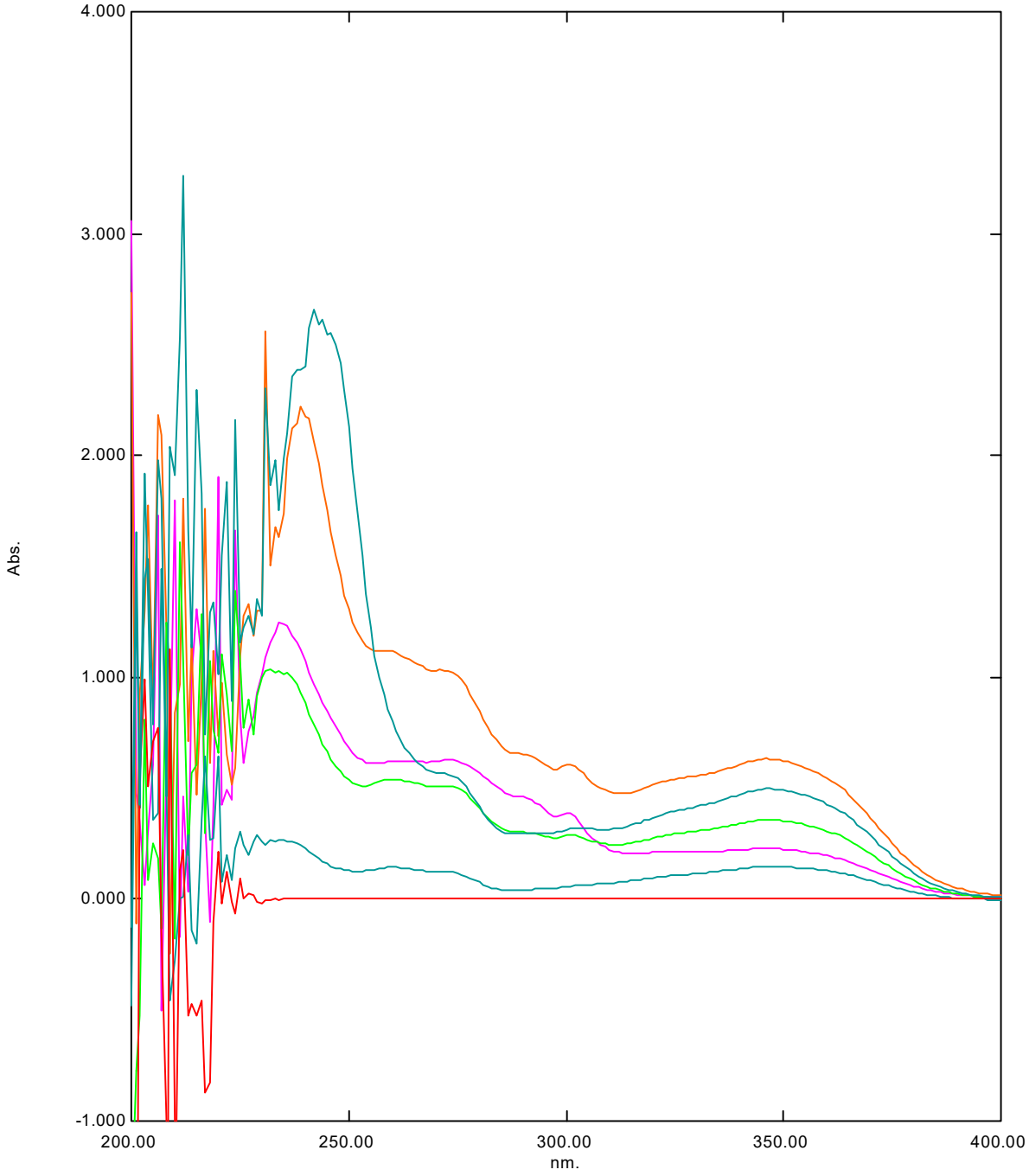

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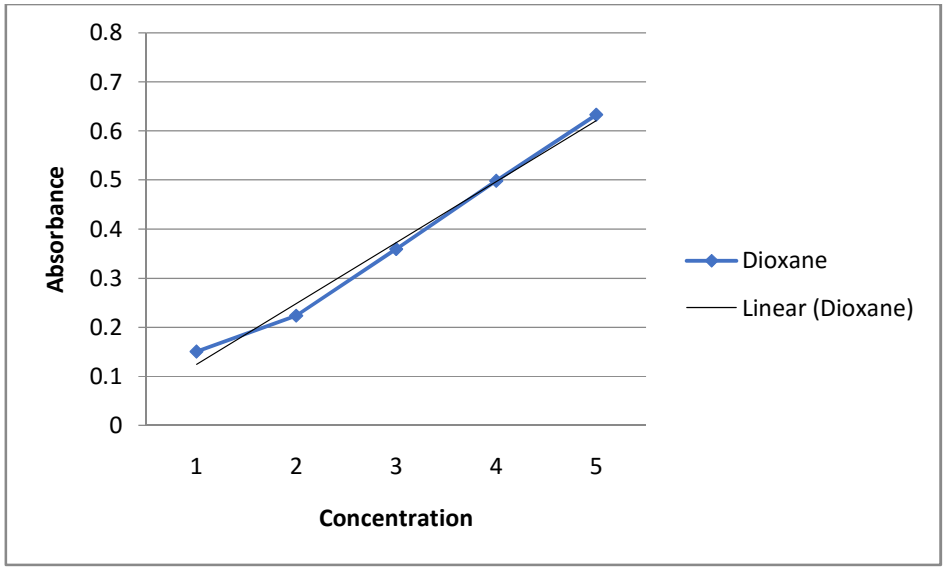
Try-2:



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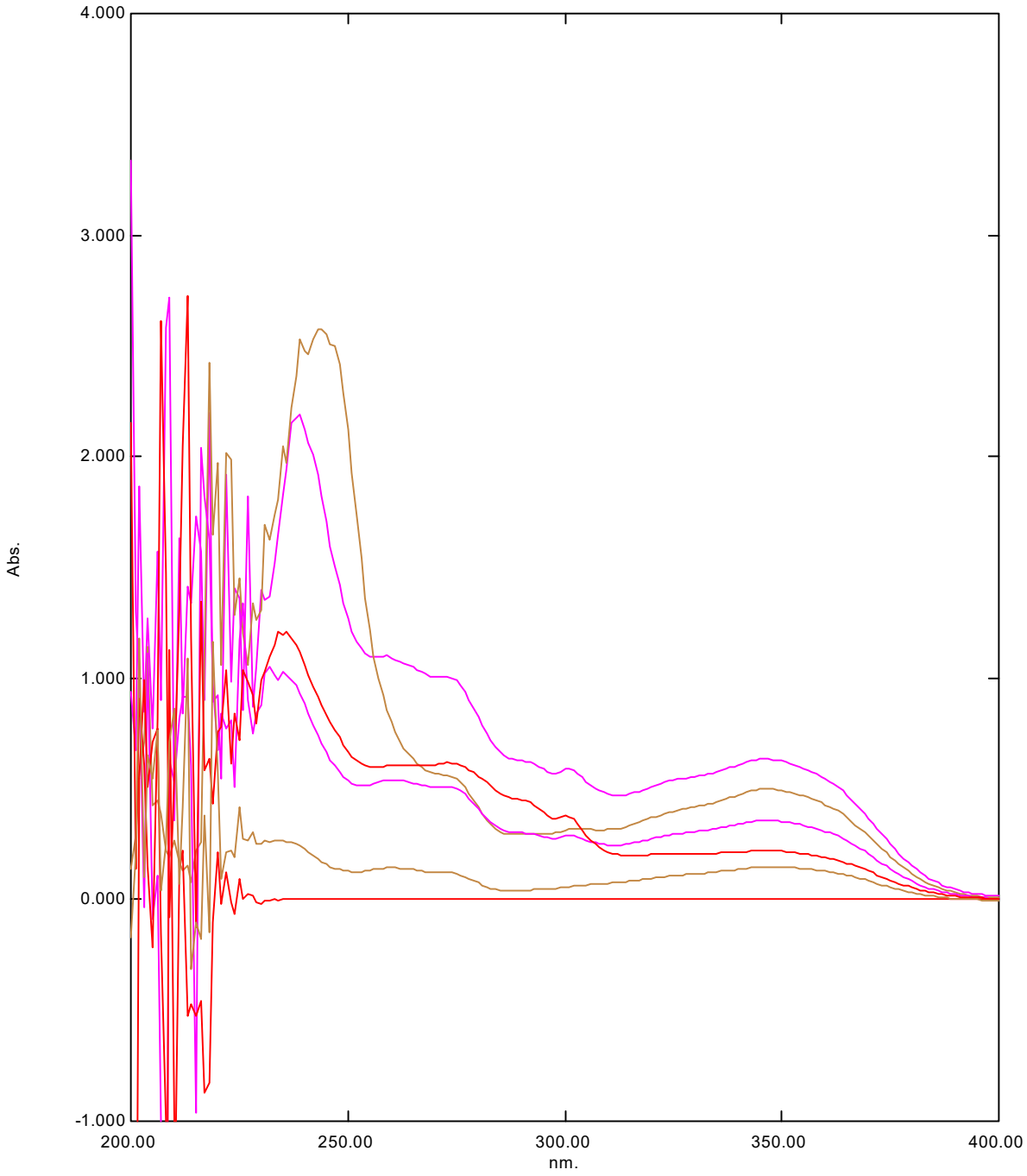

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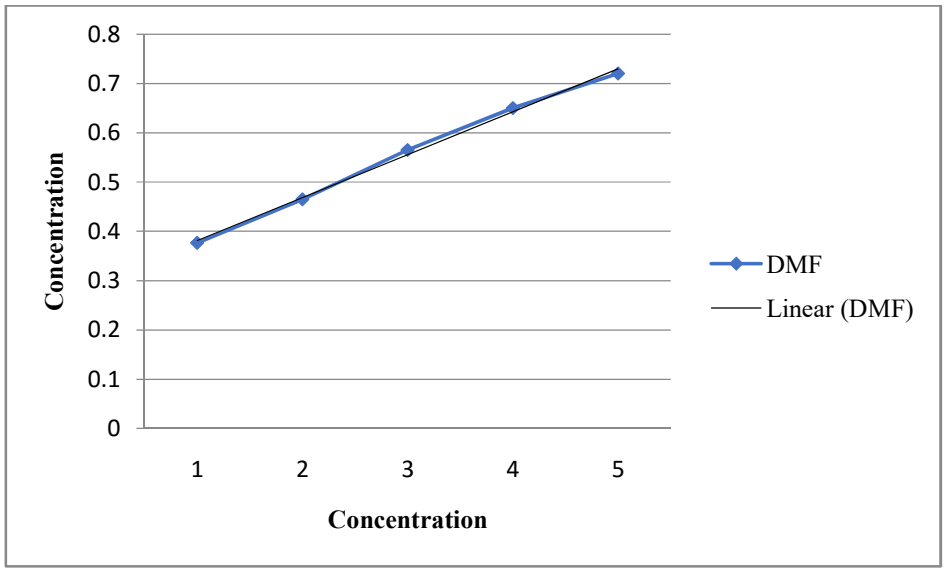
DMF:

Conc.	Absorption	Absorption	Absorption	RSD
	Try 1	Try 2	Try 3	
1mg/100mL	0.377	0.378	0.379	0.27%
2mg/100mL	0.465	0.465	0.464	0.25%
3mg/100mL	0.565	0.561	0.561	0.21%
4mg/100mL	0.720	0.721	0.727	0.32%
Unknown	0.650	0.653	0.653	0.18%

Try-1:



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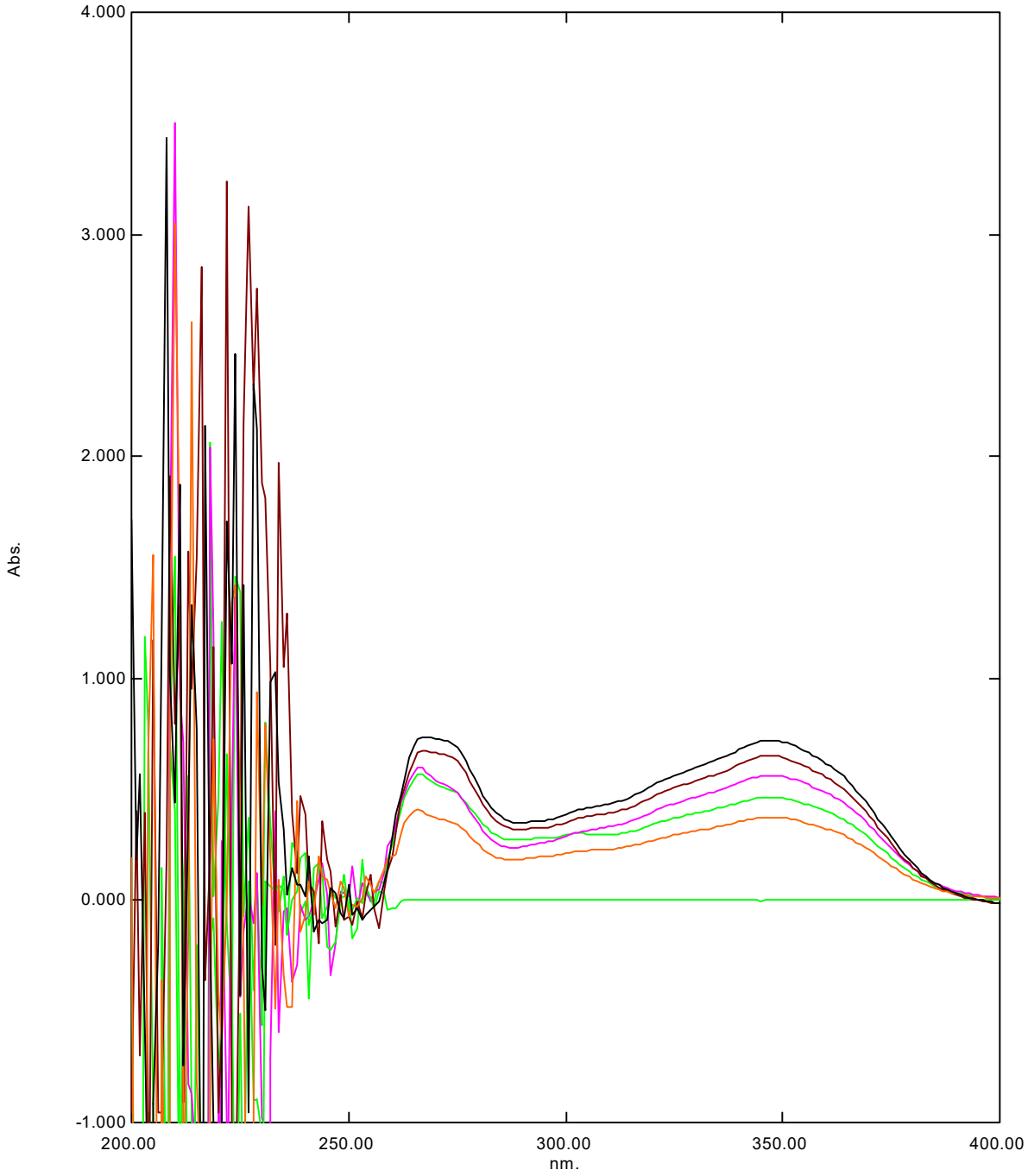

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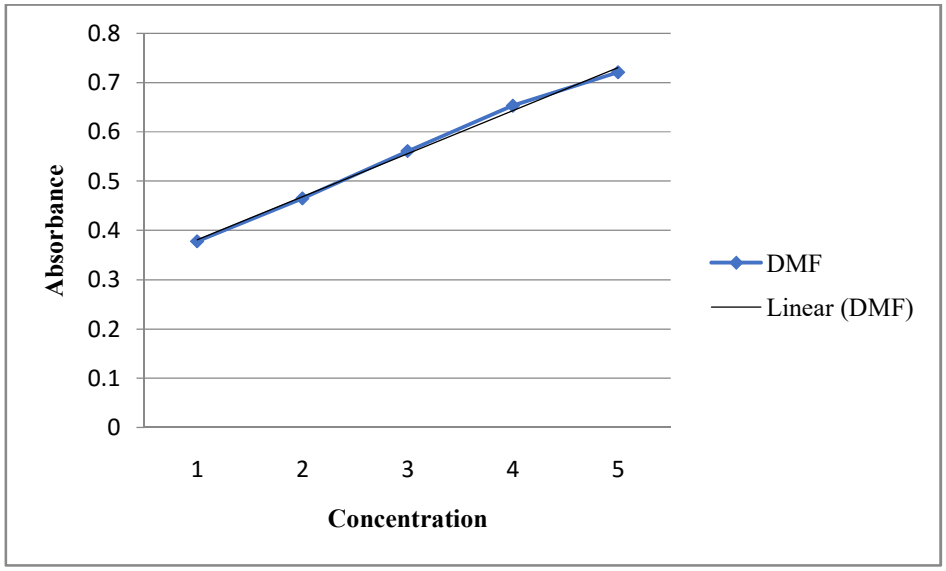
Try-2:



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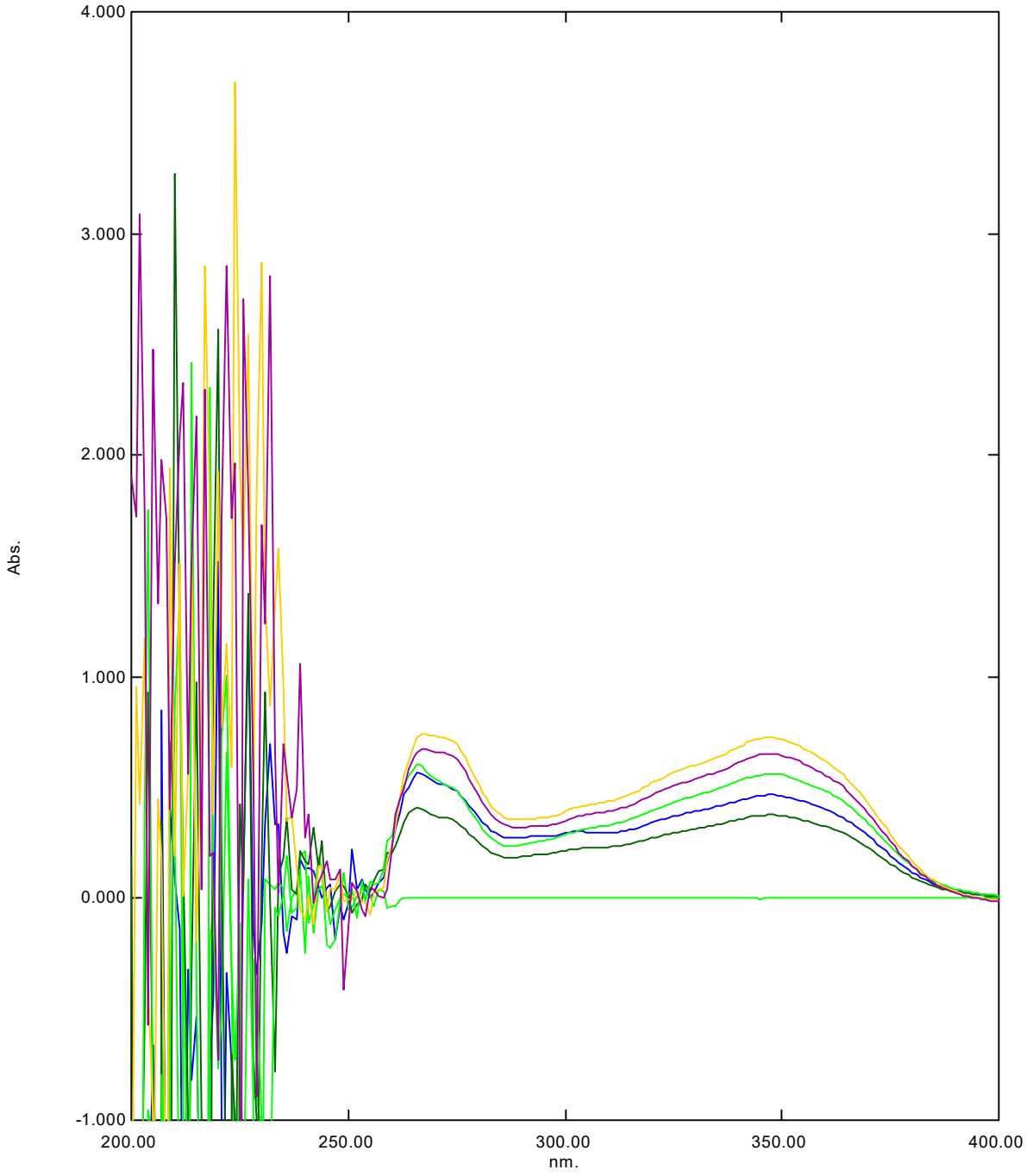
Try-2 Overlay



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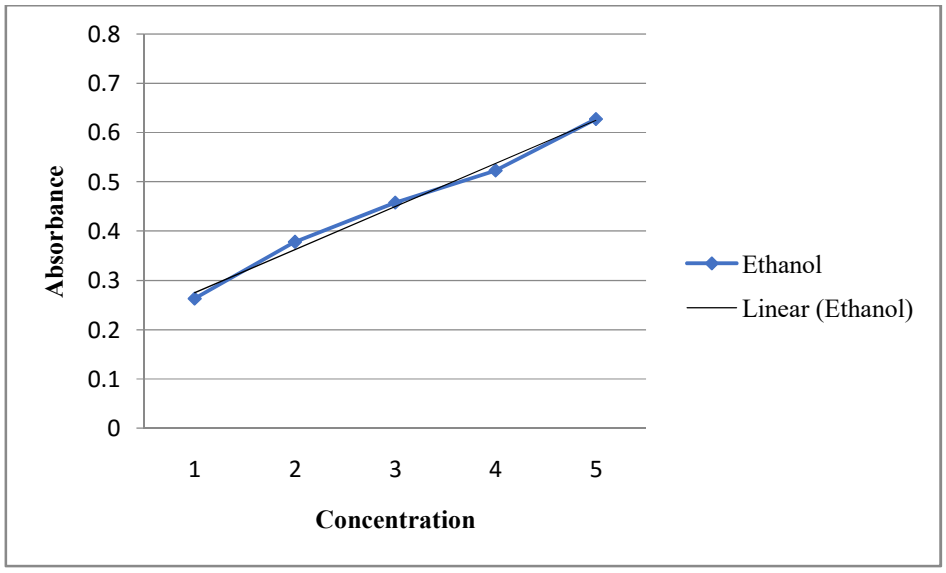
Ethanol:

Conc.	Absorption	Absorption	Absorption	RSD
	Try 1	Try 2	Try 3	
1mg/100mL	0.263	0.266	0.263	0.66%
2mg/100mL	0.458	0.456	0.458	0.25%
3mg/100mL	0.523	0.526	0.527	0.40%
4mg/100mL	0.627	0.626	0.627	0.09%
Unknown	0.378	0.376	0.373	0.67%

Try-1:



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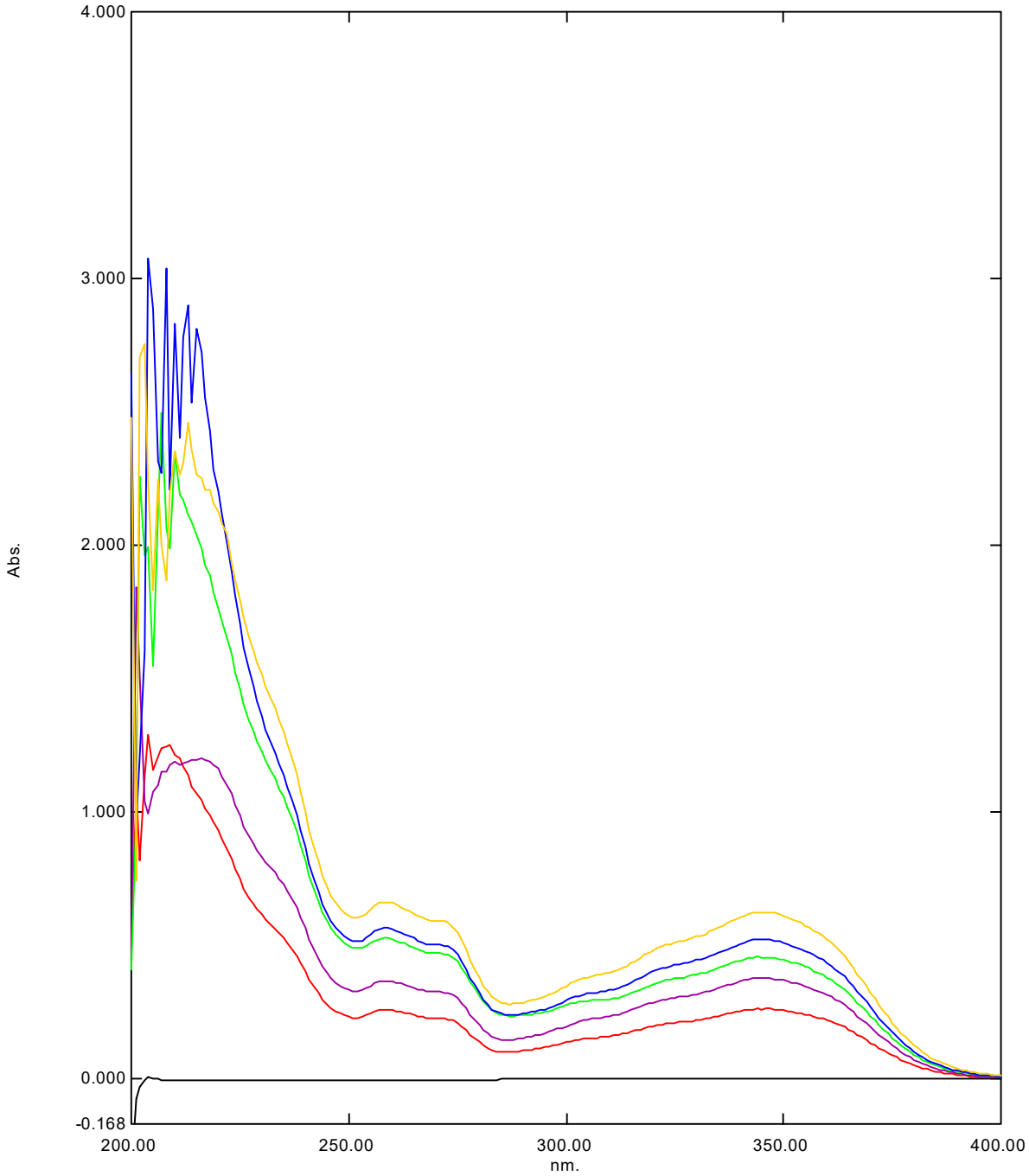
Try-1 Overlay:



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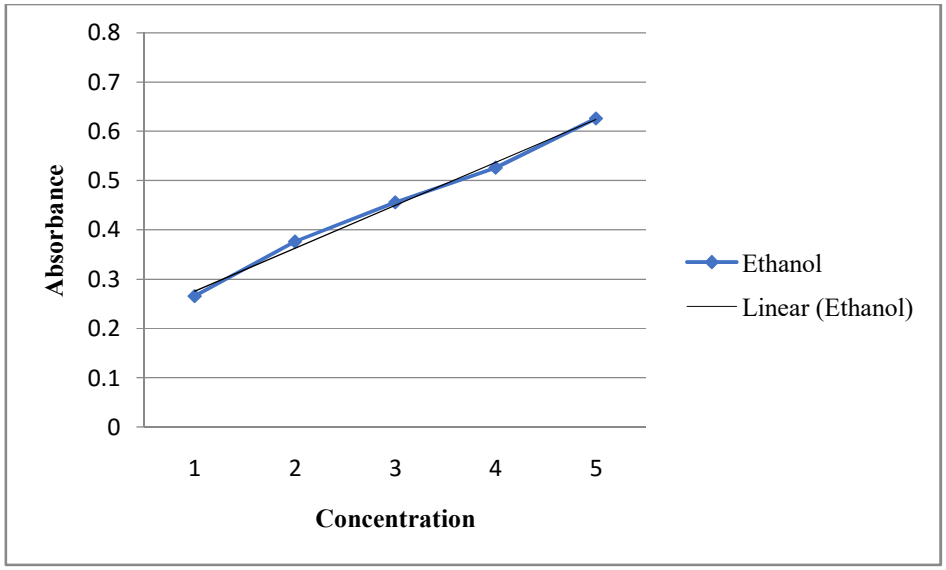
Try-2:



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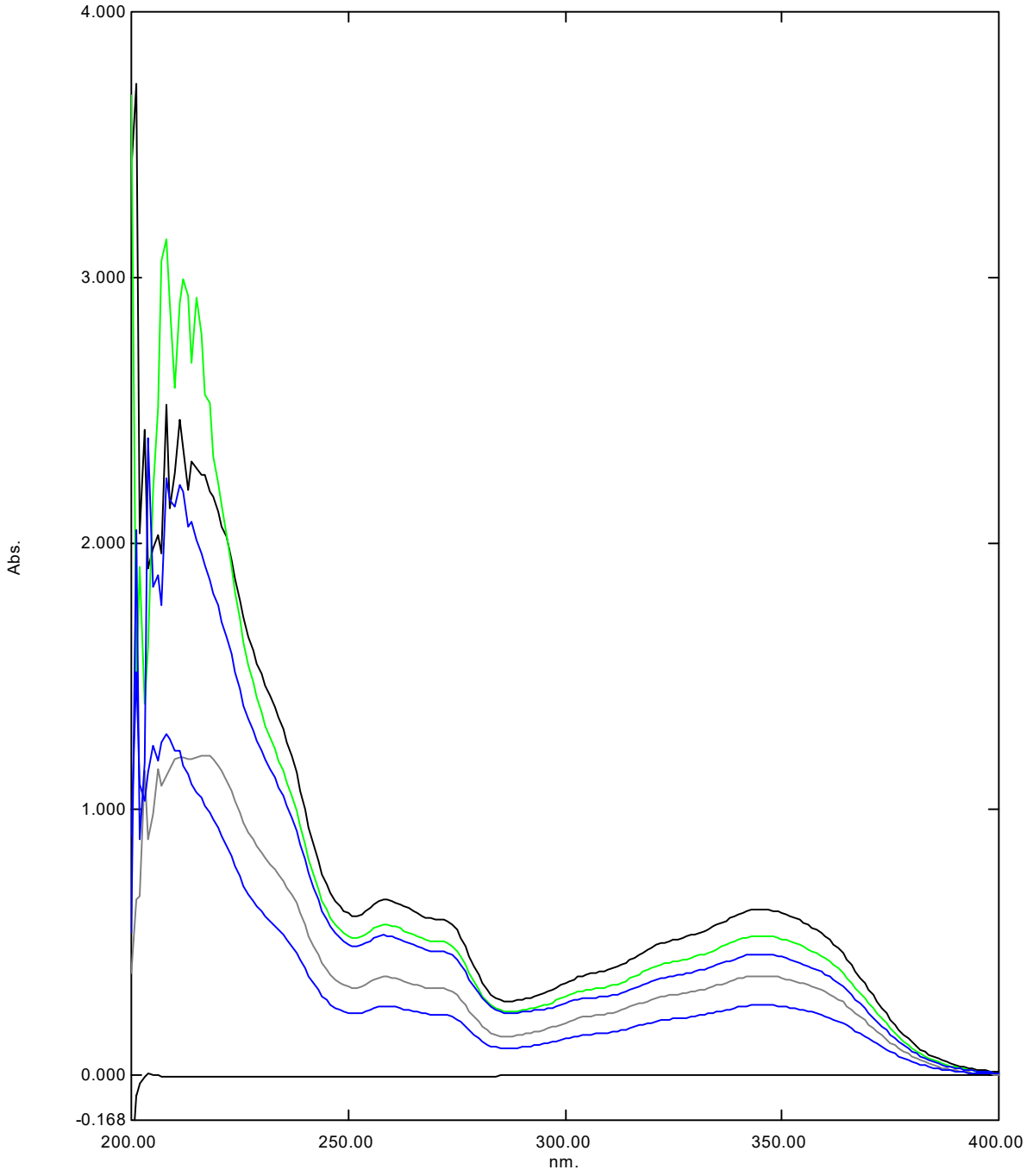
Try-2 Overlay:



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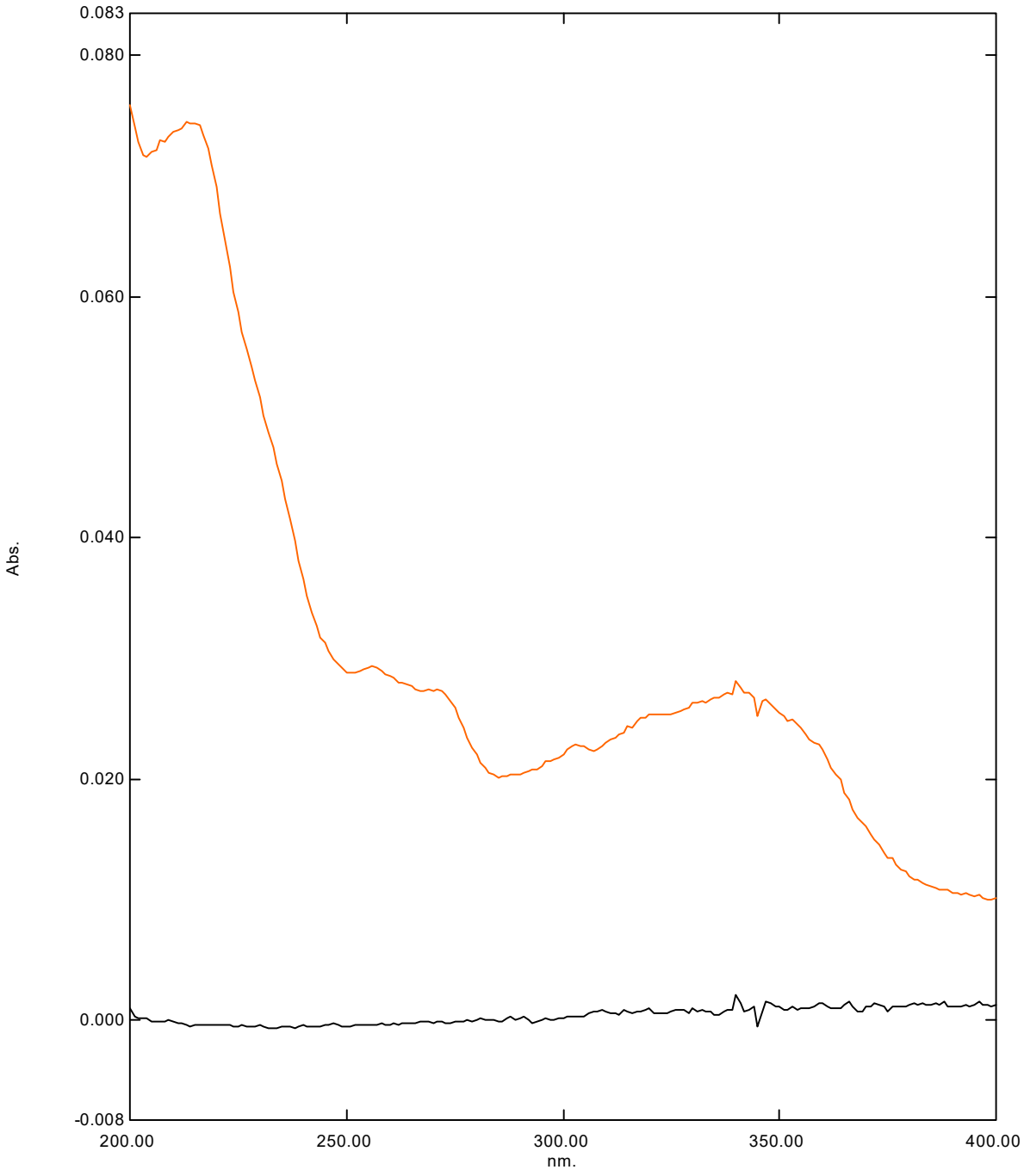
Water:

344 wavelength- 0.028 absorbance



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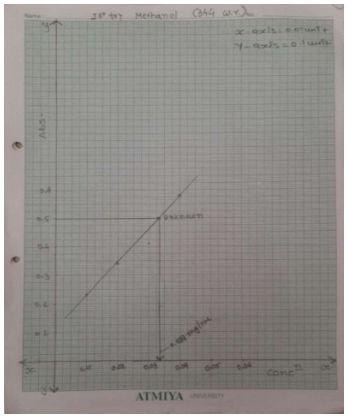
Graph: **Methanol Try-1** **Calculation:**



0.2 ⟶ 10 0.2 mL ⟶ 0.033 mg

↓ 3 mL ⟶ ?

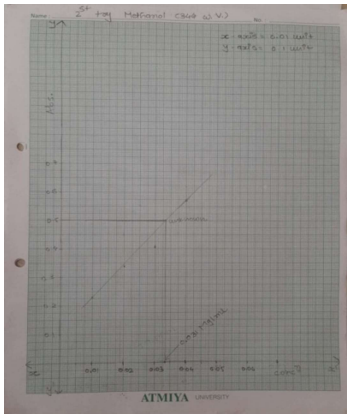
Reading

= 0.495 mg /3mL

- 0.165 mg/mL
- 16.5 mg/100mL

Result : 16.5 mg drug is soluble in 100 mL of Methanol

Methanol Try-2



0.2 ⟶ 10 0.2 mL ⟶ 0.031 mg

↓ 3 mL ⟶ ?

Reading

= 0.465 mg /3mL

- 0.155 mg/mL
- 15.5 mg/100mL

Result : 15.5 mg drug is soluble in 100 mL of Methanol

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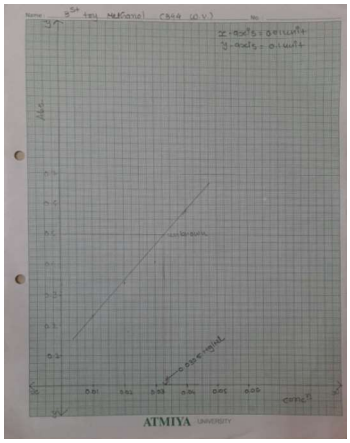
Graph: **Methanol Try-3** **Calculation:**



0.2 ⟶ 10 (Reading)

0.2 mL ⟶ 0.030 mg

3 mL ⟶ ?

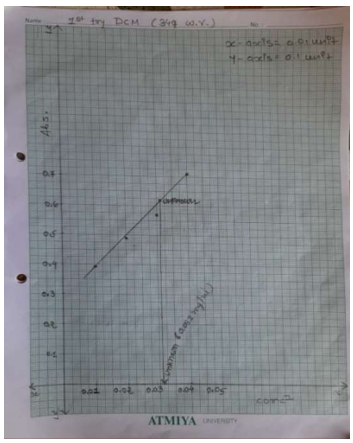
= 0.457 mg /3mL

- 0.152 mg/mL
- 15.2 mg/100mL

Result : 15.2 mg drug is soluble in 100 mL of Methanol

Conclusion : So from the average of above three results we can conclude that 15.7 mg drug is soluble in 100 mL Methanol.

DCM Try-1



0.2 ⟶ 10

1 ⟶ 10

1 ⟶ 10 (Reading)

0.2 mL ⟶ 0.031 mg

3 mL ⟶ ?

= 0.465 mg /3mL

- 0.155 mg/mL
- 15.5 mg/100mL

Result : 15.5 mg drug is soluble in 100 mL of DCM

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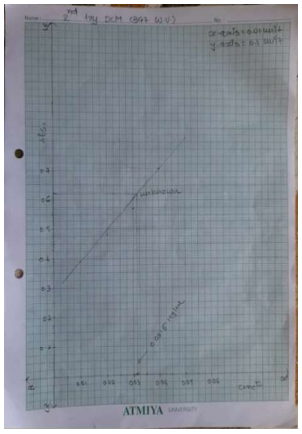
Graph:



DCM Try-2

0.2 ⟶ 10

↓

1 ⟶ 10

↓

1 ⟶ 10

↓

Reading

Calculation:

0.2 mL ⟶ 0.0315 mg

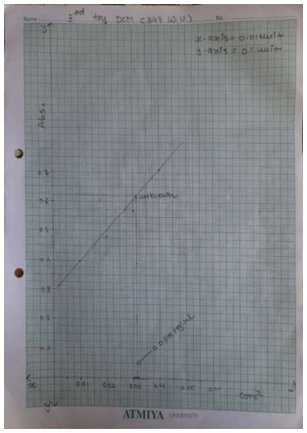
3 mL ⟶ ?

= 0.4725 mg /3mL

- 0.1575 mg/mL
- 15.75 mg/100mL

Result : 15.75 mg drug is soluble in 100 mL of DCM

DCM Try-3



0.2 ⟶ 10

↓

1 ⟶ 10

↓

1 ⟶ 10

↓

Reading

0.2 mL ⟶ 0.0315 mg

3 mL ⟶ ?

= 0.4725 mg /3mL

- 0.1575 mg/mL
- 15.75 mg/100mL

Result : 15.75 mg drug is soluble in 100 mL of DCM

Conclusion : So from the average of above three results we can conclude that 15.66 mg drug is soluble in 100 mL DCM.

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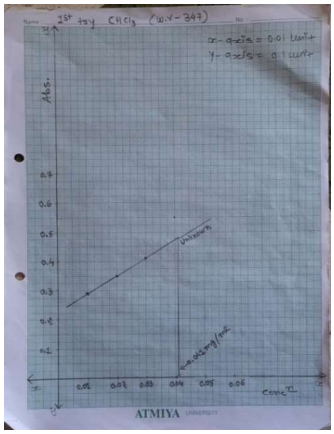
Graph: **Chloroform Try-1** **Calculation:**



0.2 ⟶ 10

↓

1 ⟶ 10

↓

1 ⟶ 10

↓

Reading

0.2 mL ⟶ 0.041 mg

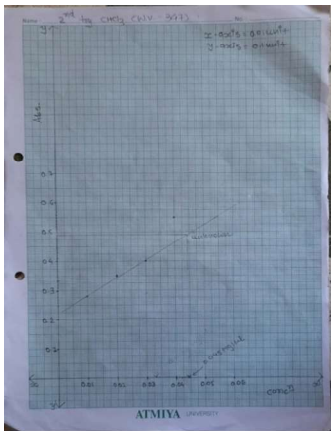
3 mL ⟶ ?

= 0.615 mg /3mL

- 0.205 mg/mL
- 20.5 mg/100mL

Result : 20.5 mg drug is soluble in 100 mL of Chloroform

Chloroform Try-2



0.2 ⟶ 10

↓

1 ⟶ 10

↓

1 ⟶ 10

↓

Reading

0.2 mL ⟶ 0.045 mg

3 mL ⟶ ?

= 0.615 mg /3mL

- 0.205 mg/mL
- 20.5 mg/100mL

Result : 20.5 mg drug is soluble in 100 mL of Chloroform

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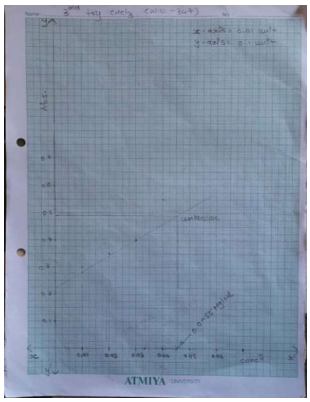
Graph: **Chloroform Try-3** **Calculation:**



0.2 ⟶ 10

↓

1 ⟶ 10

↓

1 ⟶ 10

↓

Reading

0.2 mL ⟶ 0.0455 mg

3 mL ⟶ ?

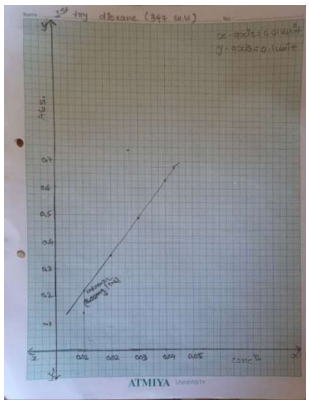
= 0.6825 mg /3mL

- 0.2275 mg/mL
- 22.75 mg/100mL

Result : 22.75 mg drug is soluble in 100 mL of Chloroform

Conclusion : So from the average of above three results we can conclude that 21.25 mg drug is soluble in 100 mL Chloroform.

Dioxane Try-1



0.2 ⟶ 10

↓

1 ⟶ 10

↓

1 ⟶ 10

↓

Reading

0.2 mL ⟶ 0.01 mg

3 mL ⟶ ?

= 0.15 mg /3mL

- 0.05 mg/mL
- 5 mg/100mL

Result : 5 mg drug is soluble in 100 mL of Dioxane

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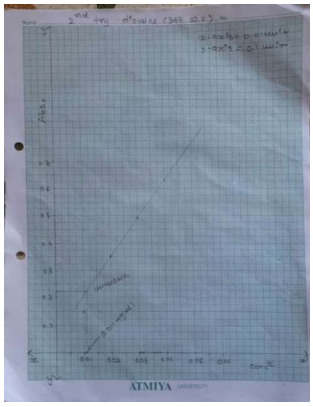
Graph: **Dioxane Try-2** **Calculation:**



0.2 ⟶ 10

↓

1 ⟶ 10

↓

1 ⟶ 10

↓

Reading

0.2 mL ⟶ 0.011 mg

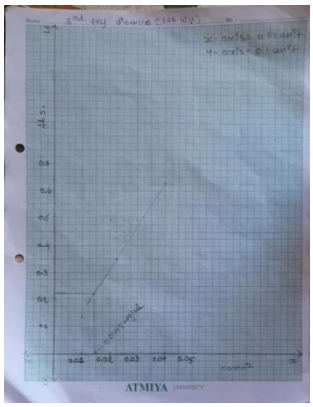
3 mL ⟶ ?

= 0.165 mg /3mL

- 0.055 mg/mL
- 5.5 mg/100mL

Result : 5.5 mg drug is soluble in 100 mL of Dioxane

Dioxane Try-3



0.2 ⟶ 10

↓

1 ⟶ 10

↓

1 ⟶ 10

↓

Reading

0.2 mL ⟶ 0.0145 mg

3 mL ⟶ ?

= 0.2175 mg /3mL

- 0.0725 mg/mL
- 7.25 mg/100mL

Result : 7.25 mg drug is soluble in 100 mL of Dioxane

Conclusion : So from the average of above three results we can conclude that 5.91 mg drug is soluble in 100 mL Dioxane.

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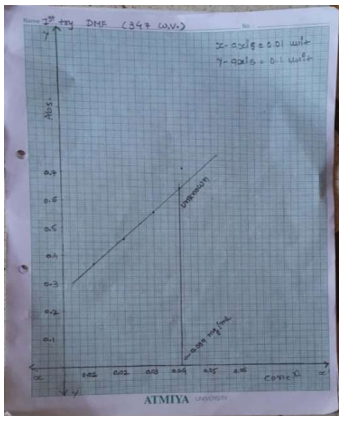
Graph: **DMF Try-1** **Calculation:**



0.2 ⟶ 10

↓

1 ⟶ 10

↓

1 ⟶ 10

↓

Reading

0.2 mL ⟶ 0.039 mg

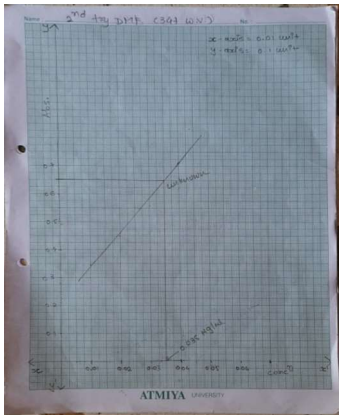
3 mL ⟶ ?

= 0.585 mg /3mL

- 0.195 mg/mL
- 19.5 mg/100mL

Result : 19.5 mg drug is soluble in 100 mL of DMF

DMF Try-2



0.2 ⟶ 10

↓

1 ⟶ 10

↓

1 ⟶ 10

↓

Reading

0.2 mL ⟶ 0.0355 mg

3 mL ⟶ ?

= 0525 mg /3mL

- 0.175 mg/mL
- 17.5 mg/100mL

Result : 17.5 mg drug is soluble in 100 mL of DMF

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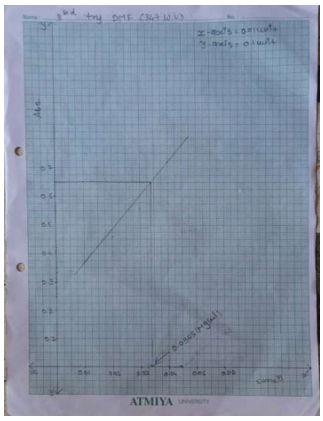
Graph: **DMF Try-3** **Calculation:**



0.2 ⟶ 10

↓

1 ⟶ 10

↓

1 ⟶ 10

↓

Reading

0.2 mL ⟶ 0.0365 mg

3 mL ⟶ ?

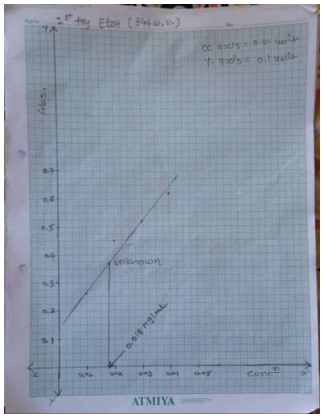
= 0.5475 mg /3mL

- 0.1825 mg/mL
- 18.25 mg/100mL

Result : 18.25 mg drug is soluble in 100 mL of DMF

Conclusion : So from the average of above three results we can conclude that 18.41 mg drug is soluble in 100 mL DMF.

Ethanol Try-1



0.2 ⟶ 10

↓

1 ⟶ 10

↓

1 ⟶ 10

↓

Reading

0.2 mL ⟶ 0.018 mg

3 mL ⟶ ?

= 0.27 mg /3mL

- 0.09 mg/mL
- 9 mg/100mL

Result : 9 mg drug is soluble in 100 mL of Ethanol

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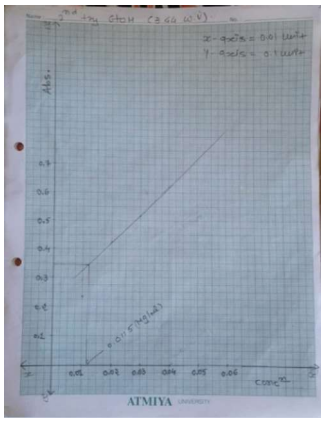
Graph:



Ethanol Try-2

0.2 ⟶ 10

↓

1 ⟶ 10

↓

1 ⟶ 10

↓

Reading

Calculation:

0.2 mL ⟶ 0.0115 mg

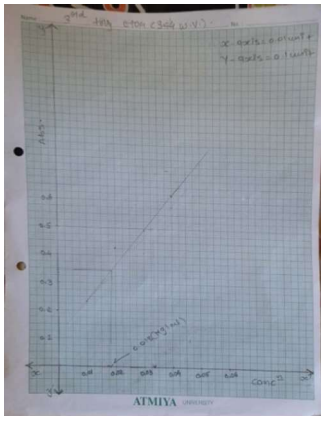
3 mL ⟶ ?

= 0.1725 mg /3mL

- 0.0575 mg/mL
- 5.75 mg/100mL

Result : 5.75 mg drug is soluble in 100 mL of Ethanol

Ethanol Try-3



0.2 ⟶ 10

↓

1 ⟶ 10

↓

1 ⟶ 10

↓

Reading

0.2 mL ⟶ 0.018 mg

3 mL ⟶ ?

= 0.27 mg /3mL

- 0.09 mg/mL
- 9 mg/100mL

Result : 9 mg drug is soluble in 100 mL of Ethanol

Conclusion : So from the average of above three results we can conclude that 7.91 mg drug is soluble in 100 mL DMF.

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Result:

No.	Solvent	Solubility
1	Methanol	15.7 mg/100mL
2	DCM	15.66 mg/100mL
3	Chloroform	21.25 mg/100mL
4	Dioxane	5.91 mg/100mL
5	DMF	18.41 mg/100mL
6	Ethanol	7.91 mg/100mL
7	Water	Insoluble

- From the above result we conclude that solubility order of the drug is as follows :

- Chloroform > DMF > Methanol > DCM > Ethanol > Dioxane > Water

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Section-3.2: DENSITY

The weight of solvents, pure solvents and solutions of organic compounds were measured by using gravity bottle. The density (ρ) was evaluated by using following equation.

$$\text{Density } (\rho) = \frac{\text{Weight of solvent with drug}}{\text{Weight of solvent without drug}}$$

- **GENERAL PROCEDURE:**

- For measuring the density of drug accurately weight 0.025gm, 0.050gm, 0.075gm and 0.10gm in vials with the help of electronic weight balance.
- Put all these four vials for stirring with rice needle for 15 minutes and make make upto 10ml with suitable solvent.
- Measure the weight of empty gravity bottle, weight of gravity bottle filled with particular solvent and weight gravity bottle filled with drug dissolved in solvent and note down the weight

- **NOTE:** The density was measured by gravity bottle with different concentration at room temperature.[40]

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DIOXANE:

(1) Weight of empty gravity bottle = 12.076gm

(2) Weight of solvent without gravity bottle = 10.054gm

(3) Weight of solvent with drug without gravity bottle =

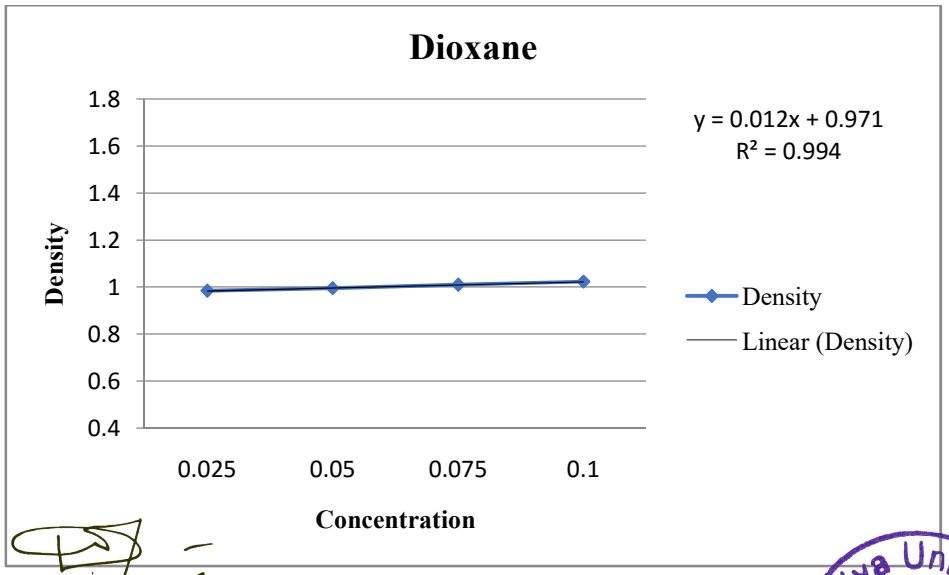
i. 0.025 = 09.901gm

ii. 0.050 = 10.003gm

iii. 0.075 = 10.155gm

iv. 0.100 = 10.285gm

CONCENTRATION	DENSITY
0.025	0.985
0.050	0.995
0.075	1.010
0.100	1.023



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CHLOROFORM:

(1) Weight of empty gravity bottle = 12.076gm

(2) Weight of solvent without gravity bottle = 09.998gm

(3) Weight of solvent with drug without gravity bottle =

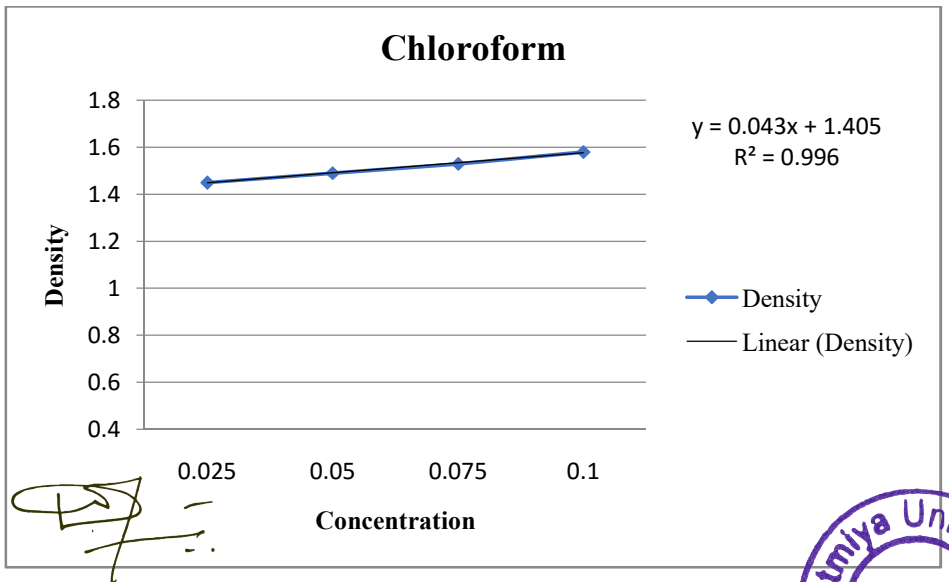
i. 0.025 = 14.535gm

ii. 0.050 = 14.921gm

iii. 0.075 = 15.333gm

iv. 0.100 = 15.790gm

CONCENTRATION	DENSITY
0.025	1.45
0.050	1.49
0.075	1.53
0.100	1.58



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ETHANOL:

(1) Weight of empty gravity bottle = 12.076gm

(2) Weight of solvent without gravity bottle = 08.036gm

(3) Weight of solvent with drug without gravity bottle =

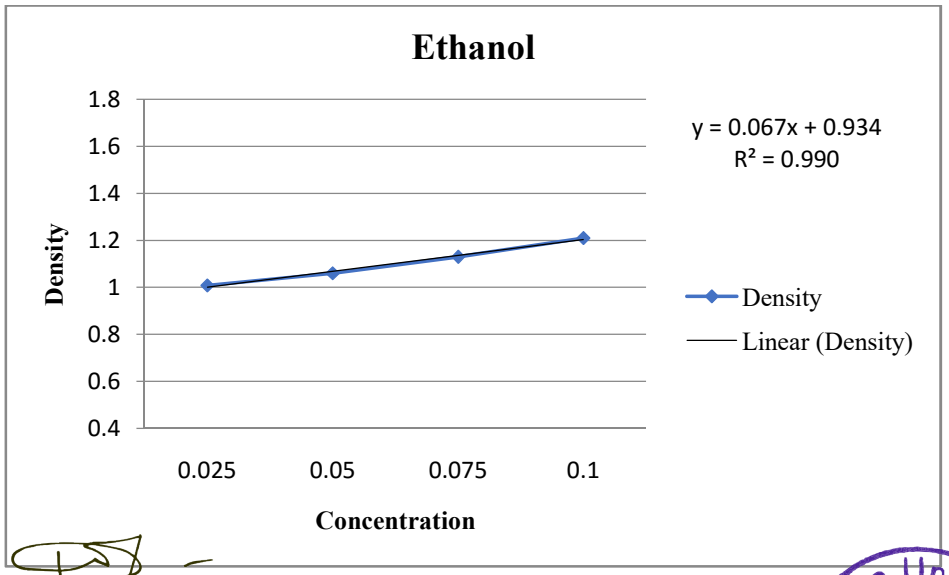
i. 0.025 = 8.113gm

ii. 0.050 = 8.518gm

iii. 0.075 = 9.160gm

iv. 0.100 = 9.720gm

CONCENTRATION	DENSITY
0.025	1.009
0.050	1.06
0.075	1.13
0.100	1.21



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DICHLOROMETHANE:

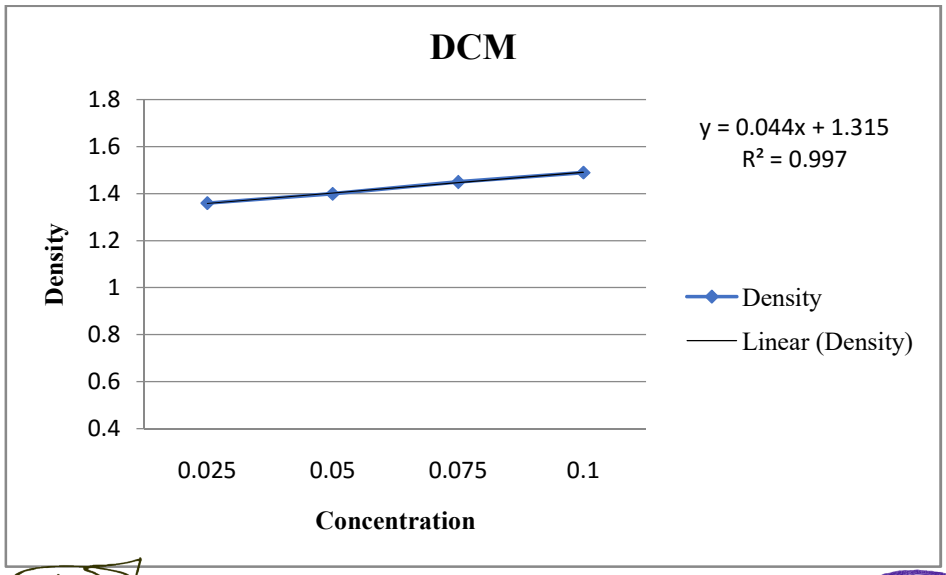
(1) Weight of empty gravity bottle = 12.076gm

(2) Weight of solvent without gravity bottle = 13.124gm

(3) Weight of solvent with drug without gravity bottle =

i. 0.025 = 17.851gm
ii. 0.050 = 18.439gm
iii. 0.075 = 19.029gm
iv. 0.100 = 19.554gm

CONCENTRATION	DENSITY
0.025	1.360
0.050	1.404
0.075	1.450
0.100	1.49



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METHANOL:

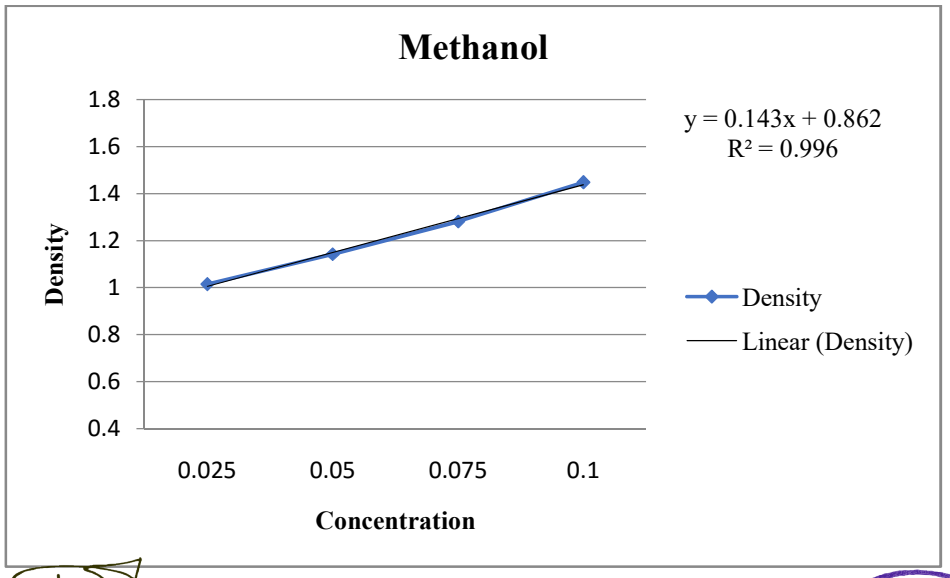
(1) Weight of empty gravity bottle = 12.076gm

(2) Weight of solvent without gravity bottle = 7.936gm

(3) Weight of solvent with drug without gravity bottle =

i. 0.025 = 8.062gm
ii. 0.050 = 9.072gm
iii. 0.075 = 10.212gm
iv. 0.100 = 11.492gm

CONCENTRATION	DENSITY
0.025	1.015
0.050	1.143
0.075	1.282
0.100	1.448



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DIMETHYLFORMAMIDE:

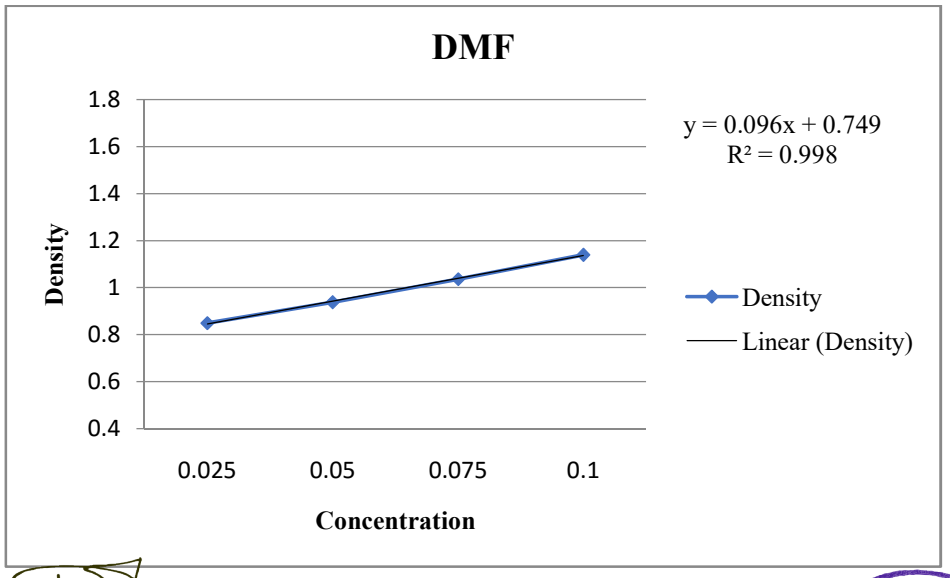
(1) Weight of empty gravity bottle = 12.076gm

(2) Weight of solvent without gravity bottle = 9.536gm

(3) Weight of solvent with drug without gravity bottle =

i. 0.025 = 08.101gm
ii. 0.050 = 08.951gm
iii. 0.075 = 09.889gm
iv. 0.100 = 10.926gm

CONCENTRATION	DENSITY
0.025	0.850
0.050	0.938
0.075	1.037
0.100	1.140



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WATER:

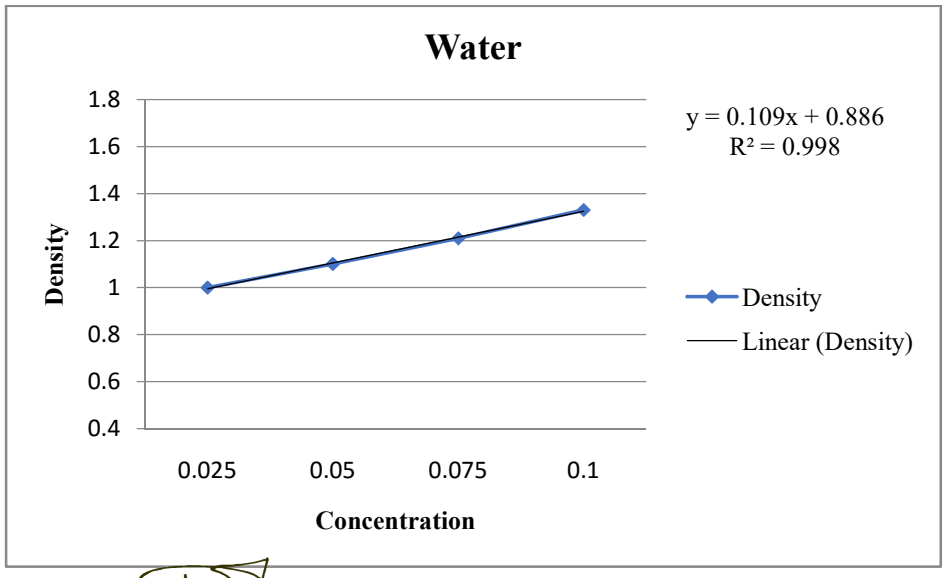
(1) Weight of empty gravity bottle = 12.076gm

(2) Weight of solvent without gravity bottle = 10.058gm

(3) Weight of solvent with drug without gravity bottle =

i. 0.025 = 10.076gm
ii. 0.050 = 11.077gm
iii. 0.075 = 12.178gm
iv. 0.100 = 13.388gm

CONCENTRATION	DENSITY
0.025	1.001
0.050	1.101
0.075	1.210
0.100	1.331



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Result:

- From the above result we can conclude that, with increase in drug concentration density of each solvent increases.

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Section-3.3: Viscosity

To determine the viscosity of solution, Ostwald viscometer was used, which obeys Stoke'slaw. The measured quantity of solvent was placed in the viscometer. The digital stopwatch with an accuracy of ± 0.01 second was used to determine flow time of solutions. [41] The viscosity of solutions were determined according to following equation:

$$V = \frac{dx \times dt}{dw \times tw}$$

Where,

dx=density of drug

dt = time

dw=density of water

dt = time taken by water

- For measuring the viscosity of drug, accurately weigh 0.025gm,0.050gm, 0.075gm and 0.100gm in 50ml beaker with the help of electronic weight balance.
- Add 30ml solvent in these 4 50ml beakers and stir it for 15 minutes on magnetic stirrer.
- Then carefully transfer the content of beaker into Ostwald's viscometer and measure the viscosity.
- Note down the results

Note: The viscosity was measured with different concentrations at room temperature.

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Dioxane:

$$\frac{dx \times dt}{dw \times tw}$$

- 0.025gm:

dx (density of drug) =0.985

dt (time taken by drug) =93 seconds

dw (density of water) =1.00

dt (time taken by water) =71 seconds

- 0.050gm:

dx (density of drug) =0.995

dt (time taken by drug) =104 seconds

dw (density of water) =1.10

dt (time taken by water) =71 seconds

- 0.075gm:

dx (density of drug) =1.010

dt (time taken by drug) =116 seconds

dw(density of water)=1.21

dt(time taken by water)=71 seconds

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- 0.1 gm:

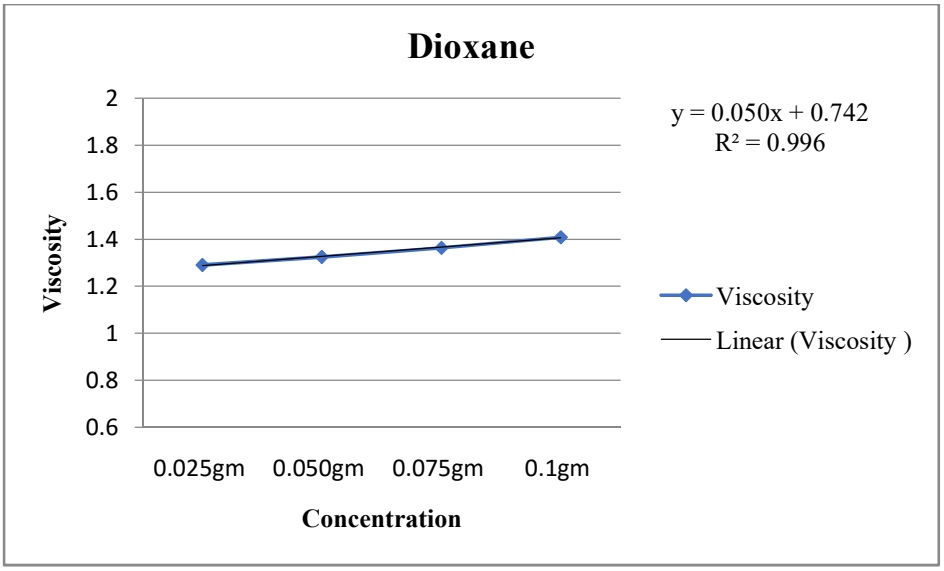
dx(density of drug)=1.023

dt(time taken by drug) =130 seconds

dw(density of water)=1.33

dt(time taken by water)=71 seconds

Concentration	Viscosity
0.025gm	1.2902
0.050gm	1.3249
0.075gm	1.3637
0.1gm	1.4082



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Chloroform:

- 0.025gm:

dx (density of drug) =1.45

dt (time taken by drug) =39 seconds

dw (density of water) =1.00

dt (time taken by water) =71 seconds

- 0.050gm:

dx (density of drug) =1.49

dt (time taken by drug) =44 seconds

dw (density of water) =1.10

dt (time taken by water) =71 seconds

- 0.075gm:

dx (density of drug) =1.53

dt (time taken by drug) =50 seconds

dw (density of water) =1.21

dt (time taken by water) =71 seconds

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- 0.1gm:

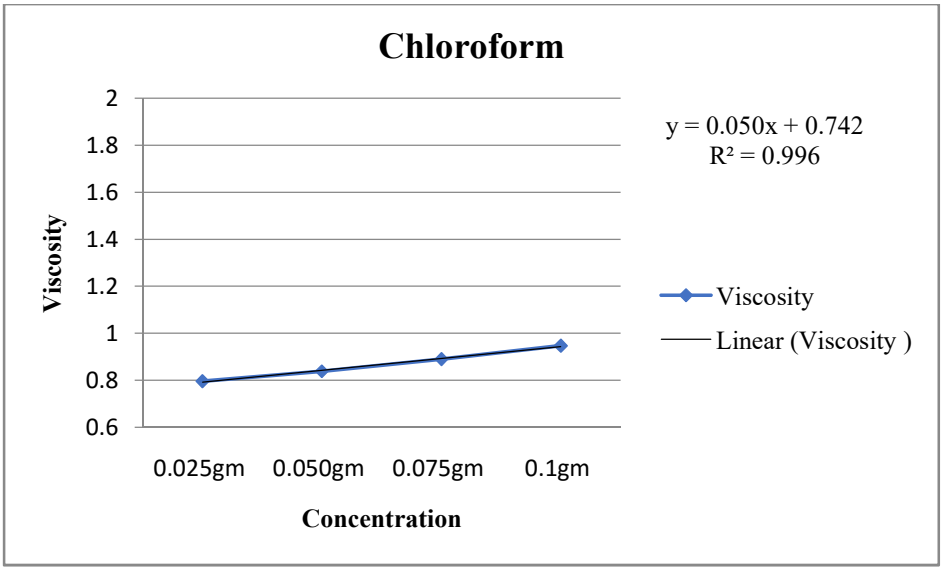
dx (density of drug) =1.57

dt (time taken by drug) =57 seconds

dw (density of water) =1.33

dt (time taken by water) =71 seconds

Concentration	Viscosity
0.025gm	0.7964
0.050gm	0.8394
0.075gm	0.8904
0.1gm	0.9476



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Ethanol:

- 0.025gm:

dx (density of drug) =1.009

dt (time taken by drug) =107 seconds

dw (density of water) =1.00

dt (time taken by water) =71 seconds

- 0.050gm:

dx (density of drug) =1.06

dt (time taken by drug) =114 seconds

dw (density of water) =1.10

dt (time taken by water) =71 seconds

- 0.075gm:

dx (density of drug) =1.13

dt (time taken by drug) =121 seconds

dw (density of water) =1.21

dt (time taken by water) =71 seconds

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- 0.1gm:

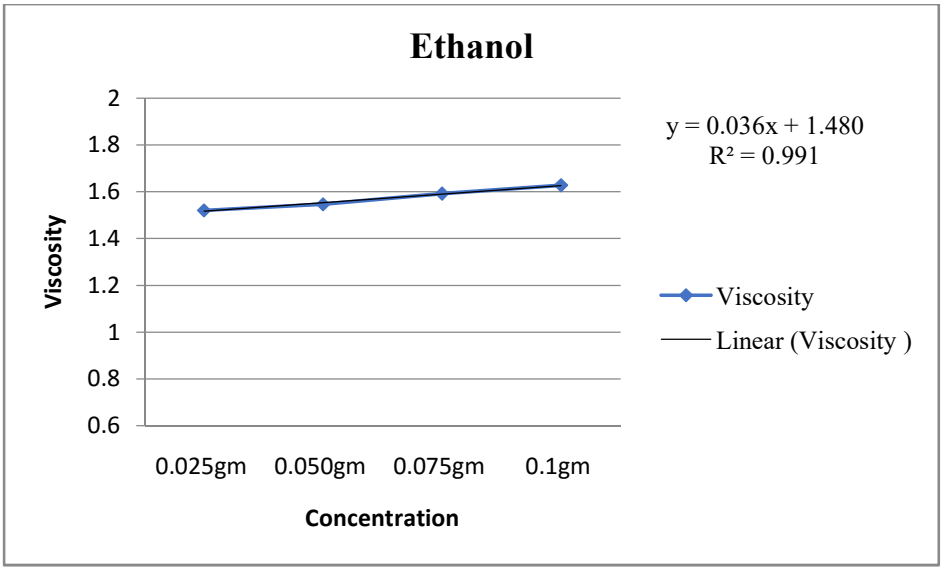
dx (density of drug) =1.21

dt (time taken by drug) =127 seconds

dw (density of water) =1.33

dt (time taken by water) =71 seconds

Concentration	Viscosity
0.025gm	1.5206
0.050gm	1.5472
0.075gm	1.5915
0.1gm	1.6273



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Dichloromethane:

- 0.025gm:

dx (density of drug) =1.36

dt (time taken by drug) =37 seconds

dw (density of water) =1.00

dt (time taken by water) =71 seconds

- 0.050gm:

dx (density of drug) =1.40

dt (time taken by drug) =40 seconds

dw (density of water) =1.10

dt (time taken by water) =71 seconds

- 0.075gm:

dx (density of drug) =1.45

dt (time taken by drug) =43 seconds

dw (density of water) =1.21

dt (time taken by water) =71 seconds

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- 0.1gm:

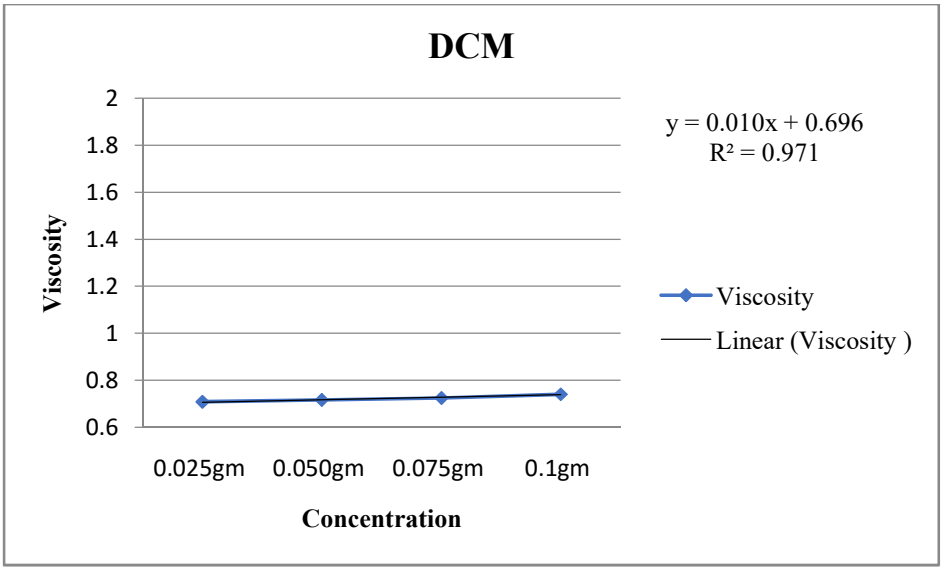
dx (density of drug) =1.49

dt (time taken by drug) =47 seconds

dw (density of water) =1.33

dt (time taken by water) =71 seconds

Concentration	Viscosity
0.025gm	0.7087
0.050gm	0.7170
0.075gm	0.7257
0.1gm	0.7416



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Methanol:

- 0.025gm:

dx (density of drug) =1.01

dt (time taken by drug) =61 seconds

dw (density of water) =1.00

dt (time taken by water) =71 seconds

- 0.050gm:

dx (density of drug) =1.14

dt (time taken by drug) =64 seconds

dw (density of water) =1.10

dt (time taken by water) =71 seconds

- 0.075gm:

dx (density of drug) =1.28

dt (time taken by drug) =67 seconds

dw (density of water) =1.21

dt (time taken by water) =71 seconds

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- 0.1gm:

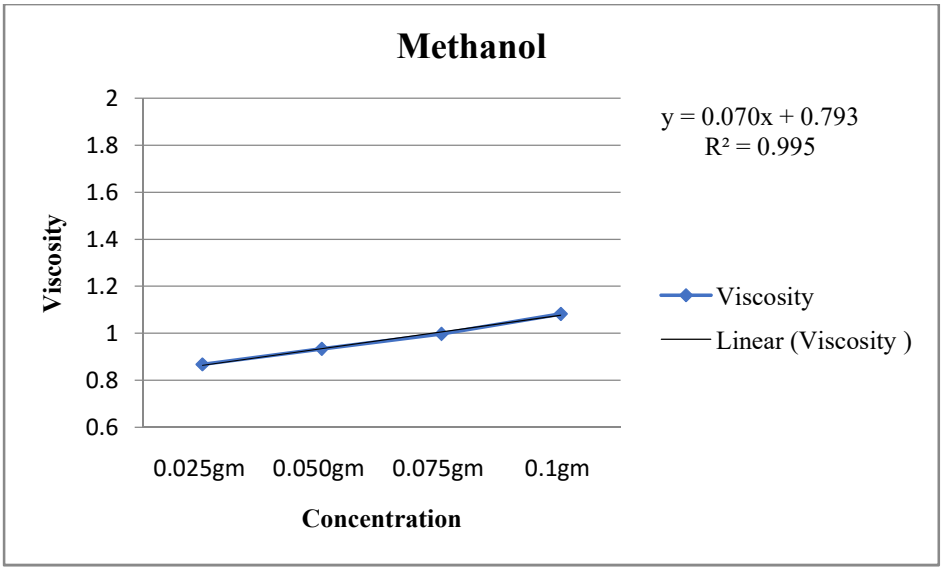
dx (density of drug) =1.44

dt (time taken by drug) =71 seconds

dw (density of water) =1.33

dt (time taken by water) =71 seconds

Concentration	Viscosity
0.025gm	0.8677
0.050gm	0.9341
0.075gm	0.9982
0.1gm	1.0827



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Dimethyl Formamide:

- 0.025gm:

dx (density of drug) =0.85

dt (time taken by drug) =77 seconds

dw (density of water) =1.00

dt (time taken by water) =71 seconds

- 0.050gm:

dx (density of drug) =0.938

dt (time taken by drug) =101 seconds

dw (density of water) =1.10

dt (time taken by water) =71 seconds

- 0.075gm:

dx (density of drug) =1.037

dt (time taken by drug) =127 seconds

dw (density of water) =1.21

dt (time taken by water) =71 seconds

- 0.1gm:

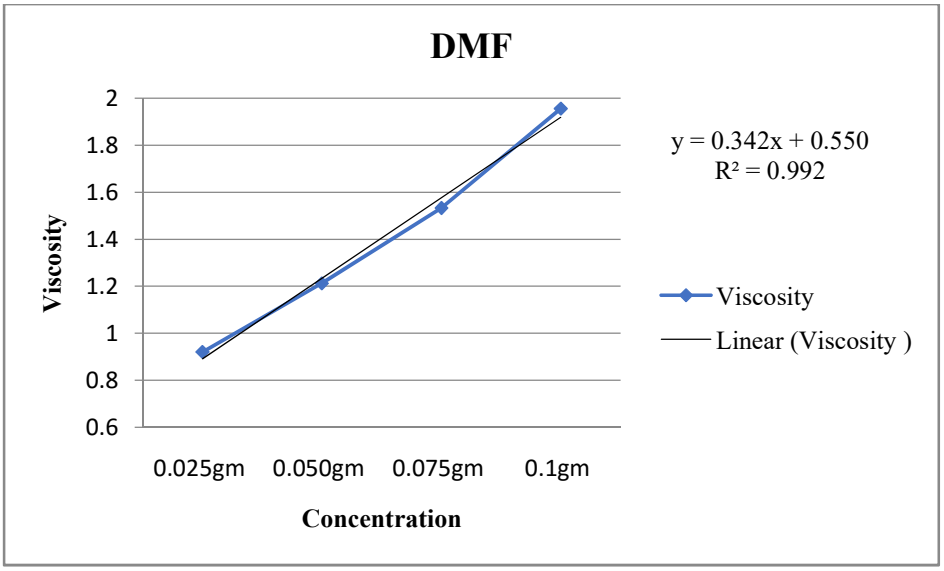
dx (density of drug) =1.14

dt (time taken by drug) =162 seconds

dw (density of water) =1.33

dt (time taken by water) =71 seconds

Concentration	Viscosity
0.025gm	0.9218
0.050gm	1.2130
0.075gm	1.5329
0.1gm	1.9557



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Water:

- 0.025gm:

dx (density of drug) =1.00

dt (time taken by drug) =76 seconds

dw (density of water) =1.00

dt (time taken by water) =71 seconds

- 0.050gm:

dx (density of drug) =1.10

dt (time taken by drug) =79 seconds

dw (density of water) =1.10

dt (time taken by water) =71 seconds

- 0.075gm:

dx (density of drug) =1.21

dt (time taken by drug) =83 seconds

dw (density of water) =1.21

dt (time taken by water) =71 seconds

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- 0.1gm:

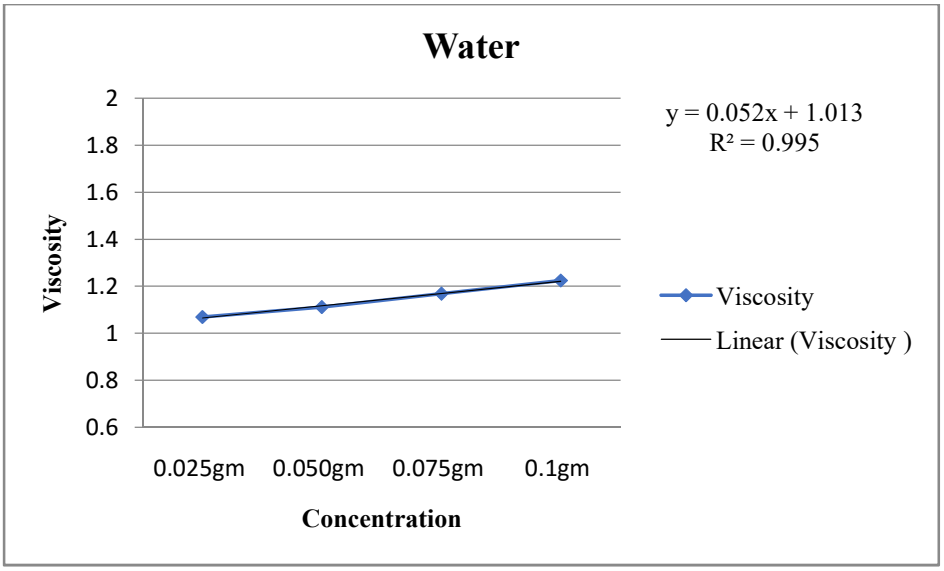
dx (density of drug) =1.33

dt (time taken by drug) =87 seconds

dw (density of water) =1.33

dt (time taken by water) =71 seconds

Concentration	Viscosity
0.025gm	1.070
0.050gm	1.112
0.075gm	1.1690
0.1gm	1.225



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Result:

- From the above result we can conclude that, with increase in drug concentration viscosity of each solvent increases.

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CONCLUSION:

The established pharmacological importance and the wide diversity of biological activities exhibited reported by benzodiazepine derivatives prompted us to carry out the present research work. As discussed previously the present research work focuses mainly on the synthesis of novel 1,5- benzodiazepine derivatives and the corresponding tricyclic compounds of 1,5-benzodiazepine derivatives of various types.

In future fluorescence activity of our novel benzodiazepine derivatives can be explored.

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Comprehensive Project

On

"FACTORS AFFECTING THE USE OF UPI SERVICES"

In partial fulfillment of the Requirement of the award

of the degree of

Master of Business Administration (MBA)

Prepared by:

Krutika Dodiya (190321011)

Drashti Pitroda (190321042)

Under the guidance of

Mr. Bhavin Patel

ATMIYA UNIVERSITY
सुहृदं सर्वभूतानाम्

Offered By

Atmiya University, Rajkot

MBA (Semester – 4)

Month & Year

March 2021

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Certificate

This is to certify that Ms. Kruti Dodiya and Ms. Drashti Pitroda students of MBA Atmiya University completed project work on "Factors affecting Use of UPI Services" under my guidance and supervision. I certify that this is an original work and has not been copied from any source.

Rating of Project Report [A/B/C/D/E]: B

(A=Excellent; B=Good; C=Average; D=Poor; E=Worst)

(By Faculty Guide)

Signature of the Faculty Guide/s

(Mr.Bhavin A Patel, Assistant Professor)

Signature of the HOD

(Dr. Meghashree Dadhich, HOD)

Head of Department
Department of Management
Faculty of Business & Commerce
Atmiya University
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Signature of Dean

(Dr. Vishal Khasgiwala, Dean)

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PREFACE

Project report is very important aspect management and every course. In such project students can get practical knowledge about financial market. It also helps students to use theoretical knowledge in practical field. Now adays, theoretical knowledge and classroom discussion is not enough for the students, for the purpose of practical viewpoints, opportunities, such projects work is very much necessary. So as students of semester 4 of MBA we also got an opportunity to learn practical knowledge from such project,

We tried our best to prepare this project. We tried to include all the necessary details regarding the subject. The main purpose behind this project is t o fill up the theory and practical aspects. All the information given there is per our efforts and knowledge about subject.

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We are presenting a Comprehensive Project Paper **"FACTORS AFFECTING THE UPI SERVICES"** as a part of the curriculum of the 'Master of Business Administration'. We wish to thank the people who gave us their valuable support.

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Thanking You.

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STUDENT DECLARATION

We hereby declare that the **Comprehensive Project Paper** titled **"Factors Affecting The Use Of UPI Services."** Is a result of our own work and our indebtedness to other work publication, reference, if any, has/have been duly acknowledged. If we are found guilty of copying from any other report or publication information 7 showing as our original work, or extending plagiarism limit, we understand that we shall be liable and punishable by the university, which may include 'Fail' in the examination or any other punishment that university may decide.

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Index

Sr no.	Chapter Name
1.	Introduction to UPI
	1.1 Introduction to Digital Finance
	1.2 Digital Financial services
	1.3 Introduction to UPI
	1.4 History of UPI
	1.5 Need for UPI
	1.6 what is UPI?
	1.7 how it works?
	1.8 Is it secure?
	1.9 difference between UPI and e-wallet
2.	Literature Review
3.	Research Methodology
	3.1 Research gap
	3.2 Research objective
	3.3 Scope of the study
	3.4 Research Methodology
	3.5 Sampling design
	3.6 Data Collection Method
	3.7 Hypothesis for the study
	3.8 Limitation
4.	Data Analysis
	4.1 Descriptive Statistics
	4.2 Hypothesis testing
5.	Conclusion
6.	References

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CHAPTER- 1 INTRODUCTION TO UPI

1.1 Introduction to Digital Finance

Digital finance is an idea that individuals and companies can have access to payments, savings and credit products by using the smart gadgets without ever stepping into a bank branch.

Digital finance can turn a smart phone into a wallet, a chequebook, a bank branch and an accounting ledger all in one.

The use of digital finance is increasing day by day. Most of the people have started using the digital finance over the usual finance or financial services. Digital finance gives civilians and companies access to payments, savings, and credit products without ever stepping into a bank branch. This is possible through digitization.

- Key Elements Of Digital Finance: - There are three major elements of any digital financial service:

I. A digital transactional platform enables customers to use a device to make or receive payments. They can also store electronic value with a bank or nonbank.

II. Retail agents that have a digital device can send and receive transaction details. They may also perform other tasks depending on regulations and arrangements with the institution.

III. The digital device of the customer serves as a means of transmitting data and information.

An example of Digital Finance is Enterprise Resource Planning (ERP). ERP is the integrated management of business processes. It is often in real-time and mediated by software.

1.2 Digital Financial Service

Digital financial services (DFS) are financial services which rely on digital technologies for their delivery and use by consumers.

Digital financial services can be defined as financial service provided through or using digital infrastructure such as smart phones and internet. It negates the reliance and usage of cash and other traditional bank branches.

This also includes personal mobile banking services like M-Pay, M-Money which provides both transactional and non-transactional services. Digital financial services are often denoted by the name of financial technology or FinTech. This digital age facilitates the growing number of

FinTech companies that actually making our digital life simpler. Digital Finance allows individuals and business to make seamless transactions across all parties. As such due to the rapid technological advances, financial services have also been successful at gaining immense insights into consumer needs and behaviours through mobile service networks.

Digital Finance allows individuals and business to make seamless transactions across all parties. The times have changed until recently though as newer business models are emerging out summed up expeditious technological innovation and government intervention, the situation has gravely improved. This has enabled banks to reach out to the excluded through third-party agents or network managers like M-PESA. As such due to the rapid technological advances, financial services have also been successful at gaining immense insights into consumer needs and behaviours through mobile service networks. The information gathered from such sources can eventually help in addressing the needs of the customers. Apart from that as the reach of the mobile network, especially in countries like India is vast and spread out, digital financial services can act as "infrastructure rails" for other products and business models to improve along with.

"infrastructure rails" for other products and business models to improve along with.

At the utmost crux of an economy stand "Financial Services" empowering households and businesses to participate in the day-to-day economic activities like saving, investing and protecting themselves from potential financial risks. Unfortunately, even today, most of the emerging economies like India are struggling hard to eliminate poverty and increase economic growth through increased financial inclusion.

Digital financial services and the digital economy is not a new thing and has been around for over a decade or so. But in the past few years, we have seen accelerated growth in this field as new favouring regulation regarding customers and service providers came to ease out the use of digital financial services and increase the reach to the underserved population. Much of the things have been done but even much more is there on the plate which is needed to be done regarding the digital finance and to popularise it in the common masses. With the government taking an interest, easing down the regulation and new and innovative service providers coming in the field it is safe to say that the future of digital finance is there in India.

Importance of digital finance

Digital finance gives civilians and companies access to payments, savings, and credit products without ever stepping into a bank branch. This is possible through digitization. It can turn a smartphone into a wallet, a cheque book, a bank branch, and even an accounting ledger. The advances in technology help solve some of the key challenges of achieving full financial inclusion.

Modern technology is now accelerating innovation and changing the financial services industry. It does this by forcing traditional business models to adapt and transform. This benefits

marginalized communities. To illustrate, examples of technology trends include artificial intelligence, automation, big data, distributed ledger technology, and machine learning.

Benefits of Digital Financial Services(DFS):

- Accessible everywhere
- Very Easy and efficient
- Save lots of time and resources- no more waiting in queues for affecting fund transfer
- Every transaction is updated on real-time
- Ease of decision making
- Reliability and Flexibility in affecting a transaction
- Seamless integration of all digital platforms
- Eco-friendly
- Increase in customer base with tech support
- Increases the reach through Omni channel digital marketing

These are the advantages of digital financial services that benefit both the business and consumers in society. The evolution of computing technology is changing the dynamics of conventional banking and financial systems.

1.3 Introduction to UPI

UPI or Unified Payments interface is an immediate real-time payment system that helps in instantly transferring the funds between the two bank accounts through a mobile platform. Hence, UPI is a concept that allows multiple bank accounts to get a single mobile application. This idea was developed by the National Payments Corporation of India and is controlled by RBI and IBA (Indian Bank Association).

1.4 History of UPI

United Payments Interface (UPI) is India's real-time mobile payments system, developed by the National Payments Corporation of India (NCPI). Launched in April 2016, the interface facilitates inter-bank transactions and is regulated by the Reserve Bank of India. It connects multiple bank accounts into a single mobile application, allowing immediate money transfer and payments 24/7. The interface allows individuals to link their bank accounts to multiple peer-to-peer (P2P) payment apps, such as Paytm, Google Pay, PhonePe, MobiKwik, and BHIM (NCPI's P2P app), among others. Individuals can use UPI to pay each other, as well as banks and institutions that are UPI enabled, via phone numbers, QR codes, account numbers and IFSC codes, Aadhar numbers, their unique Virtual Payment Address (VPA) or their UPI IDs.

In October 2019, India's UPI system crossed 1 billion transactions and over 100 million users, merely three years after its launch. UPI now fulfils more than half of all digital transactions in the country. In November 2019, India's UPI went international, with demo transactions being tested in Singapore via the NCPI's BHIM app. It is expected to launch fully later this year. According to reports, the Indian government is exploring launching the BHIM UPI app in the UAE as well, due to the large Indian expatriate population residing there. Both Singapore and the UAE have already opened their markets to India's RuPay cards and, if the adoption of the UPI system goes through, Indian expats will have a cheaper and easier alternative to send their remittances back home.

Tech giant Google's flagship payments app, Google Pay (previously launched as Tez), has witnessed immense success as UPI's popularity has grown among Indian residents. Within two years of its launch, the app recorded 67 million monthly active users (MAU) followed by rival PhonePe (owned by Flipkart), at 55 million active users per month. Paytm, India's homegrown unicorn valued at $16 billion, remains the market leader with 140 million active users per month

Across the world, several countries have marveled at India's success with real-time mobile payments. Following Google Pay's success with UPI, in 2019, Google recommended that the U.S. Federal Reserve also implement a real-time payments platform, on the lines of India's UPI.

1.5 Need for UPI

Simplicity: Paying and receiving payments should be as easy as swiping a phonebook entry and making a call on mobile phone, says the document. An account holder should be able to send and receive money from their mobile phone with just an identifier without having any other bank/account details. All they need to do is to "pay to" or "collect from" a "payment address"

Security: The solution had to provide end-to-end strong security and data protection. The trick here was not to reveal too much data like banking or other personal details which could be misused. For convenience, the solution also had to offer 1-click 2-factor authentication, protection from phishing, risk scoring and many more.

Adoption: Given the size of the potential user base, the key was to have a solution which should not crash and be scalable to a billion users and enable large scale adoption. It should allow gradual adoption across smartphone and feature phone users and provide full interoperability across all payment players, phones, and use cases. People using smartphone should be able to send money to others who are not yet using any mobile application and vice versa.

Cost: India is a cost-conscious country and any product with a high cost is likely to have a short life. Since mobile phone number is used as an authentication device, use of virtual payment addresses, and use of third party portable authentication schemes such as Aadhaar should allow both acquiring side and issuing side cost to be driven down.

Innovation: The idea here was to come up with a solution so that innovations on both payee and payer side can evolve without having to change the whole interface. It should allow application providers to take advantage of enhancements in mobile devices, provide integrated payments on new consumer devices provide innovative user interface features, take advantage of newer authentication services and much more.

1.6 What is UPI?

UPI is a single platform that merges various banking services and features under one umbrella. A UPI ID and PIN are sufficient to send and receive money. Real-time bank-to-bank payments can be made using a mobile number or virtual payment address (UPI ID).

UPI is an initiative taken by the National Payments Corporation of India (NPCI) together with the Reserve Bank of India and Indian Banks Association (IBA). NPCI is the firm that handles RuPay payments infrastructure, i.e. similar to Visa and MasterCard. It allows different banks to interconnect and transfer funds. Immediate Payments Service (IMPS) is also an initiative of NPCI. UPI is considered as the advanced version of IMPS.

- Key features of UPI

  Some of the features of UPI are listed below:

a. Immediate money transfer through mobile device round the clock 24*7 and 365 days.
b. Single mobile application for accessing different bank accounts.
c. Single Click 2 Factor Authentication – Aligned with the Regulatory guidelines, yet provides for a very strong feature of seamless single click payment.
d. Virtual address of the customer for Pull & Push provides for incremental security with the customer not required to enter the details such as Card no, Account number; IFSC etc.
e. Bill Sharing with friends.
f. Best answer to Cash on Delivery hassle, running to an ATM or rendering exact amount.
g. Merchant Payment with Single Application or In-App Payments.
h. Utility Bill Payments, Over the Counter Payments, Barcode (Scan and Pay) based payments.

i. Donations, Collections, Disbursements Scalable.

j. Raising Complaint from Mobile App directly.

1.7 How UPI works?

UPI has made the money transfer process a lot easier. You do not have to remember the receiver's account number, account type, IFSC, and bank name. Instead, you can do the money transfer only by knowing their Aadhaar number, mobile phone number registered with the bank account, or UPI ID. You can set up UPI ID on one of the apps that support UPI service. Mostly, a UPI ID begins with your mobile number followed by '@' symbol and ends with the app you are using. For example, if your mobile number is 90xxxxxx60 and if you are using Paytm app, the UPI ID can be '90xxxxxx60@paytm'. The ID can be set up by providing the details of your bank account on the app. The app will send an OTP to your registered mobile number to make sure that you are an authorised person. Once you enter the OTP, you will be prompted to create a PIN for the UPI ID. Upon completing the registration, you can choose any mobile number from your contacts and send money. You can also request money from anyone on your contacts list.

1.8 Is it secure?

UPI transactions use highly secure encryption format that is not easy to tamper. NPCI's IMPS network handles about Rs.8,000 crore worth transactions every day. This is expected to exponentially increase with UPI technology. It uses a two-factor authentication method, similar to OTP, for verifying every transaction. However, UPI PIN will be used in the place of OTP for validation.

- What make UPI a secure platform?
  This interface is based on 2 factor authentication with a seamless single click payment. This feature of UPI is aligned with the regulatory guidelines that make it the safest. 2 factor authentication is quite similar to OTP. Here, MPIN will be used instead of OTP. Nandan Nilekani, NPCI advisor, assures the security is fool proof with UPI as the transaction will happen in a highly encrypted format. NPCI's IMPS network already manages more than Rs.8000 cr. Transaction per day, which will now increase with the use of mobile phones.

1.9 Difference between UPI and E-wallet

- **Money source:** Using UPI, your money stays in your bank account. No change required, whatsoever. While in e-wallet, your money needs to be transferred from your bank account to a wallet provider such as Paytm or Freecharge or similar ones.
- **Account identity:** In UPI, an email address like in the format username@bankname for example- leo_great_123@icici OR modi@sbi. This is called the VPA – Virtual Payment Address. This is easy to create from the bank's website and will/should be unique. While dealing with e-wallet, the account identity will be your phone number.
- **Send money:** Using UPI, to just about anyone with a bank account and UPI activated. Technically, to anyone having a VPA. Receiving party need not be an account holder of your own bank. They get the money instantly in their bank account and can use 100% of it to withdraw/transfer/buy/whatever. While in e-wallet, receiving party should have an account with the same wallet provider that you use. After the transfer, they don't get the money instantly in their bank account and when they choose to transfer that received money to their bank account they lose a small percentage as Wallet charges.
- **Receive money:** From anyone and is available instantly in your bank account to use/withdraw/whatever by using UPI. By using e-wallet, Only from users of the same wallet provider. Again, you don't get the money instantly in your bank account as described above.

CHAPTER - 2 LITERATURE REVIEW

1. Compared to all other payment systems it would not be misplaced to say that UPI is most advanced payment system in the world. With its standards set to API, UPI has allowed different banks to communicate with each other and has enabled interoperability between desperate bank payment system. UPI works as a safe, secure and robust platform to make it more secure than any extent payment system. (Gochhwal R, 2017)
2. UPI seeks to make money transfer hassle-free, brief and clean. The proliferation of smart phones, the availability of an online variable identity, universal access to banking and the introduction of biometric sensors in phones will proactively encourage electronic payment systems for ushering in a less – cash society in India. (Somanjoli Mohapatra, 2017)
3. Excitement over the growth of mobile payments perpetuated the phenomenon of disconnected island and disjoints experiences. With UPI there is no need of any other payment app at all. On the other hand, if one wants to keep a particular mobile wallet UPI could enable the interoperability of wallets allowing users to transfer funds from one wallet to another. (Kate, 2016)
4. UPI is a tool with well suited capabilities that can make financial transactions easy and low cost to the clients even though it is difficult to sideline the challenges. A robust Adhar platform (UID) mixed fact for the united states referring to improved economic illusion, cellphone adoption and telecom subscription imply wonderful potentialities for UPI while competition from cell wallets and viable cases of failure from banks overcome technical errors mainly relating to the front-gibe up platform designed through them can negatively affect the scope of this innovative payment tool. (Roshna Thomas, Dr Abhijeet Chatterjee, 2017

CHAPTER – 3 RESEARCH METHODOLOGY

3.1 Research gap

The UTAUT Model has been used in this research project not many research is done using the UTAUT model, more research should be conducted using the UTAUT model.

- **UTAUT MODEL**

  The Unified Theory Of Acceptance and Use of Technology (UTAUT) uses four determinants to determine users Behaviour Intentions (BI), to use a technology: Performanve expectancy (PE), Effort Expectancy (EE), Social Influence (SI), and Facilitating Conditions (FC) (VENKATESH et al., 2012).

PERFORMANCE EXPECTANCY: Performance expectancy is the degree to which using a technology will provide benefits to consumers in performing certain activities (Venkatesh et al., 2012). The individual's perception that using digital payment services will help to attain gains in performing payment tasks may thus influence the behavioural intention to adopt digital payment services.

EFFORT EXPECTANCY: Effort expectancy is the degree of ease associated with consumers' use of technology (Venkatesh et al., 2012). According to Miltgen et al. (2013) it contributes to a precise prediction of intention to adopt a new technology. When users feel that digital payment services is easy to use and does not require much effort, they have higher expectations toward acquiring the desired performance (Venkatesh et al., 2003).

SOCIAL INFLUENCE: Social influence is the extent to which consumers perceive that important others believe they should use a particular technology (Venkatesh et al., 2012). It reflects the effect of environmental factors such as opinions of a user's friends, relatives, and superiors on behaviour (Venkatesh et al., 2003), when they are positive it may encourage the user to adopt digital payment services.

FACILITATION CONDITIONS: Facilitating conditions (FC) refers to consumers' perceptions of the resources and support available to perform a behaviour (Venkatesh et al., 2012). If an operational infrastructure exists and supports the use of digital payment, the behavioural intention to adopt digital payment services will increase.

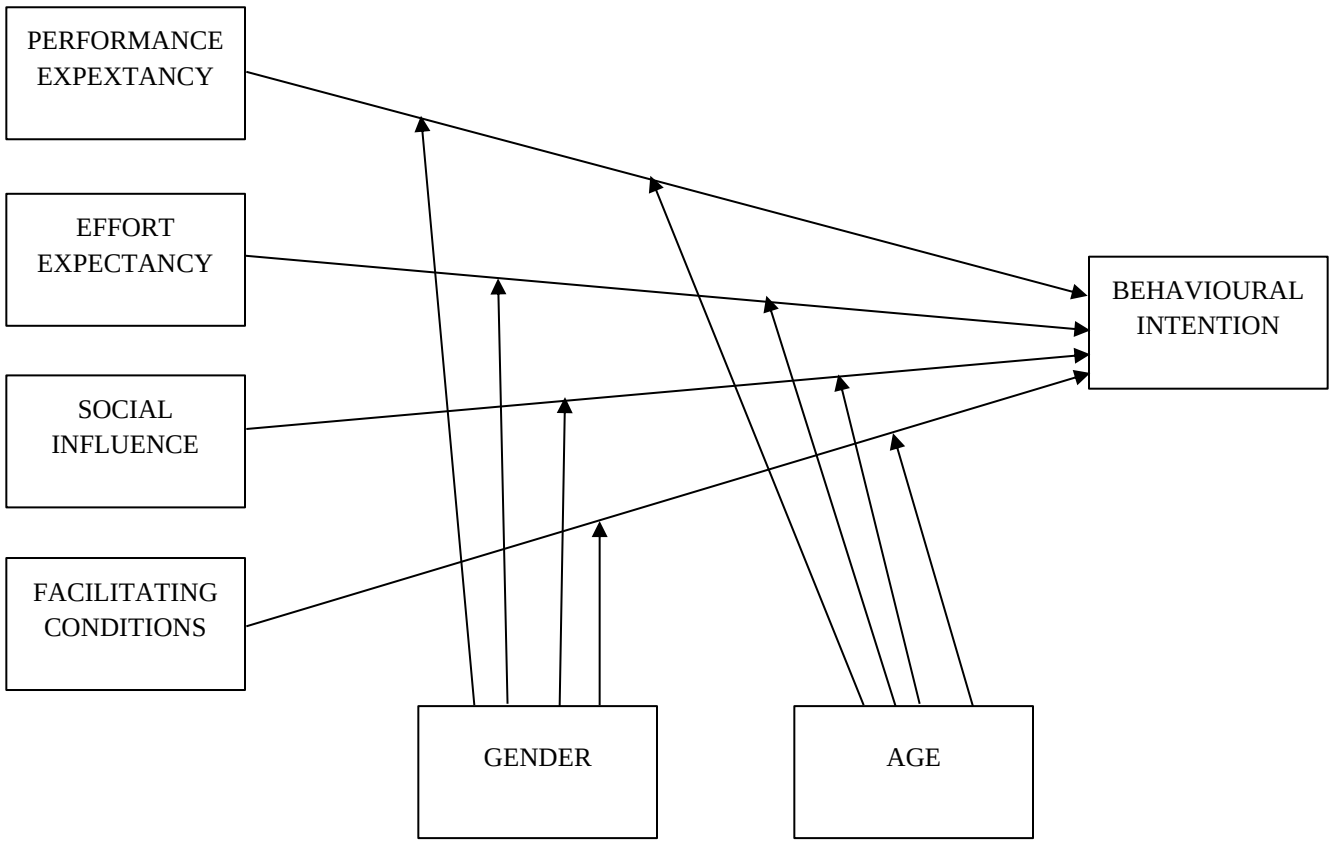

Figure 1. Researcher's specified model from UTAUL model by Vankatesh el al. (2013)

3.2 Research Objective

A research objective describes concisely what the research is trying to achieve. They summaries the accomplishments a researcher wishes to achieve through the project and provide direction to the study. The objectives of these research are:

- To determine the factors affecting adoption of UPI services in Rajkot.
- To analyze the relationship between demographic variables and adoption of UPI services.

3.3 Scope of the study

The scope of the study explains the extent to which research area is explored in the work and specifies the parameter within the study.

- Place: Rajkot
- Time: The duration of the study may not be specified as the questionnaire used here is a structured questionnaire.

- Sample size: 100 people

3.4 Research Methodology

To analyze the factors affecting the use of UPI services, researchers extended the UTAUT model. From the review of literature we found that factors like Performance Expectance (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC) and Behavioural Intention (BI) have significant relation with the usage of UPI Services.

The respondents were selected based on convenience sampling methods, structured questionnaire was used as data collection instrument and 100 questionnaires were found valid to be used for analysis.

3.5 Sampling design

A sampling design is the framework, or road map, that serves as the basis for the selection of a research sample and affects many other important aspects of research as well.

- Convenient sampling and proposed sample size for research would be 100.Targeted audience: All people who are using UPI services in Rajkot

3.6 Data Collection Method

Data collection is defined as the procedure of collecting, measuring and analyzing accurate insights for research using standard validated techniques. A researcher can evaluate their hypothesis on the basis of collected data.

- We are using Structured Questionnaire as we are using UTAUT model, it would be easy to gather information of the large number of people.

3.7 Hypothesis for the study

- **Hypothesis 1:** Performance expectancy is positively related to behavioural intention. The null hypothesis is rejected.
- **Hypothesis 2:** Effort expectancy is positively related to behavioural intention. The null hypothesis is rejected.
- **Hypothesis 3:** Social factors are positively related to behavioural intention. The null hypothesis is rejected.
- **Hypothesis 4:** Facilitating conditions positively influence the behavioural intention to adopt UPI Services.

3.8 Limitations

The research has some limitations they are as follows…

- Some people might not answer the questionnaire genuinely.
- The area of research is limited as it is not able to reach out to all the people of Gujarat.
- Insufficient sample size for statistical measurement
- It was a time consuming process.

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CHAPTER-4 DATA ANALYSIS

4.1 Descriptive Statistics

The respondents were selected based on convenience sampling methods, structured questionnaire was used as data collection instrument and 100 questionnaires were found valid to be used for analysis. The sample profile is shown in Table 1.

TABLE 1. Sample Profile

		Frequency	**Percentage**
Gender	Male	47	47
	Female	53	53
Age	18 years – 25years (Gen Z)	74	74
	26 years & above (Gen Y)	26	26
Education	Higher Secondary	4	4
	Secondary	58	58
	Post Graduate	37	37
	Doctorate	1	1
Occupation	Businessman	30	30
	Salaried	26	26
	Professional	15	15
	Others (Students)	29	29
Monthly Income	Less than Rs 20,000	46	46
	Rs 20,000 – Rs 30,000	18	18
	Above 30,000	36	36

4.2 Hypothesis Testing

Table 2. Correlation Matrix: UTAUT Model

	PEScore	EEScore	SIScore	FCScore	BIScore
PEScore	1				
EEScore	.736**	1			
SIScore	.697**	.648**	1		
FCScore	.713**	.699**	.613**	1	
BIScore	.701**	.646**	.612**	.577**	1

Note: **. Correlation is significant at the 0.01 level (2-tailed).

From Table 2. The analysis of correlation showed Performance Expectancy (PE) is positively related with Behavioural Intention (BI) ($r = 0.736$, $p < 0.01$). Therefore, H1 is supported by the statistical test of correlation.

Effort Expectancy (EE) is positively related with Behavioural Intention (BI) ($r = 0.648$, $p < 0.01$). Therefore, H2 is supported by the statistical test of correlation.

Social Influence (SI) is positively related with Behavioural Intention (BI) ($r = 0.613$, $p < 0.01$). Therefore, H3 is supported by the statistical test of correlation.

Facilitating Conditions (FC) positively influenced by Behavioural Intentions (BI) ($r = 0.577$, $p < 0.01$). Therefore, H4 is supported by the statistical test of correlation.

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CHAPTER-5 CONCLUSION

This research aimed to study the factors affecting the use of UPI services. The study replicated the extended version UTAUT model for analysing the factors affecting UPI services. It was found that Generation Z perceives UPI Services more useful than Generation Y. Secondly, Generation gap doesn't affect behavioural intention to use UPI services other determinants age and gender.

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Sample Evaluated projects report / field work submitted by the students.

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Phytochemical Screening and Chromatographic Profiling of *Carica papaya* Leaves

A Dissertation Report submitted

For the partial fulfillment of the Degree of Master of Science

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CERTIFICATE

This is to certify that the dissertation entitled "**PHYTOCHEMICAL SCREENING AND CHROMATOGRAPHIC PROFILING OF *CARICA PAPAYA* LEAVES**" was successfully carried out by **Mr. Vishvraj V. Devmurari, Ms. Poojaben P. Patel, Ms. Rajeshreeba A. Jadeja, Ms. Camey P. Bhadaniya, Ms. Priti P. Aghara** a post graduate students of Department of Chemistry, Atmiya University in M.Sc. Chemistry (Analytical Chemistry) during academic year 2019-20.

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Table of Contents

	Title	Page no
Acknowledgement		i
List of Figures		iv
List of Schemes		v
List of Tables		vi
Aim and Objectives		vii
Chapter:1 – Introduction & Literature review		1
1.1	Introduction of Natural Products	2
1.2	Plant derived drugs approved by the US-FDA	3
1.3	Introduction of *Carica papaya*	4
1.3.1	Plant description	5
1.3.2	Origin and distribution	6
1.3.3	Botanical classification	6
1.3.4	Pharmacological uses and Activity of Each part of*Carica papaya*	7
1.3.5	Pharmacological uses of *Carica papaya* Leaves	8
1.3.6	Additional Benefits of Papaya Leaves	10
1.3.7	Healing Properties of *Carica papaya*	10
1.3.8	Importantphytochemicalsfoundindifferentpartsof*Carica papaya*	11
1.4	Recent Work on *Carica papaya*	13
1.5	In Vitro studies of extracts of different parts of *Carica papaya*	15
Chapter:2 –Materials and Methods		17
2.1	List of Used Chemicals and reagents	18
2.2	List of Used Instruments	18
2.3	Plant collection	19
2.3.1	Collection and Identification of *Carica papaya*	19
2.3.2	Drying of the leaves of *Carica papaya*	19
2.3.3	Powdering and Storage of the dried samples	19
2.3.4	Authentication of plant	20

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

2.4		Determination of soluble extractive value……..……...	21
2.5		Extraction for Qualitative test from the dried powder sample...	22
2.6		Qualitative tests……...…….……...……....	23
2.7		Extraction of Alkaloid……..……..……..…	28
	2.7.1	Chromatographic method (TLC) Development……..…….....	29
	2.7.2	LC-MS Analysis……...……..…….....	30
2.8		Extraction of Fatty acid (Unsaponifiable Fraction)…..…….....	31
	2.8.1	GC-MS Analysis……...….	32
2.9		Extraction of Saponin……..……...….	33
	2.9.1	Chromatographic method (TLC) Development…….....	34
2.10		Extraction of Steroid (Saponifable Fraction)…….....	36
	2.10.1	Chromatographic method (TLC) Development…….....	37
	2.10.2	GC-MS Analysis……...…….	39
Chapter:3 –Result & Discussion……...……...……..…			40
3.1		Soluble extractive value……...……..…..	41
3.2		Qualitative test……...……..…	41
3.3		Extraction of Alkaloid……..……...……..…	42
	3.3.1	Chromatographic method (TLC) Development……...……..	42
	3.3.2	LC-MS Analysis……...……..….	43
3.4		Extraction of Fatty acid (Unsaponifiable Fraction) ……...….	45
	3.4.1	GC-MS Analysis……...….	45
3.5		Extraction of Saponin……...……..……..…	49
	3.5.1	Chromatographic method (TLC) Development……..	49
3.6		Extraction of Steroid (Saponifable Fraction)…….....	50
	3.6.1	Chromatographic method (TLC) Development…….....	50
	3.6.2	GC-MS Analysis……...……..….	51
3.7		Discussion……...……...….	56
Chapter:4 –References……...….....			57

Registrar
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Rajkot

Atmiya University
Rajkot

List of Figures

Sr. No.	Title	Page no
1	Leaves of *Carica papaya*	5
2	Important phytochemicals found in different parts of *Carica papaya*	12

Registrar
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Atmiya University
Rajkot

List of Schemes

Sr. No.	Title	Page no
1	Schematic representation of Procedure for extract the Crude Alkaloid mixture	28
2	Schematic representation of Procedure for extract the Crude Fatty acid mixture	31
3	Schematic representation of Procedure for extract the Crude Saponin mixture	33
4	Schematic representation of Procedure for extract the Crude Steroid mixture	36

Registrar
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Atmiya University
Rajkot

List of Tables

Sr. No.	Title	Page no
1	Plant derived drugs approved by the US-FDA	3
2	Botanical Classification of *Carica papaya*	6
3	Traditional uses of different parts of *Carica papaya* in various localities	7
4	In vitro studies of extracts of different parts of *Carica papaya*	15
5	List of different solvent system for TLC of Crude Alkaloid	29
6	List of different solvent system for TLC of Crude Saponin	34
7	List of different solvent system for TLC of Crude Steroid	37
8	List of different solvent soluble extractive value	41
9	Result of different Qualitative tests	41
10	Rf value & TLC of extracted Crude Alkaloid mixture	42
11	Rf value & TLC of extracted Crude Saponin mixture	49
12	Rf value & TLC of extracted Crude Steroid mixture	50

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Rajkot

Aim and Objective

This Dissertation study was conducted with the following main aims:

1. To Extract and Isolate group of compounds from *Carica papaya*leaves.
2. Chromatographic method development (TLC) of different extract and fraction.
3. To Characterize Fraction byGC-MS.
4. To Characterize Fraction byLC-MS
5. To Characterize Fraction byTLC-MS.

Chapter: 1
Introduction & Literature review

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1.1 Introduction of NaturalProducts

A natural product is a Chemical substance can derive from living organism-that is, found in nature. A chemical substance present in nature that have different pharmacological effect. Natural product has a specific activity on living organism and decrease the side effects. One of the natural compound is photochemical that are occur in plants, vegetables they react with nutrients and fibres to act against diseases. Bioactive photochemical constituents like alkaloids, steroids, fatty acids, saponin, glycosides, tannins, terpenoids and phenoliccompounds.

The term medicinal plants used for the plant related to herbal medicine; those plants have therapeutic importance. Medicinal plants act as raw material for extraction method and to isolate active ingredients and played a central role in the developing the organic chemistry for synthesize the drugmolecules.

Medicinal plants classified as trees, shrubs, woody perennials, annuls biennials and climbers. The plants can be used as a whole, or extracts or their synthetics, there discovery originated from the long run follow of medicinal herbalism by man.

Plants have a capacity to produce different types of chemical compounds used to perform necessary biological function and protect plant against from insects, fungi and herbivorous mammals. India has important role in medicinal herbs and spices, which consist more than 2000 species and high potential capacities for Ayurvedic, Unani, Siddha traditional medicines. Only in India traditional-ethno-medicines with nucleus system haspresent.

In India, forest mainly repository big number of medicinal and aromatic plants, which are act as raw material for manufacture of drugs and perfumery products. World Health Organization (WHO) concluded that 80% people depend on herbal medicines for primary healthcare needs. Medicinal plants have minimal adverse effect.

Herbal medicines having highly biological and medicinal activities, and rich in safety margins and low cost. Plants have several secondary metabolites that are biosynthetically turn out from primary metabolites and has important activity towards micro-organisms, some diseases and important source of different pharmaceutical drug.

Medicinal plant constituents may be isolated and/or directly used as starting materials for pharmacologically active compounds in drug synthesis. The general research methods for works with medicinal plants are, preparation of crude extracts, biological screening, toxicological and clinical studies, standardization, detailed chemo pharmacological investigations and use of active part as the lead grain for drug design.

1.2 Plant derived drugs approved by the US-FDA[1,2,3,4,5]

Drug	Plant-source	Clinical use
Taxol	*Taxus brevifolia*	Ovarian and breast Cancers
Vinblastine and Vincristine	*Catharanthus Roseus*	Leukaemia, bladder and Testicular Cancers
Etoposide and Teniposide	*Podophyllum Peltatum*	Small-cell lung cancer, Testicular cancer, lymphomas and other cancers
Topotecan	*Camptotheca acuminata*	Ovarian and small-cell lung cancers
Irinotecan	*Camptotheca acuminata*	Metastatic colorectal Cancer

Table: 1 - Plant derived drugs approved by the US-FDA

1.3 Introduction of *Caricapapaya*

Papaya may be a powerhouse of nutrients and is out there throughout the year. It is an upscale source of threes powerful antioxidant vitamin C, vitamin A and vitamin E; the minerals, magnesium and potassium; the B-complex vitamin pantothenic acid and folate and fiber. In addition to all this, it contains a digestive enzyme-papain the effectively treats causes of trauma, allergies and sports injuries. All the nutrients of papaya as an entire improve circulatory system, protect against heart diseases, heart attacks, strokes and stop carcinoma.

The fruit is a superb source of beta-carotene that forestalls damage caused by free radicals which will cause some sorts of cancer. It is reported that it helps in the prevention of diabetic heartdisease.

Papaya lowers high cholesterol levels as it is a good source of fiber. Papaya effectively treats and improves all kinds of digestive and abdominal disorders. It is a medicine for dyspepsia, hyperacidity, dysentery and constipation. Papaya helps within the digestion of proteins because it may be a rich source of proteolytic enzymes. Even papain-a digestive enzyme found in papaya is extracted, dried as a powder and used as aid indigestion. Ripe fruit consumed regularly helps in habitual constipation. It is also reported that papaya prevents premature aging. It may be that it works because a poor digestion does not provide enough nutrients to our body. The fruit is considered a remedy for abdominal disorders the skin of papaya works as a best medicine for wounds. Even you can use the pulp left after extracting the juice from papaya as poultice on thewounds.

The enzymes papain and chymopapain and antioxidant nutrients found in papaya are found helpful in lowering inflammation and healing burns. That is why people with diseases (such as asthma and osteoarthritis) that are worsened by inflammation, find relief because the severity of the condition reduces after taking all these nutrients. Papaya contributes to a healthy system by increasing your resistance to coughs and colds due to its vitamin A and C contents. Papaya included in diet ensures an honest supply of vitamin A and C that are highly essential for maintaining an honest health.

Carica papaya constituents exhibit alkaline combination, like borax or carbonate and that they have showed good leads to treatment of warts, corns, sinuses, eczema,

cutaneous tubercles and other hardness of the skin, and also injected into indolent glandular tumors to promote their absorption. Green fruits of papaya are wont to treat high vital sign, dyspepsia, constipation, amenorrhoea, general debility, expel worms and stimulate reproductive organs.[6]

1.3.1 Plantdescription

C.papaya is a fast growing, soft-wooded, herbaceous plant that reaches three to 10 meters in height. The stem is single and hollow centered, and bears prominent scars from fallen leaves. The leaves are large (30 to 60 cm long), yellow-green to dark green in color, palmately lobed, arranged spirally and clustered at the crown Papaya plants are mostly dioecious (having male and female flowers on separate plants) or hermaphroditic (having bisexual flowers); are rarely monoecious (having both male and female flowers); and have fragrant, white or cream colored flowers. Male flowers are borne on long stalks, while the pear-shaped female or cylindrical bisexual flowers are larger and borne on short peduncles in leaf axils along the main stem. Plants begin bearing fruits approximately 10 to 14 months after germination. Fruits have various shapes: elongated oblong, spherical, ovoid, obovate or pyriform. The skin of immature fruit is green, hard and rich in white latex until becoming ripe, when it turns yellow or red-orange. The flesh is yellow-orange to pinkish-orange at maturity, juicy and pleasantly sweet. Mature fruits contain many grey-black ovoid peppery seeds of about 5 mm in length.[7]

Figure: 1 - Leaves of *Carica papaya*

1.3.2 Origin anddistribution

Geographically papaya is native to Tropical America, southern Mexico, Hawaii, Tropical Africa, Philippines, India, Malaysia, and Australia. In India, papaya is fertilized in Maharashtra, Bengal, Bihar, Haryana, Punjab, Delhi, Andhra Pradesh and Uttar Pradesh. [8]

1.3.3 Botanical classification[9]

Kingdom	Plantae-Plantes, Planta, Vegetal, Plants
Subkingdom	Viridaeplantae-green plants
Infrakingdom	Streptophyta-land plants
Divison	Tracheophyta-vasular plants, tracheophytes
Subdivision	Spermatophytina-Spermatophytes,Seed Plants, Phanerogames
Class	Magnoliopsida
Super order	Rosanae
Order	Brassicales
Family	Caricaceae-papayas
Genus	Carica L.- papaya
Species	Carica papaya L.- papaya, pawpaw

Table: 2 - Botanical Classification of *Carica papaya*

1.3.4 Pharmacological uses and Activity of Each part of *Carica papaya*[10]

Plantpart	Method of use	Medicinal use and locality
Ripe fruit	Fruit juice, topical ulcer dressings and cosmetics (ointments and soaps)	Warts, corns, sinuses and chronic forms of skin induration in the Caribbean, Philippines; chronic skin ulcers in Jamaica and tomachic, digestive, diuretic, expectorant, sedative and tonic, bleeding piles and dyspepsia in India
Green fruit	Juice	Contraceptive and abortifacient in Pakistan, India and Sri Lanka; malaria, hypertension, diabetes mellitus, hyper-cholesterolaemia, jaundice,intestinal helminthiasis in Nigeria
Latex	Topical	Dermatitis and psoriasis in Africa, Asia and Europe; abortifacient in India and Malaysia
Seeds	Chewing, juice, powder, paste and pessaries	Abortifacient, anthelminthic, thirst quencher, pain alleviator, bleeding piles and enlarged liver and spleen in the West Indies and India
Leaves	Fine paste, smoke, juice, infusion and decoction	Heart tonic, febrifuge, vermifuge, colic, fever, beriberi, abortion, asthma in India; Rheumatic complaints in the Philippines; stomach troubles and cancer in Australia and Vietnam
Flowers	Infusion and decoction	Jaundice, cough, hoarseness, bronchitis, laryngitis and tracheitis in Asia
Roots/barks	Decoction, poultice and infusion	Digestive, tonic and abortifacient in Australia; sore teeth in India; syphilis in Africa

Table: 3 - Traditional uses of different parts of *Carica papaya* in various localities

1.3.5 Pharmacological uses of *Carica papaya* Leaves[11,12]

Papaya leaf has a numberless of benefits. In some parts of Asia, the young leaves of the papaya are steamed and eaten like spinach.

1. Denguefever:

Commencing on studies of Dr. Sanath Hettige, who conducted the research on 70 dengue patients; said papaya leaf juice helps increase white blood cells and platelets, normalizes clotting, and repairs the liver.

2. Cancer Cell Growth Inhibition:

Recent research on papaya leaf tea extract has demonstrated neoplastic cell growth inhibition. It appears to boost the production of key signalling molecules called Th1-type cytokines, which help regulate the immunesystem.

3. Antimalarial and AntiplasmodialActivity:

Papaya leaves are made into tea as a treatment for malaria. Antimalarial and antiplasmodial activity has been noted in some preparations of the plant but the mechanism isn't understood and not scientifically proven.

4. FacilitateDigestion:

The leaves of the papaya plants contain chemical compounds of carpain, Substance which kills microorganisms that always interfere with the digestive function.

5. Coloncancer:

The fiber of papaya is in a position to bind cancer-causing toxins within the colon and keep them far away from the healthy colon cells. These nutrients provide synergistic protection for colon cells from radical damage to their DNA.

6. Anti-InflammatoryEffects:

Protein enzymes including papain and chymopapain and antioxidant nutrients found in papaya; including vitamin C, vitamins E, and beta-carotene, reduce the severity of the conditions like asthma, osteoarthritis, and rheumatoidarthritis.

7. Rheumatoid Arthritis:

Vitamin C-rich foods, like papaya, provide humans with protection against inflammatory polyarthritis, a sort of atrophic arthritis involving two or more joints.

8. Prevent ProstateCancer:

Men consuming lycopene-rich fruits and vegetables like papaya, tomatoes, apricots, pink grapefruit, watermelon, and guava were 82% less likely to possess prostatic adenocarcinoma compared to those consuming the smallest amount lycopene-rich foods.

9. Anti-SicklingActivity:

Current research proves that papaya has an anti-sickling activity.

10. Promote LungHealth:

Eating vitamin A rich foods, like papaya, help the lung to be healthy and save life.

11. AnticoagulantEffect:

Injection of papain extract during a dog increases prothrombin and coagulation threefold. It is also claimed that the enzyme eliminates necrotic tissues in chronic wounds, burns and ulcers. Papain is additionally of economic importance within the brewery industry, within the food industry and within the textile industry.

12. kidneyfailure:

Papaya seed extract may have in toxicity-induced renal failure. Evidently a kidney-transplant patient in London was cured of a post-operative infection by placing strips of papaya on the wound for 48hours. Women in India, Bangladesh, Pakistan, Sri Lanka, and other countries have long used green papaya as an herbal medicine for contraception and abortion. Enslaved women within the West Indies were noted for consuming papaya to stop pregnancies and thus preventing their children from being born into slavery.

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1.3.6 Additional Benefits of Papaya Leaves[13]

- Relievenausea
- Increaseappetite
- Ease menstrualpain
- Meattenderizer
- Acnemedicine

1.3.7 Healing Properties of *Carica papaya*[14]

1. Increases quality of proteins in wholeorganism.
2. Revitalize the human body and maintain energy andvitality.
3. Encourages the renewal of muscletissue.
4. Supports cardiovascular system.
5. Boosts up the immunesystem.
6. Helps with the nausea andconstipation.
7. Can benefit people suffering colon cancer and other forms of cancers and aliments of cardiovascular and gastrointestinal systems.
8. Alleviatesinflammation.
9. Helps with the digestive system, by breaking down the proteins and supporting production of digestiveenzymes.
10. Papaya can be used also externally as a treatment for skin wounds that doesn't heal quickly, for this anybody can be used papaya peel or ointments made out of papaya.
11. Prevents the cataractformation.

1.3.8 Important phytochemicals found in different parts of *Carica papaya* [15,16,17]

Carica papaya leaf contains a broad spectrum of phytochemicals, including Steroid, Saponine, Fatty acid, Carbohydrate, Flavonoids (quercetin, kaempferol and myricetin) and carotenoids (β-carotene, lycopene, cryptoxanthin, violaxanthin and zeaxanthin), with different carotenoid profiles between yellow-fleshed and red-fleshed papaya.

The milky latex from unripe fruits and other plant parts of the papaya is a rich source of different types of enzymes, such as papain, chymopapain, protease omega, glycyl-endopeptidase and caricain. The presence of many phenolic compounds (such as protocatechuic acid, *p*-coumaric acid, caffeic acid, chlorogenic acid, 5,7-dimethoxycoumarin, kaempferol and quercetin) has been detected in papaya leaves, together with several alkaloids, such as carpaine, pseudocarpaine and dehydrocarpaine I and II. Benzyl glucosinolate (BG) and its enzymatic hydrolysed product, benzyl isothiocyanate, have been found in the pulp, pericarp and especially in the seeds of thepapaya.

The seeds are also reported to be rich in proteins, lipids and crude fibre. presents some of the important phytochemicals found in *C. papaya*.

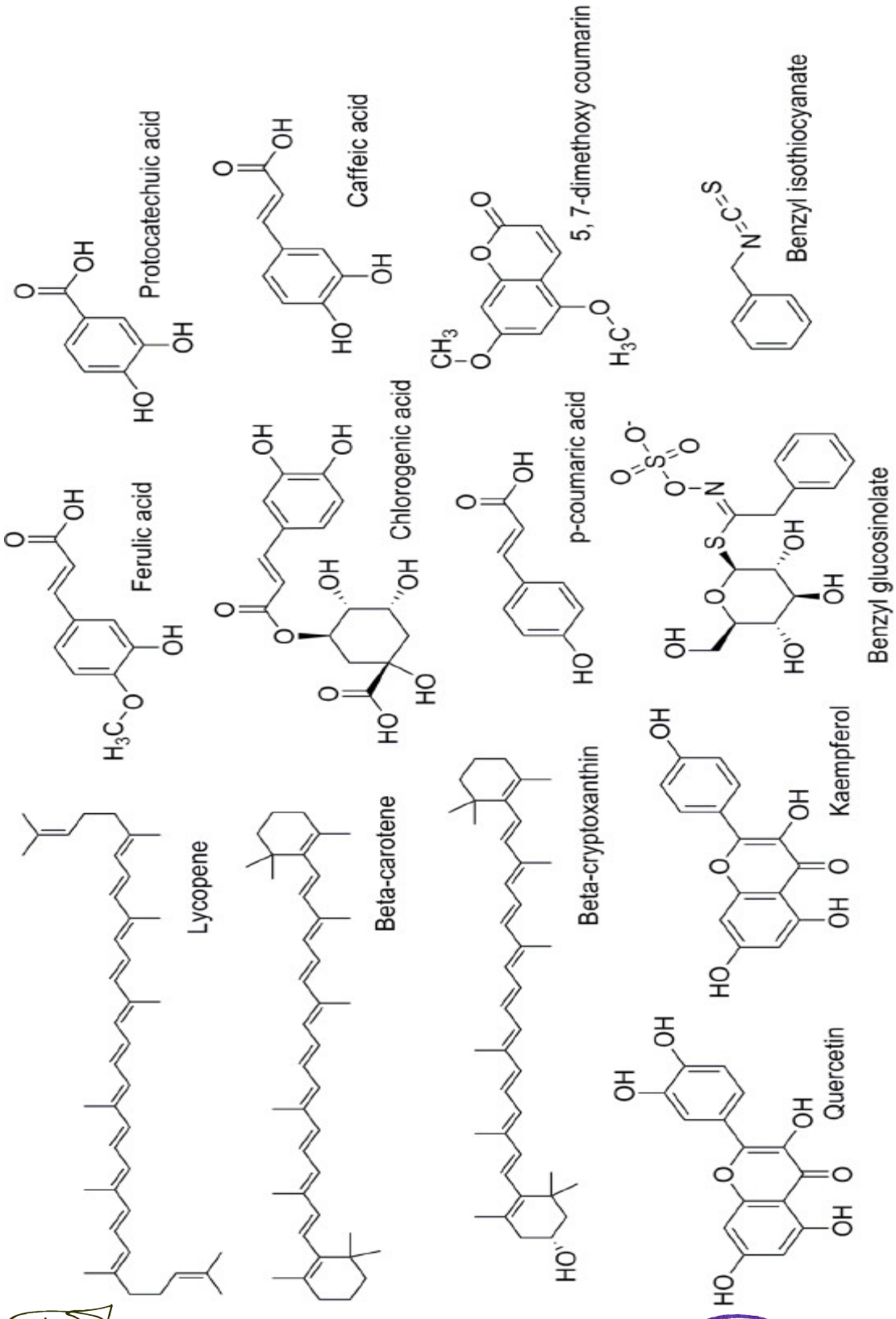

Figure 2: Important phytochemicals found in different parts of *Carica papaya*

1.4 Recent Work on *Caricapapaya*

1. Efficacy and safety of *Carica papaya* leaf extract (CPLE) treatment significantly improves the platelet counts in severe thrombocytopenia in dengue, large prospective studies are required to validate the study findings which are very relevant and cost effective for the resource limited dengue endemic regions.[18]
2. The biological and toxicological study of papaya leaves of various polarities extracts was done and the extracts showed promising activity when antioxidant and cytotoxic Screened activities against DPPH and BSL bioassays. In our cytotoxic experimental, methanol extract showed the highest cytotoxicity among the six prepared extracts. Similarly, in antioxidant activity, the hexane extract showed the IC50 compared to other extracts. However, further studies are required to determine the actual chemical nature of these compounds and their mechanism of action.[19]
3. Metronidazole loaded silver nanoparticles were synthesis successfully using eco-friendly method with the *Carica papaya* leaf extract as a reducing agent. UV-Vis spectroscopy confirmed the formation of silver nanoparticles with an absorption peak at 435nm for the entire nanoparticle. The metronidazole nanoparticles showed extended release profiles. The silver nanoparticles synthesized from *Carica papaya* can serve as effective drug delivery systems.[20]
4. The medicinal value of *Carica papaya* leaf and Nilavembukudineerchoornam to possess potent antibacterial and antifungal property. The FTIR spectrum of seed extracts of the peak values and the probable functional groups (obtained by FTIR analysis) present in seed extracts (Prepared in Water, Ethanol, Methanol, Chloroform and Diethyl Ether) and *Carica papaya* leaf and Nilavembukudineerchoornam presented in the plant. It also concluded in FTIR analysis of alcohol (C-O) functional group responsible for the antibacterial activity against E. coli. The results signify traditional values of *Carica papaya* lead and Nilavembukudineerchoornam might be accountable for its antibacterial potential. GC-MS analysis detected 18 active compounds in *Carica papaya* leaf and 25 active compounds in Nilavembukudineer. The peak 18 was assumed as the major active compound due to has the highest peak with retention time and 22 peak was assumed as the major active compound due to has the highest peak with retentiontime.Inthisstudyshowedthatthehighpeakvalueofoleicacidsshowed

in Nilavembukudineerchoornam when compare to *Carica papaya* leaf of ethanol extract. Supports better health surveillance against the dengue fever. Further studies need to be conducted to prevent the dengue virus and its control in near future. [21]

5. The bioactive Carpaine from *C. papaya* leaf was isolated and simultaneously estimated by using the validated HPTLC method from the dried leaves of the plant material, PE, and its tablet formulation. This rapid and reproducible method can be successfully used for quality control and quality assurance of *C. papaya* leaf extract. In addition, the PE (5.02% w/w) can be used in the preparation of various phyto-pharmaceutical commercial products.[22]
6. The chemical content of papaya leaves is known to have a variety of chemical properties. Among others bromelin enzymes, alkaloids, karpaina, papain enzymes, pseudocarpain, carposid, glycoside saponin, calcium and many contain vitamin B, vitamin B, vitamin C. Papaya leaves is containing many substances which needed by the body and various kinds of vitamin content, one of them is vitamin A which can help the hypotheses of prolactin in the epithelium of the brain so that prolactin will increase. It is crucial to educate postpartum mother to consumpt papaya leaf to increase theirbreastmilk[23].

1.5 In Vitro studies of extracts of different parts of *Carica papaya*[24,25,26,27,28,29,30]

Cancer Cell lines	Treatment	Results
Breast cancer cell line Liver cancer cell line Chang liver cell line (normal cell)	Papaya fruit juice (0.28-28 mg/mL), lycopene extracted from papaya juice, pure lycopene (3-30 µg/mL)	Pure lycopene and papaya juice inhibited viability of liver cancer cell line Hep G2 (IC50 = 22.8 µg/mL and 20 mg/mL, respectively), but had no effect on breast cancer cells or normal cells. Lycopene extracted from papaya juice did not show any effect on eithercell line.
Acute promyeloytic leukaemia HL-60 cells	n-hexane extract of papaya seed or pulp (0.1-100 µg/mL), pure benzyl isothiocyanate (10 µM)	Extract of the seed dose-dependently inhibited the superoxide generation (IC50=10 µg/mL) and viability of cells (IC50 = 20 µg/mL), comparable to that of pure BITC. Extract of the pulp had no effects at 100 µg/mL.
Breast cancer cell line	Aqueous extract of papayaflesh (0.01-4% v/v)	Significant inhibitory effect on proliferation of MCF-7 cells (p <0.05).
Breast cancer cell line treated with sodium nitroprusside- a nitric oxide donor	Ethanolic extract of papaya pericarp (50-640 µg/mL)	Inhibited cell growth in MCF-7 cells (decrease in cell viability). Scavenged nitric oxide in dose-dependent manner (about 35% of nitric oxide was scavenged by extract at 640 µg/mL).
Breast cancer cell line	Protein fraction containing ribosome-activating proteins isolated from leaves	The protein fraction possessed cytotoxicity: IC50 = 2.8 mg/mL). Induction of apoptosis by regulation of p53 and BCl-2 protein expression (increased by 59.4% and decreased by 63%, respectively).

Stomach cancer cell line Pancreatic cancer cell line Colon cancer cell line Ovarian cancer cell line Lymphoma cell line Breast cancer cell line Neuroblastoma cell line Uterine cancer cell line T cell leukaemia cell line	Aqueous extract of papaya leaves (1.25-27 mg/mL)	Papaya leaf extract showed a concentration-dependent anticancer effect on each of the cancer cell lines, and suppressed DNA synthesis by suppressing the incorporation of 3H-thymidine.
T cell lines Burkitt's lymphoma celllines Chronic myelogenous leukaemia cellline Cervical carcinoma cell line Hepatocellular carcinoma cell lines Lung adenocarcinoma cell line Pancreatic epithelioid carcinoma cellline Mesothelioma cell lines Plasma cell leukaemia cell line Anaplastic large cell lymphoma cell line Breast adenocarcinoma cell line Mesothelioma cell line Pancreatic adenocarcinoma cell line	Aqueous extract of papaya leaves (0.625-20 mg/mL)	Inhibited the proliferative responses of both haematopoietic cell lines and solid tumour cell lines. In peripheral blood mononuclear cells, papaya extract reduced the production of IL-2 and IL-4, and increased the production of Th1 types cytokines, such as IL-12p40, IL-12p70, IFN-γ and TNF-α. The expression of 23 immunomodulatory genes was enhanced by the addition of papaya extract.
Human pancreatic cancer cells	Saponin-enriched water and ethanolic extracts (100 µg/mL)	Ethanolic extracts were more effective than or at least as effective as the chemotherapeutic agent, gemcitabine.

Table: 4 - In vitro studies of extracts of different parts of *Carica papaya*

Chapter: 2
Materials and Methods

2.1 List of Used Chemicals andreagents

Acetic acid, Acetic anhydride, Acetone, Ammonium hydroxide, p-anisaldehyde, Benzene, n-butanol, BSA (Bovine Serum Albumin), Bismuth nitrate, Chloroform, Con. Hydrochloric acid, Con. Sulphuric acid, Diethyl ether, Ethyl acetate, Ferric chloride, Formic acid, n-hexane, Methanol, Petroleum ether, Phosphoric acid buffer solution, Potassium hydroxide, Potassium iodide, Sodium chloride, Toluene, Vanillin, Water of different chemical companies like Rankem, Molychem, Chemdyes, Qualigens Fine Chemicals, Merck.

2.2 List of UsedInstruments

1. GC-MS
2. LC-MS
3. TLC-MS
4. UVSpectrophotometer
5. Rotaryevaporator
6. UV-chamber
7. Centrifuge
8. Refrigerator

2.3 Plantcollection

2.3.1 Collection and Identification of *Caricapapaya*

The plant was collected from Rajkot, Gujarat in January 2019 during winter season. The plant only with leaves was collected.

2.3.2 Drying of the leaves of *Caricapapaya*

The leaves were washed with water. The leaves were cut into small pieces and spread in thin layers in trays and dried the leaves at room temperature for 3 days.

2.3.3 Powdering and Storage of the driedsamples

The dried parts were ground to coarse powder with the help of blender. This process breaks the plant parts to smaller pieces thus exposing internal tissues and cells to solvents thus facilitating their easy penetration into the cells to extract the constituents. Then the powdered sample was kept in clean closed glass containers till extraction process. During grinding of sample, the grinder was thoroughly cleaned to avoid contamination with any remnant of previously ground material or other extraneous matters deposited on thegrinder.

The weight of the total dry powder was 90 gm.

2.3.4 Authentication ofplant

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Yogidham Gurukul, Kalawad Road,
Rajkot – 360005; (Gujarat) INDIA

HERBARIUM

AUTHENTIFICATION CERTIFICATE

Based upon the Organolaptic/Biochemical Analysis examination of fresh Sample, it is certified that the specimen given by Vishvraj V. Devmurari (co-workers: Camey P. Bhadaniya, Rajeshree A. Jadeja, Pooja P. Patel, Priti P. Aghara) is Identified as below:

Binomial: *Carica Papaya L.*

Synonym: Papaya Carica.

Family: Caricaceae

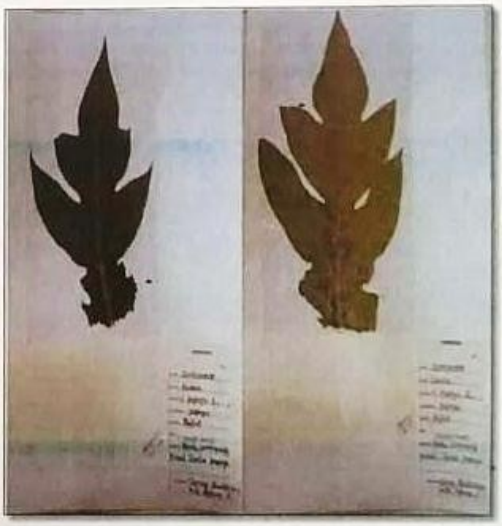
Regional name: Papaya

Voucher specimen number: RPD |31|1|2020 -10.

Reference: Cook flora of Gujarat state

Date: 31| Jan |2020

Place: Rajkot



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2.4 Determination of soluble extractive value[31]

2.4.1 Water soluble extractivevalue

This method determines the amount of active constituents extracted with water from a given amount medicinal plants. It gives some idea about the amount of water soluble constituent present in a particular drug such as sugar, mucilage, glycosides, tannin etc. About 10 gm, accurately weighed sample was macerated with 100 ml of distilled water in a closed flask for 24 hours, shaking frequently during 6 hours and allowed to stand for 18 hours. It was filtered, taking precaution against loss of solvent and 25 ml of the filtrate was evaporated to dryness in a previously weighed dried evaporating dish. First dried over water bath and then at 110^0C in hot air oven, to constant weight and weight was noted down. From the weight of the residue the percentage of water-soluble extractive was calculated with reference to air-driedsample.

2.4.2 Alcohol soluble extractivevalue

Alcohol soluble extractive value was determining by same procedure as described in water soluble extractive value by taking 95% alcohol instead of water.

2.4.3 Petroleum ether soluble extractivevalue

Petroleum ether soluble extractive value was determining by same procedure as described in water soluble extractive value by taking pet. ether instead of water.

2.5 Extraction for Qualitative test from the dried powder sample[31]

1. The fine powder of papaya leaves soaked in 100 ml methanol and it thoroughly shaken to dissolve the plant constituents into the solvent. Then it kept for 24 hours and frequently it shaken to dissolve the compound properly. After 24 hours the powder of papaya leaves filtered using filterpaper.
2. The fine powder of papaya leaves soaked in 100 ml water and it thoroughly shaken to dissolve the plant constituents into the solvent. Then it kept for 24 hours and frequently it shaken to dissolve the compound properly. After 24 hours the powder of papaya leaves filtered using filterpaper.
3. The fine powder of papaya leaves soaked in 100 ml petroleum ether and it thoroughly shaken to dissolve the plant constituents into the solvent. Then it kept for 24 hours and frequently it shaken to dissolve the compound properly. After 24 hours the powder of papaya leaves filtered using filterpaper.

2.6 Qualitativetests

Phytochemical are naturally shown in plants. They have endless medicinal applications. Phytochemical have an important role against some diseases like asthma, cancer, arthritis. They do not cause any adverse effects so it considered as “human friendly medicines”.

In water extract, pet ether extract and methanol extract to preliminary phytochemical testing to detect the presence of different compound like steroids, saponins, tannins, alkaloids, flavonoid, proteins and amino acids as described and literatures.

- **Alkaloids**

These are the largest group of secondary chemical constituents made largely of ammonia compounds comprising basically of nitrogen bases synthesized from amino acid building blocks with various radicals replacing one or more of the hydrogen atoms in the peptide ring, most containing oxygen.

Qualitative Test for Alkaloid

1. **Mayer’s Test:** Filtrates were treated with Mayer‟s reagent (Potassium Mercuric Iodide). Formation of a yellow coloured precipitate indicates the presence of alkaloids.
2. **Wagner’s Test:** Filtrates were treated with Wagner‟s reagent (Iodine in Potassium Iodide). Formation of brown/reddish precipitate indicates the presence ofalkaloids.
3. **Dragendroff’s Test:** Filtrates were treated with Dragendroff‟s reagent (solution of Potassium Bismuth Iodide). Formation of red precipitate indicates the presence ofalkaloids.
4. **Hager’s Test:** Filtrates were treated with Hager‟s reagent (saturated picric acid solution). Presence of alkaloids confirmed by the formation of yellow coloured precipitate.

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- **Amino acid &Protein**

A broad category of chemical compounds composed of amino acids Including polypeptides and enzymes. Main functions: very large variety of functions, from maintenance or repairing of existing tissues and synthesis of new ones to the catalysis of all the biochemical reactions that take place in living organisms.

Qualitative test for Amino acids

1. **Ninhydrin Test:** To the extract, 0.25% w/v ninhydrin reagent was added and boiled for few minutes. Formation of blue/purple colour indicates the presence of aminoacid.
2. **Biuret Test:** To the extract, added equal volume of 1% strong base (sodium or potassium hydroxide) followed by a few drops of aqueous copper(II) sulfate. If the solution turns purple, it containsprotein.

- **Carbohydrates**

A broad category of chemical compounds, also referred as sugars. The most abundant class of bio-organic molecules on earth. Although relatively low in human, it constitutes about 75% by mass of dry plant materials. A main function of it is Energy storage, structure element, source of carbon of the biosynthesis of other substances, “Markers” on cell surface for cell-cell recognition.

Qualitative test for Carbohydrates

Extracts were dissolved individually in 5 ml distilled water and filtered. The filtrates were used to test for the presence of carbohydrates.

1. **Molisch’s Test:** Filtrates were treated with 2 drops of alcoholic α-naphthol solution in a test tube. Formation of the violet ring at the junction indicates the presence ofCarbohydrates.
2. **Benedict’s test:** Filtrates were treated with Benedict‟s reagent and heated gently. Orange red precipitate indicates the presence of reducingsugars.
3. **Fehling’s Test:** Filtrates were hydrolysed with dil. HCl, neutralized with alkali and heated with Fehling A & B solutions. Formation of red precipitate indicates the presence of reducingsugars.

- **Flavonoid**

Flavonoids are derived from 2-phenylchromen-4-one (2-phenyl-1-4-benropyrone). They are having anti-oxidant activities and low in toxicity. Flavonoids referred to as nature‟s biological response modifiers because of their inherent ability to modify the body‟s reaction to allergens, viruses, and carcinogens. They show anti-allergic, anti-inflammatory, anti-microbial and anti-cancer activity.

Qualitative test for Flavonoid

1. **Alkaline Reagent Test:** Extracts were treated with few drops of sodium hydroxide solution. Formation of intense yellow colour, which becomes colourless on addition of dilute acid, indicates the presence offlavonoids.
2. **Lead acetate Test:** Extracts were treated with few drops of lead acetate solution. Formation of yellow colour precipitate indicates the presence offlavonoids.

- **Glycosides**

Glycosides are formed when the hydroxyl group on the anomeric carbon of a sugar and the hydroxyl group of another molecule condense to form an acetal or ketal linkage known as a glycosidic bond. Glycosides formed from glucose are glucosides; likewise, those from fructose are fructosides. If the second molecule forming the acetal is a sugar, then the glycoside is adisaccharide.

Qualitative Test for Glycoside

Extracts were hydrolysed with dil. HCl, and then subjected to test for glycosides.

1. **Modified Borntrager's Test:** Extracts were treated with Ferric Chloride solution and immersed in boiling water for about 5 minutes. The mixture was cooled and extracted with equal volumes of benzene. The benzene layer was separated and treated with ammonia solution. Formation of rose-pink colour in the ammonical layer indicates the presence of anthranol glycosides.

- **Saponin**

Saponins are glycosides of 27 carbon atom steroids, or 30 carbon atom triterpenes in plant. They are characterized by their bitter taste and they ability to haemolyse red blood cells. They are used medically as expectorant, emetic and for the treatment of excessive salivation, epilepsy, cholorosis and migraines. They are used in ayurvedic medicines as a treatment of eczema, psoriasis and for controlling cholesterol. Saponins are plants immune system acting as an anti-biotic to protect the plant against microbes andfungus.

Qualitative Test for Saponin

1. **Froth Test:** Extracts were diluted with distilled water to 20ml and this was shaken in a graduated cylinder for 15 minutes. Formation of 1 cm layer of foam indicates the presence ofsaponins.
2. **Foam Test:** 0.5 gm of extract was shaken with 2 ml of water. If foam produced persists for ten minutes it indicates the presence ofsaponins.

- **Steroid**

Plant steroids also referred to as „cardiac glycosides" are one of the most naturally occurring plant phytoconstituents that have found therapeutic application as arrow poisons or cardiac drugs. The cardiac glycosides are basically steroids with inherent ability to afford a very specific and powerful action mainly on cardiac muscles when administered through injection into man or animal. Steroids have been observed to promote nitrogen retention in osteoporosis and in animals with wasting illness Caution should be taken when using steroidal glycosides as small amount would exhibit the much needed stimulation on a diseased heart, whereas excessive does may cause evendeath.

Qualitative test for Steroid

1. **Salkowski's Test:** Extracts were treated with chloroform and filtered. The filtrates were treated with few drops of Conc. Sulphuric acid, shaken and allowed to stand. Appearance of golden yellow colour indicates the presence ofsteroid.
2. **Liebermann Burchard's test:** Extracts were treated with chloroform and filtered. Thefiltrateswere treated with few drops of acetic anhydride, boiled and cooled.

Conc. Sulphuric acid was added. Formation of brown ring at the junction indicates the presence of steroid.

- **Tannin**

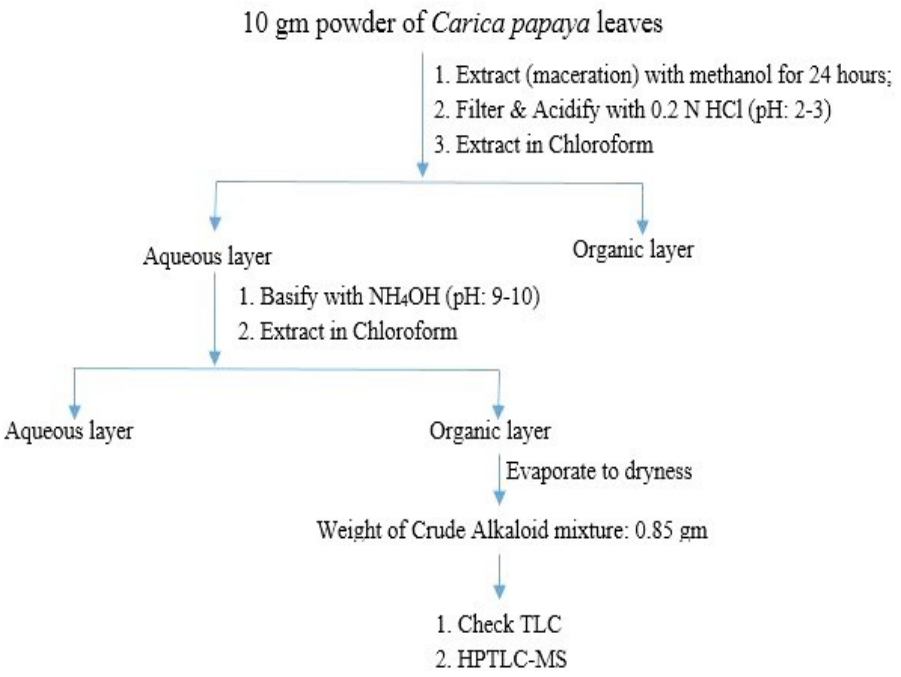
Tannin is complex organic, non-nitrogenous derivatives of polyhydroxy benzoic acid. They are soluble in alcohol and water. Tannins have an ability feature to tan, i.e. to convert things into leather. Tannin is used as antiseptic and this activity is due to presence of phenolic group. Tannins are acting as healing agent in various diseases.

Qualitative test for Tannin

1. Gelatine Test: To the extract, 1% gelatine solution containing sodium chloride was added. Formation of white precipitate indicates the presence oftannins.

2.7 Extraction of Alkaloid[32]

Take 10 gm plant powder and add 100 ml methanol and allow it to extract for 24 hours. After 24 hours filter the extract and acidify the filtrate with 0.2 N HCl and adjust the pH 2-3. Now partition with chloroform and separate the organic and aqueous layer. Collect aqueous layer and basify it with ammonium hydroxide and adjust the pH 9-10. Again partition with chloroform and collect organic layer and evaporated it to dryness and collect the crude mixture of alkaloid (0.85 gm). Develop TLC plate and after developing TLC, fraction sent for TLC-MS.



Scheme: 1 - Schematic representation of Procedure for extract the Crude Alkaloid mixture

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2.7.1 Chromatographic method (TLC)Development

Sr. No.	Solvent System	Ratio	Spray reagent
1	DCM : Methanol	9 : 1	Dragendorff
2	Chloroform : Methanol	9 : 1	

Table: 5 - List of different solvent system for TLC of Crude Alkaloid

Preparation of spray reagent

1. Dragendorff reagent

- **Solution A:** Dissolve 0.85 g bismuth(III) nitrate in 10 ml glacial acetic acid and 40 mlwater.
- **Solution B:** Dissolve 8 g potassium iodide in 20 mlwater.
- S**tock solution:** Mix equal parts of A and B. The mixture can be stored in a dark bottle for a longtime.
- **Spray solution:** Mix 1 ml stock solution with 2 ml glacial acetic acid and 10 ml water beforeuse.

Reference:

R. Munier, M. Macheboeuf, Bull. soc. chim. biol. 33, 846 (1951).

H. Jatzkewitz, Hoppe-Seylers Z. physiol. Chem. 292, 99 (1953).

2.7.2 LC-MS Analysis

Preparation ofSolution

- **Sample preparation:** Soluble inMethanol
- **Mobilephase:**

  A: Acetonitrile

  B: 10 mM Ammonium Acetate

Instrument: Shimadzu LC-MS (Model no. 8030)

Protocol:

Parameters	**Used**		
Column	Gemini C18, (150mm x 4.6mm, 5µm)		
Mobile Phase	**Time (Min)**	**A (%)**	**B (%)**
	0.01	25	75
	3.00	25	75
	8.00	40	60
	20.00	40	60
	30.00	95	5
	35.00	95	5
	38.01	25	75
	40.00	25	75
Flow rate	0.800 mL/min,		
Column oven temperature	40 ± 0.3°C		
Autosampler temperature	15 ± 3°C		
Volume of injection	10.0 µL		
Detector	PDA & Mass detector		
Run time	40.0 minutes		

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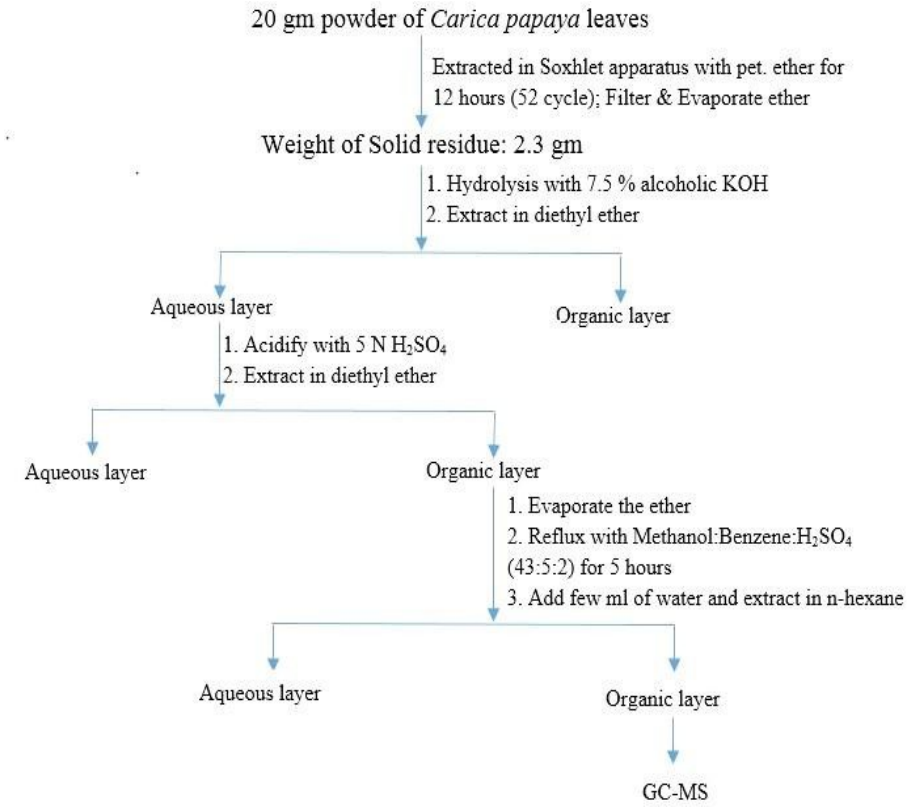
2.8 Extraction of Fatty acid (Unsaponifiable Fraction)[32-35]

Take 20 gm plant powder and make a thimble to perform soxhlet extraction with 300 ml of petroleum ether for 12 hours (52 cycles). Put it for evaporate to dryness in water bath for 15-20 min to get solid residue (2.3 gm). Solid residue reflux with 50 ml 7.5% alcoholic KOH for 5-6 hours. Allow it to cool at room temperature. Add diethyl ether to separate the organic and aqueous layers, out of that collect aqueous layer. Acidify aqueous layer with 5 N H_2SO_4. Add diethyl ether to separate the organic and aqueous layers, out of that collect organic layer. Allow it to evaporate to concentrate the mixture. Add 50 ml of methanol : benzene : H_2SO_4 (43:5:2) and reflux it for 5 hour and allow to cool at room temperature. Add few ml of water and separate by partition with hexane and collect organic layer. Fraction sent for GC-MS analysis.



Scheme: 2 - Schematic representation of Procedure for extract the Crude Fatty acid mixture

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2.8.1 GC-MSAnalysis

Preparation of Solution

- **Sample preparation:** Soluble in Hexane

Instrument: Shimadzu GC-MS (Model no. TQ8040)

Protocol:

Parameter	Used
Column	SH-Rxi-5Sil MS (30 m, 0.25 mmID, 0.25 µm df)
Column Oven Temp.	50.0 °C
Injection Temp.	100.00 °C
Injection Mode Flow	Split
Control Mode	Pressure
Pressure	73.0 kPa
Total Flow	11.1 mL/min
Column Flow	1.27 mL/min
Linear Velocity	40.8 cm/sec
Purge Flow	3.5 mL/min
Split Ratio	5.0
High Pressure Injection	OFF
Carrier Gas Saver	OFF
Splitter Hold	OFF

Oven Temp. Program:

Rate	Temperature(°C)	Hold Time(min)
-	50.0	2.00
10.00	100.0	5.00
15.00	150.0	2.00
15.00	250.0	2.00
15.00	280.0	0.00

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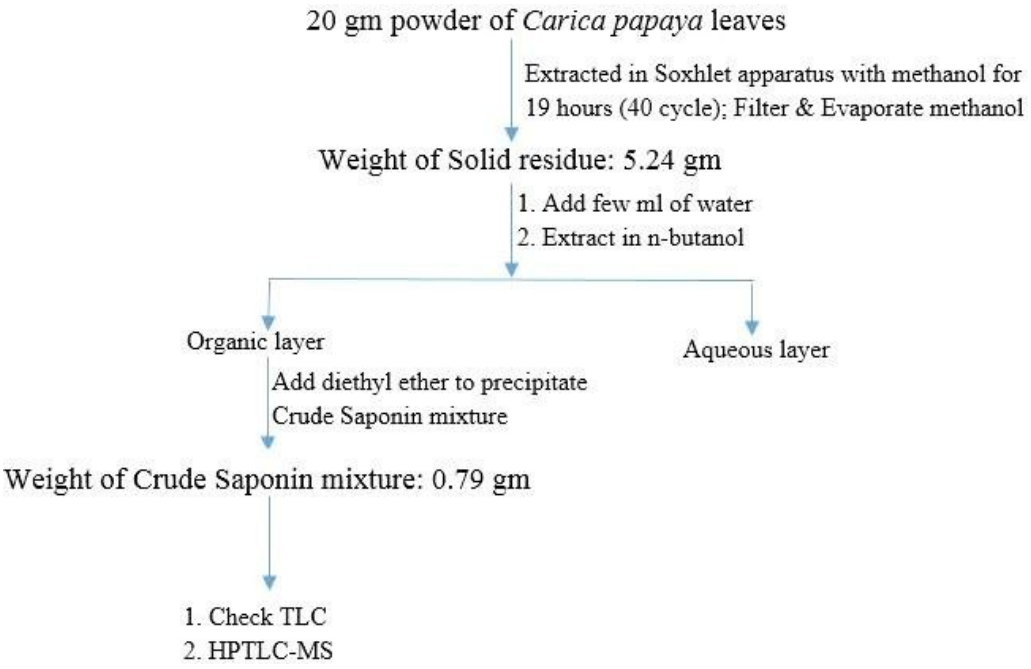
2.9 Extraction of Saponin[32]

Take 20 gm plant powder and make a thimble of plant powder. Now perform soxhlet extraction with 300 ml of methanol for 19 hours (40 cycle). Put it for evaporate to dryness in water bath for 15-20 min (5.24 gm). Solid residue mix with water and partition with n-butanol. Collect organic layer and add diethyl ether to precipitate crude saponin mixture (0.79 gm). Collect crude saponin and develop TLC plate. After developing TLC, fraction sent for TLC-MS.



Scheme: 3 - Schematic representation of Procedure for extract the Crude Saponin mixture

2.9.1 Chromatographic method (TLC)Development

Sr. No.	Solvent System	Ratio	Spray Reagent
1	Toluene : Ethyl : GAA : FA	7 : 3 : 0.1 : 0.1	Ferric Chloride
2	Toluene : Ethyl acetate : GAA : FA	5 : 5 : 0.1 : 0.1	
3	Toluene : Ethyl acetate : GAA : FA	4 : 6 : 0.1 : 0.1	
4	Hexane : Ethyl acetate	5 : 5	
5	Hexane : Ethyl acetate	3 : 7	
6	Hexane : Ethyl acetate	7 : 3	
7	Chloroform : Methanol	5 : 5	
8	Chloroform : Methanol	4 : 6	
9	Chloroform : Methanol	2 : 8	
10	Chloroform : Methanol	7 : 3	
11	Chloroform : Methanol	0.5 : 9.5	
12	Hexane : Ethyl acetate : Methanol	6 : 3 : 1	
13	Chloroform: Methanol : GAA : Water	6.4 : 0.2 : 3.2 : 0.2	
14	n-butanol : Methanol : Water	1 : 1 : 1	
15	Hexane : Ethyl acetate : GAA : FA	7 : 3 : 0.1 : 0.1	
16	Hexane : Ethyl acetate : GAA : FA	3 : 7 : 0.1 : 0.1	
17	Chloroform : Methanol : GAA : FA	9 : 1 : 0.1 : 0.1	
18	Chloroform : Methanol : GAA : FA	5 : 5 : 0.1 : 0.1	
19	Hexane : Ethyl acetate : Methanol	6 : 3 : 1	Anisaldehyde - sulfuric acid
20	Chloroform : Methanol : GAA : FA	9 : 1 : 0.1 : 0.1	
21	n-butanol : Methanol : Water	1 : 1 : 1	

Table: 6 - List of different solvent system for TLC of Crude Saponin

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Preparation of Spray reagent

1. Iron(III) chloride (Ferric chloride)reagent

- **Spray solution:** 1-5% solution of iron(III) chloride in hydrochloric acid.

Reference:

K. Fink, R.M. Fink, Proc. Soc. Expl. Bio. Med. 70, 654 (1949)

2. Anisaldehyde - sulfuric acid reagent

- **Spray solution:** Prepare freshly before use a solution of 0.5 ml p-anisaldehyde in 50 ml glacial acetic acid and 1 ml 97% sulfuricacid.
- **After-treatment:** Heat to 100-105°C until maximal visualisation of the spots. The background may be brightened by watervapour.

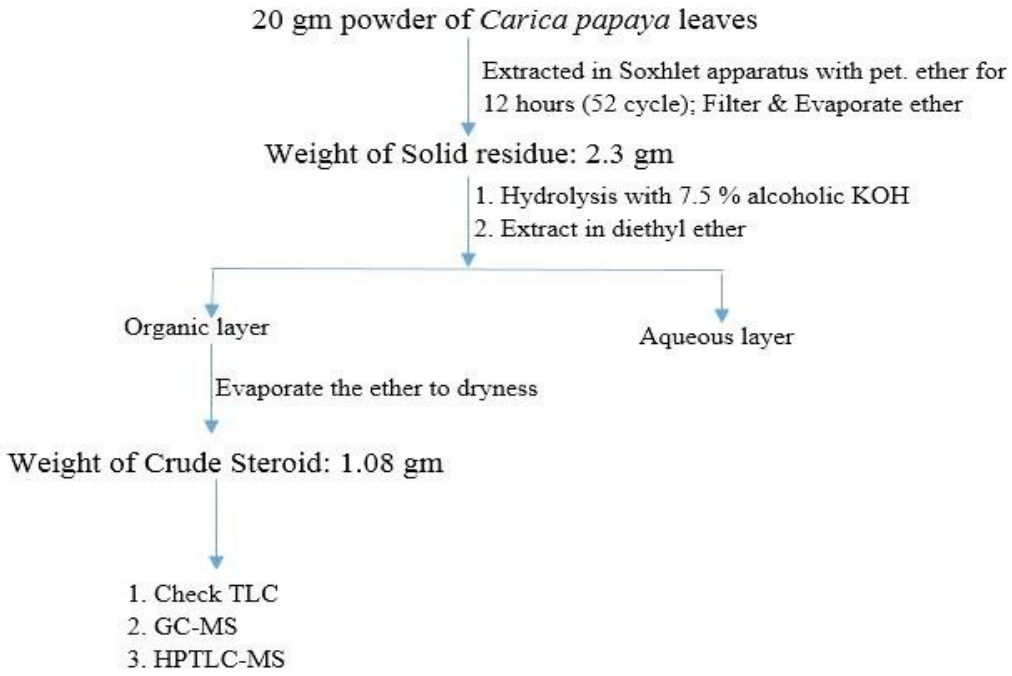
Reference:

E. Stahl, U. Kaltenbach, J. Chromatog. 5, 351 (1961).

B.P. Lisboa, J. Chromatog. 16, 136 (1964).

2.10 Extraction of Steroid (Saponifable Fraction)[32-35]

Take 20 gm plant powder and make a thimble to perform soxhlet extraction with 300 ml of petroleum ether for 12 hours (52 cycles). Put it for evaporate to dryness in water bath for 15-20 min to get solid residue (2.3 gm). Solid residue reflux with 50 ml 7.5% alcoholic KOH for 5-6 hours. Allow it to cool at room temperature. Add diethyl ether to separate the organic and aqueous layers, out of that collect organic layer. Evaporate the organic layer to solidify the mixture of crude steroid and weigh it (1.08 gm). Check TLC plate of crude steroid and after developing TLC, sample sent for GC-MS and TLC-MSanalysis.



Scheme: 4 - Schematic representation of Procedure for extract the Crude Steroid mixture

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2.10.1 Chromatographic method (TLC)Development

Sr. No.	Solvent System	Ratio	Spray Reagent
1	Benzene : Ethyl acetate	5 : 1	Vanillin - sulfuric acid (A)
2	Hexane : Acetone	8 : 2	
3	Chloroform : Methanol	9 : 1	
4	Benzene : Ethyl acetate	5 : 1	Vanillin - sulfuric acid (B)
5	Hexane : Acetone	8 : 2	
6	Chloroform : Methanol	9 : 1	
7	Chloroform : Methanol	8.5 : 1.5	
8	Chloroform : Methanol	9.5 : 0.5	
9	Chloroform : Methanol	8.5 : 1.5	Acetic anhydride-sulphuric acid
10	Chloroform : Methanol	9.5 : 0.5	

Table: 7 - List of different solvent system for TLC of Crude Steroid

Preparation od spray reagent

1. Vanillin - sulfuric acid (A)reagent

- **Spray reagent**: Dissolve 1 gm vanillin in 100 ml 97% sulfuricacid.
- **After-treatment:** Heat the chromatogram at 120°C until the spots attain maximum colourintensity.

Reference:

E. Tyihák, D. Vágujfalvi, P.L. Hágony, J. Chromatog. 11, 45 (1963).

A.L. le Rosen, R.T. Moravek, J.K. Carlton, Anal. Chem. 24, 1335 (1952).

2. Vanillin - sulfuric acid (B)reagent

- **Spray reagent**: Dissolve 0.5 g vanillin in 100 ml of a mixture of 97% sulphuric acid and ethanol(40+10).
- **After-treatment:** Heat the chromatogram at 120°C until the spots attain maximum colourintensity.

Reference:

J.S. Matthews, Biochim. et biophys. Acta 69, 163 (1963)

3. Acetic anhydride - sulfuric acid (Liebermann-Burchard)reagent

- **Spray solution:** Mix carefully and with cooling freshly before use 5 ml acetic anhydride with 5 ml 97% sulfuric acid and add the mixture with cooling to 50 ml ethanol.
- **After-treatment:** Heat 10 min at 110°C. Characteristic fluorescence in long-wave UVlight.

Reference:

C. Michalec, Biochim. et biophys. Acta 19, 187 (1956).

R. Tscheche, J. Chromatog. 5, 217 (1961).

K. Takeda, S. Hara, A. Wada, N. Matsumoto, J. Chromatog. 11, 562 (1963).

2.10.2 GC-MSAnalysis

Preparation of Solution

- **Sample preparation:** Soluble in Chloroform

Instrument: Shimadzu GC-MS (Model no. TQ8040)

Protocol:

Parameter	Used
Column	SH-Rxi-5Sil MS (30 m, 0.25 mmID, 0.25 µm df)
Column Oven Temp.	100.0 °C
Injection Temp.	250.00 °C
Injection Mode Flow	Split
Control Mode	Pressure
Pressure	73.0 kPa
Total Flow	9.5 mL/min
Column Flow	1.00 mL/min
Linear Velocity	37.2 cm/sec
Purge Flow	3.5 mL/min
Split Ratio	5.0
High Pressure Injection	OFF
Carrier Gas Saver	OFF
Splitter Hold	OFF

Oven Temp. Program:

Rate	Temperature(°C)	Hold Time(min)
-	100.0	2.00
15.00	180.0	0.00
5.00	300.0	10.0

Chapter: 3
Result & Discussion

3.1 Soluble extractive value[31]

Solvent	Powder Weight (gm)	Soluble residue Weight (gm)	Percentage (%)
Methanol	10	1.2	10
Pet. Ether	10	0.8	8
Water	10	1.5	15

Table: 8 - List of different solvent soluble extractive value

3.2 Qualitative test [31]

Sr no.	Parameter	Water extract	Methanol extract	Pet. Ether extract	Reference test
1.	Alkaloids	-	+	-	Dragendroff's Test
		+	+	-	Mayer's Test
		-	-	-	Hager's Test
		+	+	-	Wagner's Test
2.	Amino acid & Protein	+	+	-	Ninhydrin Test
		-	-	-	Biuret Test
3.	Carbohydrate	+	+	-	Molisch's Test
		+	+	-	Benedict's test
		+	+	-	Fehling's Test
4.	Flavonoid	-	-	-	Alkaline Test
		-	-	-	Lead acetateTest
5.	Glycosides	+	+	-	Modified Borntrager's Test
6.	Saponin	+	+	-	Froth Test
		+	+	-	Foam Test
7.	Steroid	-	-	+	Salkowski's Test
		-	-	+	Libermann Burchard's test
8.	Tannin	-	-	-	Gelatin Test

Table: 9 – Result of different qualitative test

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3.3 Extraction of Alkaloid

3.3.1Chromatographic method (TLC)Development

Samplepreparation : Extracted crude alkaloid mixture dissolved inmethanol

Mobilephase : Chloroform : Methanol = 9 : 1

Stationaryphase : Precoated Silica gel G254 (Merck)

Detection : (i) Short U.V. (254nm)

(ii) Long U.V. (365nm)

(iii) Spraying with DragendorffReagent

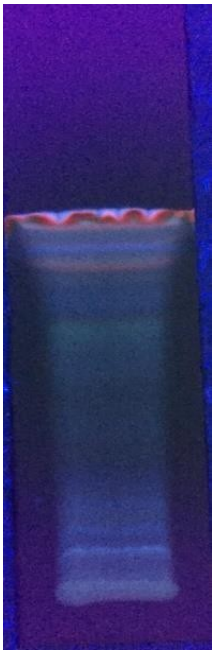
	UV light		After spraying of Dragendorff reagent
	254 nm	365 nm	
No. of visualize spot	3	6	5
Rf value	0.20, 0.30, 0.90	0.10, 0.16, 0.22, 0.70, 0.86 ,0.92	0.04, 0.20, 0.40, 0.48, 0.80
TLC			

Table: 10 - Rf value & TLC of extracted Crude Alkaloid mixture

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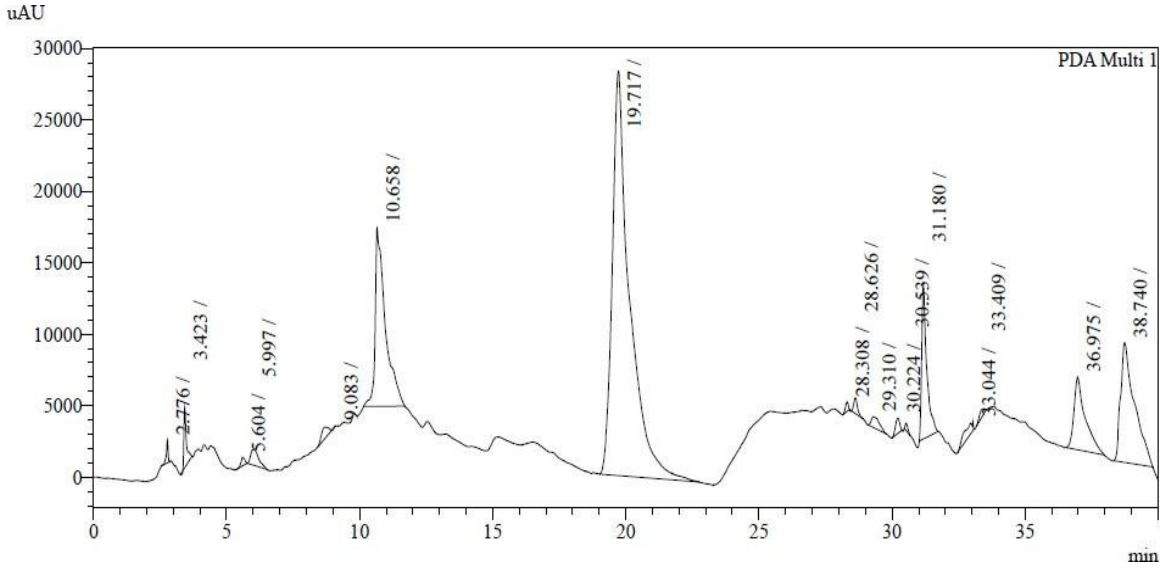
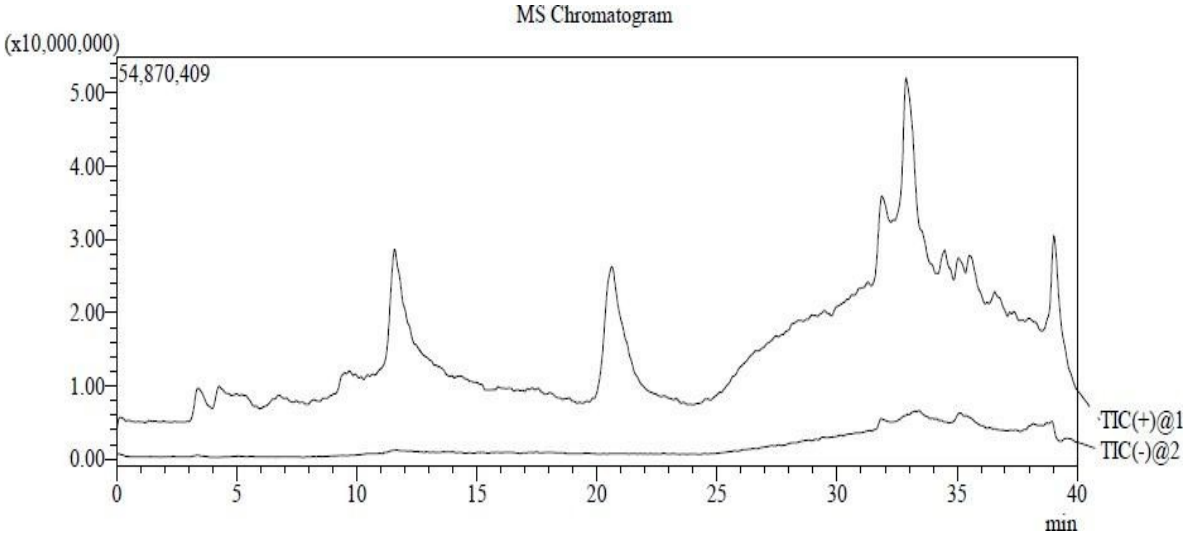
3.3.2 LC-MS Analysis

PDA Chromatogram



Mass Chromatogram



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Peak table

Peak #	R.T.	Area	Area %	Molecular weight
1	2.776	6913	0.291911	280.2
2	3.423	27717	1.170388	414.3
3	5.604	6098	0.257496	428.3
4	5.997	23209	0.980031	513.4
5	9.083	14654	0.618785	595.4
6	10.658	334921	14.14249	521.4
7	19.717	1283880	54.21356	263.1
8	28.308	4996	0.210963	798.4
9	28.626	9921	0.418928	772.4
10	29.310	17061	0.720424	836.5
11	30.224	11621	0.490712	880.4
12	30.539	3350	0.141458	279.2
13	31.180	142356	6.011173	502.3
14	33.044	20079	0.847863	654.4
15	33.409	7524	0.317711	670.3
16	36.975	150811	6.368197	391.3
17	38.740	303079	12.79792	479.4
Total	40	2368190	100	

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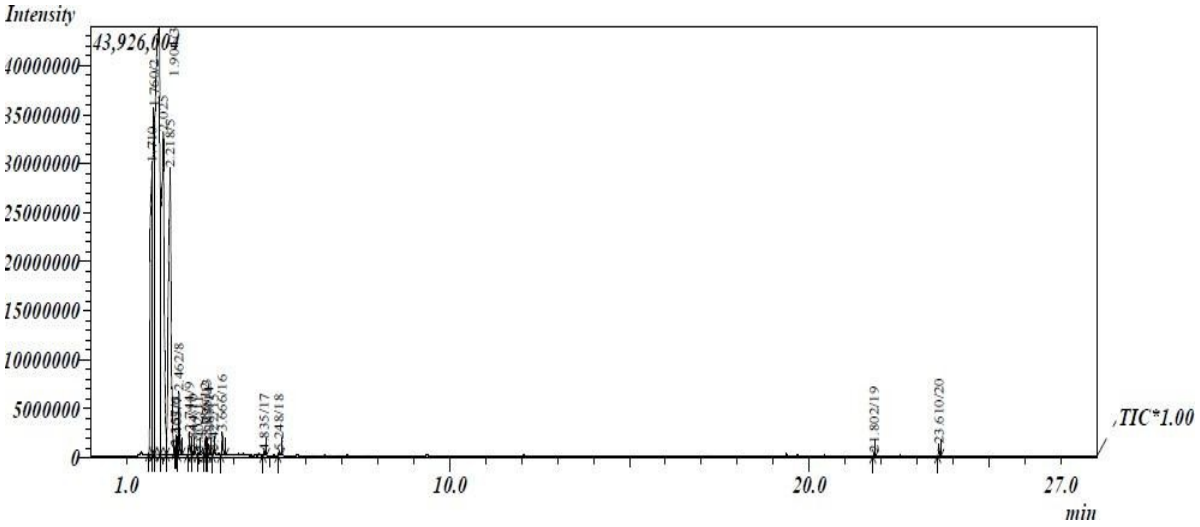
3.4 Extraction of Fatty acid (Unsaponifiable Fraction)

3.4.1GC-MSAnalysis

GCgraph



Peaktable

Peak #	R.T.	Area %	Height %	Name
1	1.710	11.99	15.61	Pentane, 2-methyl-
2	1.760	11.72	18.52	Pentane, 3-methyl-
3	1.904	37.49	22.87	Acetyl valeryl
4	2.025	19.55	17.28	Cyclopentane, methyl-
5	2.218	15.40	15.34	Cyclohexane
6	2.357	0.06	0.26	Tridecane, 3-methylene-
7	2.405	0.10	0.32	Cyclopentane, 1,2-dimethyl-
8	2.462	1.02	3.34	Heptane
9	2.744	0.57	1.24	Cyclohexane, methyl-
10	2.844	0.05	0.16	Cyclopentane, ethyl-
11	3.002	0.04	0.12	Cyclopentane, 1,2,3-trimethyl-, (1.alpha.,2.alpha.,3.beta.)
12	3.186	0.30	0.79	Heptane, 2-methyl-
13	3.226	0.45	1.02	Toluene
14	3.285	0.23	0.57	Heptane, 3-methyl-
15	3.422	0.04	0.13	Cyclohexane, 1,3-dimethyl-, cis-
16	3.666	0.50	1.22	Octane

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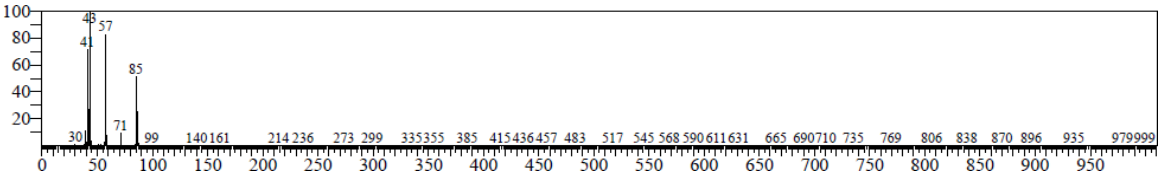
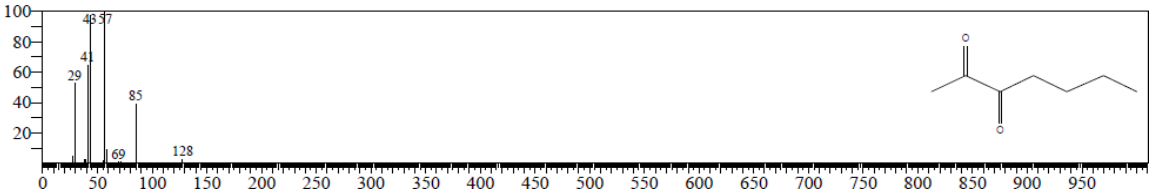
17	4.835	0.11	0.22	p-Xylene
18	5.248	0.08	0.18	2-Propenoic acid, butyl ester
19	21.802	0.06	0.20	Methyl tetradecanoate
20	23.610	0.22	0.62	Hexadecanoic acid, methyl ester
Total	27	100.00	100.00	

Mass spectra

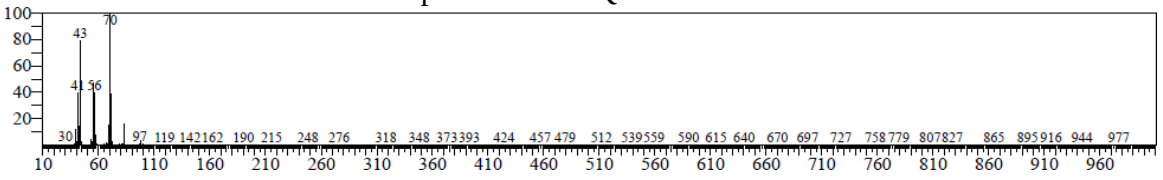
Line#:3 R.Time:1.905(Scan#:382)
MassPeaks:303
RawMode:Averaged 1.900-1.910(381-383) BasePeak:43.10(5042069)
BG Mode:Calc. from Peak Group 1 - Event 1 Q3 Scan



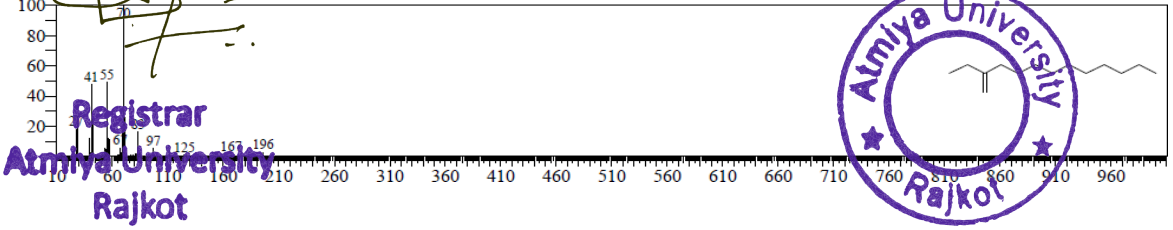
Hit#:1 Entry:13760 Library:NIST17.lib
SI:90 Formula:$C_7H_{12}O_2$ CAS:96-04-8 MolWeight:128 RetIndex:989
CompName:Acetyl valeryl



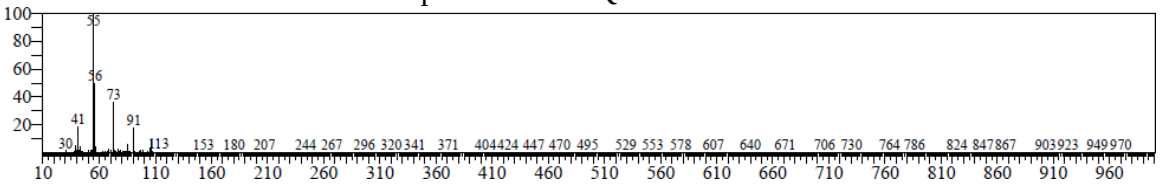
Line#:6 R.Time:2.355(Scan#:472)
MassPeaks:466
RawMode:Averaged 2.350-2.360(471-473) BasePeak:70.10(81581)
BG Mode:Calc. from Peak Group 1 - Event 1 Q3 Scan



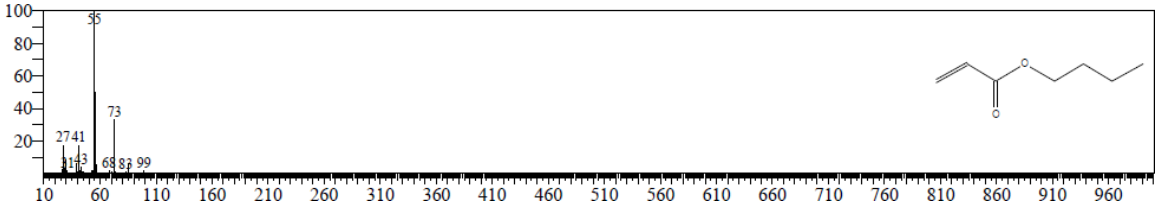
Hit#:1 Entry:67651 Library:NIST17.lib
SI:90 Formula:$C_{14}H_{28}$ CAS:19780-34-8 MolWeight:196 RetIndex:1380
CompName:Tridecane, 3-methylene-



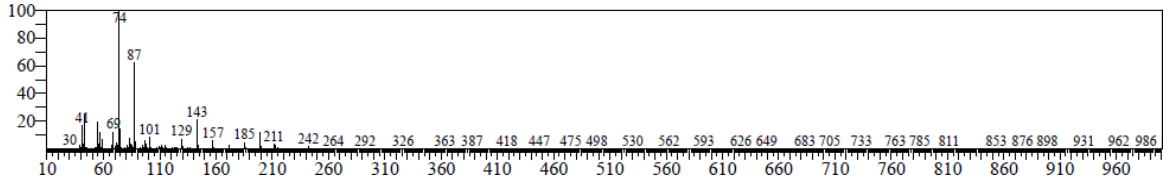
Line#:18 R.Time:5.250(Scan#:1051)
MassPeaks:418
RawMode:Averaged 5.245-5.255(1050-1052) BasePeak:55.05(111156)
BG Mode:Calc. from Peak Group 1 - Event 1 Q3 Scan



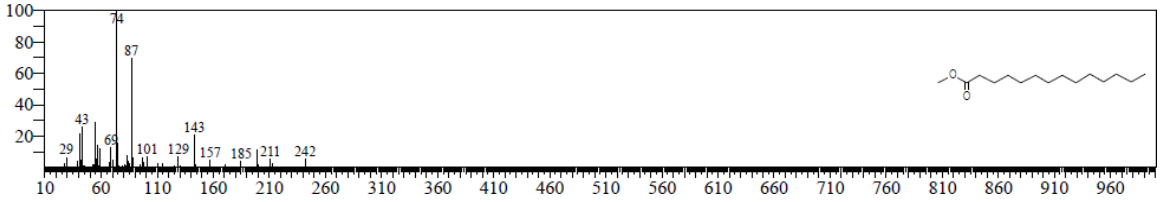
Hit#:1 Entry:13749 Library:NIST17.lib
SI:91 Formula:$C_7H_{12}O_2$ CAS:141-32-2 MolWeight:128 RetIndex:874 CompName:2-Propenoic acid, butyl ester



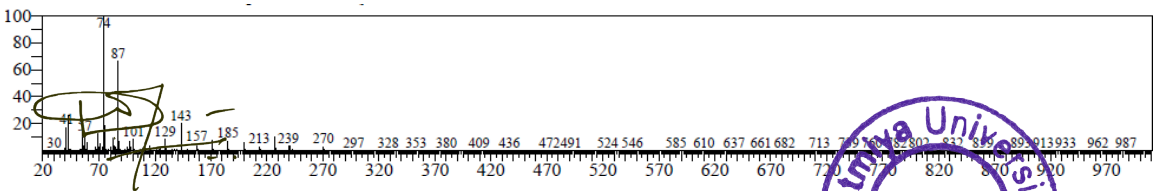
Line#:19 R.Time:21.800(Scan#:4361)
MassPeaks:576
RawMode:Averaged 21.795-21.805(4360-4362) BasePeak:74.10(82277)
BG Mode:Calc. from Peak Group 1 - Event 1 Q3 Scan



Hit#:1 Entry:114635 Library:NIST17.lib
SI:96 Formula:$C_{15}H_{30}O_2$ CAS:124-10-7 MolWeight:242 RetIndex:1680
CompName:Methyl tetradecanoate



Line#:20 R.Time:23.610(Scan#:4723)
MassPeaks:479
RawMode:Averaged 23.605-23.615(4722-4724) BasePeak:74.10(240849)
BG Mode:Calc. from Peak Group 1 - Event 1 Q3 Scan



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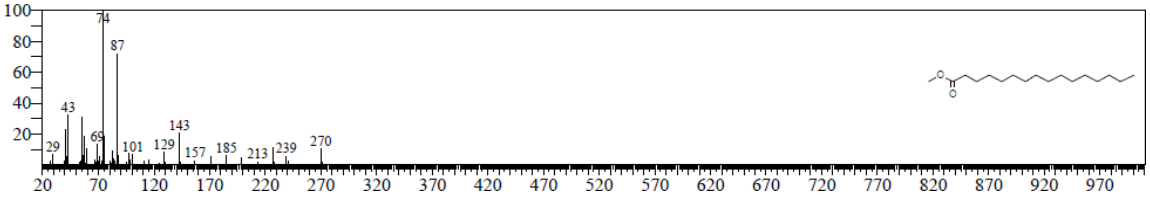
Hit#:1 Entry:144285 Library:NIST17.lib
SI:95 Formula:$C_{17}H_{34}O_2$ CAS:112-39-0 MolWeight:270 RetIndex:1878
CompName:Hexadecanoic acid, methyl ester



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3.5 Extraction of Saponin

3.5.1 Chromatographic method (TLC)Development

Samplepreparation : Extracted crude saponin mixture dissolved inn-butanol
Mobilephase : n-butanol : Methanol : Water = 1 : 1 : 1
Stationaryphase : Precoated Silica gel G254 (Merck)
Detection : (i) Short U.V. (254nm)
(ii) Long U.V. (365nm)
(iii) Spraying with p-anisaldehydeReagent

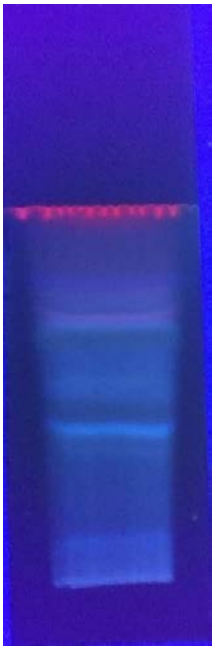
	UV light		After spraying of p-anisaldehyde reagent
	254 nm	365 nm	
No. of visualize spot	3	7	5
Rf value	0.02, 0.46, 0.70	0.10, 0.32 ,0.40, 0.50, 0.66, 0.70, 0.76	0.06, 0.40, 0.52, 0.66, 0.70
TLC			

Table: 11 - Rf value & TLC of extracted Crude Saponin mixture

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3.6 Extraction of Steroid (Saponifable Fraction)

3.6.1 Chromatographic method (TLC)Development

Sample preparation : Extracted crude steroid mixture dissolved in chloroform

Mobilephase : Chloroform : Methanol = 9.5 : 0.5

Stationary phase : Precoated Silica gel G254 (Merck)

Detection : (i) Short U.V. (254nm)

(ii) Long U.V. (365nm)

(iii) Spraying with L.B.Reagent

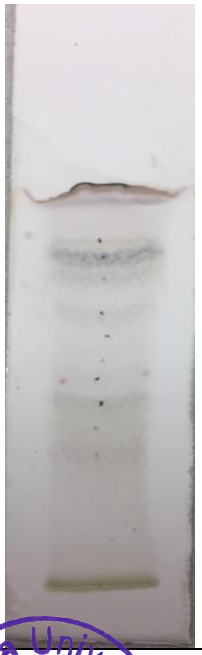
	UV light		After spraying of L.B. reagent
	254 nm	**365 nm**	
No. of visualize spot	10	5	8
Rf value	0.32, 0.37, 0.43, 0.50, 0.56, 0.62, 0.66, 0.75, 0.81, 0.84.	0.32, 0.47, 0.67, 0.77, 0.92.	0.32, 0.37, 0.43, 0.60, 0.66, 0.75, 0.81, 0.84.
TLC			

Table: 12 - Rf value & TLC of extracted Crude Steroid mixture

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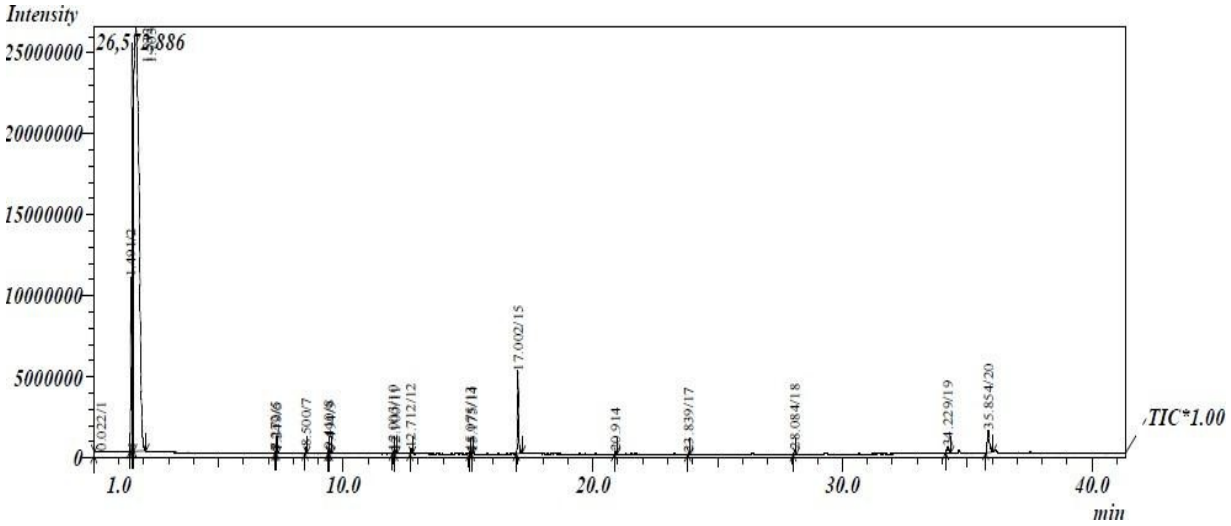
3.6.2GC-MS Analysis

GCgraph



Peaktable

Peak #	R.T.	Area %	Height %	Name
1	0.022	0.04	0.23	Oxygen
2	1.491	4.50	15.01	Ethanol
3	1.532	21.83	35.30	Trichloromethane
4	1.703	67.70	36.65	Trichloromethane
5	7.272	0.04	0.19	3-Hexadecene, (Z)-
6	7.349	0.02	0.13	Hexadecane
7	8.500	0.12	0.52	2,4-Di-tert-butylphenol
8	9.410	0.08	0.34	9-Eicosene, (E)-
9	9.494	0.05	0.20	Hexadecane
10	12.003	0.06	0.23	9-Eicosene, (E)-
11	12.100	0.05	0.18	Heneicosane
12	12.712	0.11	0.40	2-Pentadecanone, 6,10,14-trimethyl-
13	15.075	0.05	0.17	1-Hexacosene
14	15.175	0.04	0.13	Heneicosane
15	17.002	3.06	7.11	Phytol
16	20.914	0.09	0.19	4,8,12,16-Tetramethylheptadecan-4-olide
17	23.839	0.05	0.13	Bis(2-ethylhexyl) phthalate

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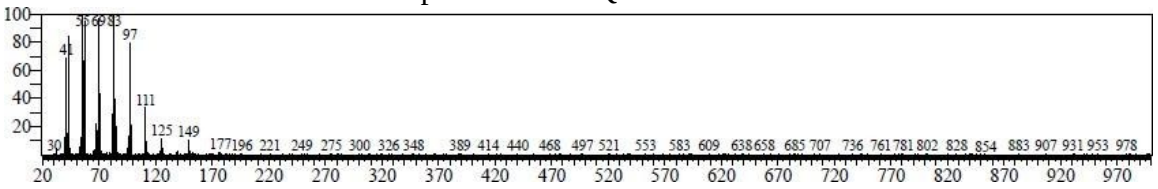
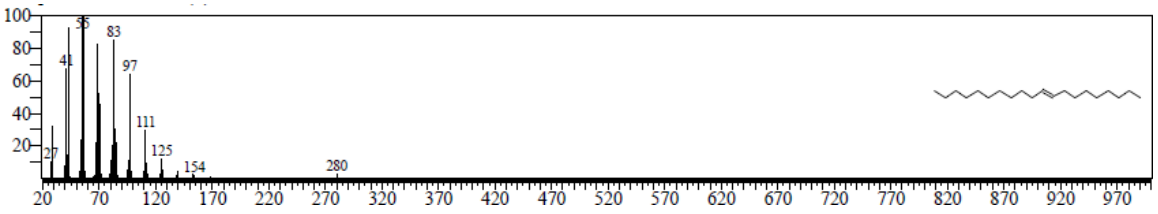
18	28.084	0.16	0.42	Squalene
19	34.229	0.35	0.49	Campesterol
20	35.854	1.63	1.97	.gamma.-Sitosterol
Total	40	100.00	100.00	

Mass spectra

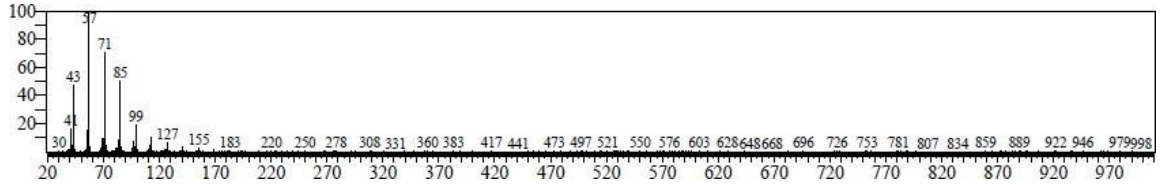
Line#:8 R.Time:9.410(Scan#:1883)
MassPeaks:558
RawMode:Averaged 9.405-9.415(1882-1884) BasePeak:55.05(18846)
BG Mode:Calc. from Peak Group 1 - Event 1 Q3 Scan



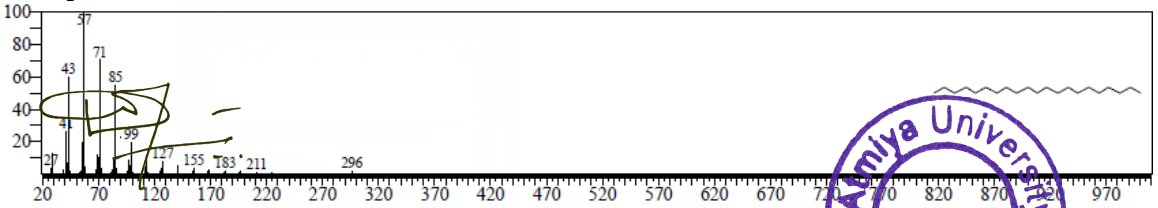
Hit#:1 Entry:154888 Library:NIST17.lib
SI:95 Formula:$C_{20}H_{40}$ CAS:74685-29-3 MolWeight:280 RetIndex:2017
CompName:9-Eicosene, (E)-



Line#:14 R.Time:15.175(Scan#:3036)
MassPeaks:553
RawMode:Averaged 15.170-15.180(3035-3037) BasePeak:57.10(18886)
BG Mode:Calc. from Peak Group 1 - Event 1 Q3 Scan



Hit#:1 Entry:172573 Library:NIST17.lib
SI:95 Formula:$C_{21}H_{44}$ CAS:629-94-7 MolWeight:296 RetIndex:2109
CompName:Heneicosane



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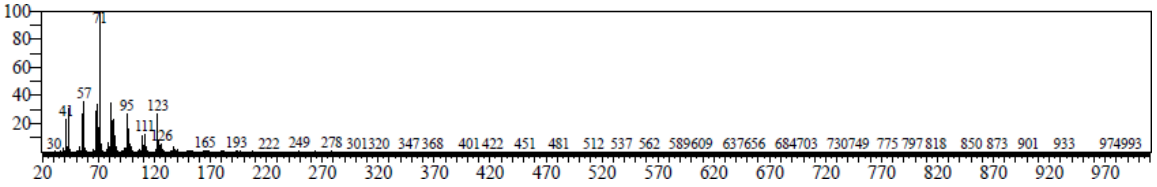
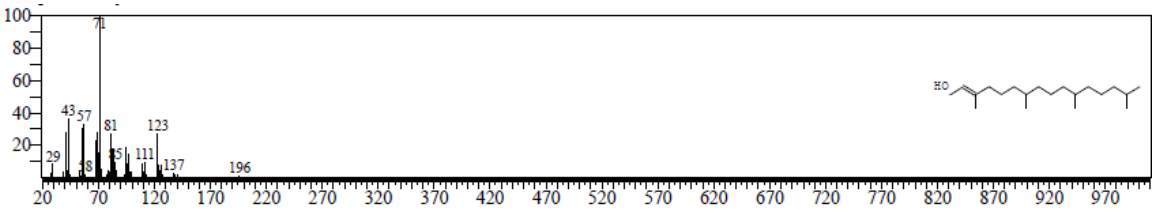
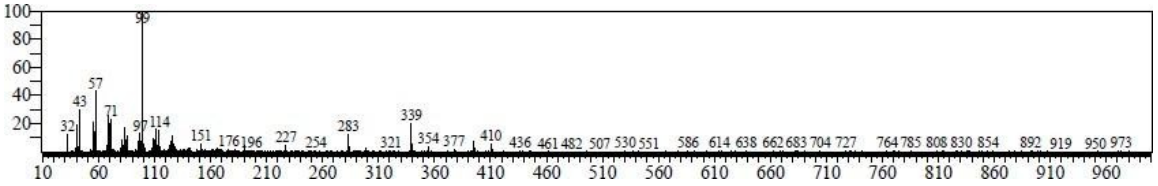
Line#:15 R.Time:17.000(Scan#:3401)
MassPeaks:530
RawMode:Averaged 16.995-17.005(3400-3402) BasePeak:71.05(777967)
BG Mode:Calc. from Peak Group 1 - Event 1 Q3 Scan



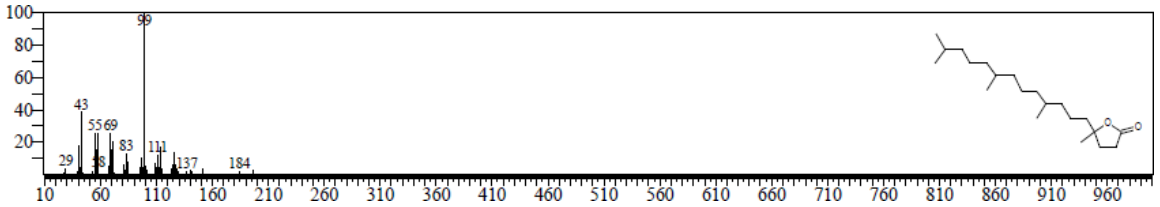
Hit#:1 Entry:172522 Library:NIST17.lib
SI:96 Formula:$C_{20}H_{40}O$ CAS:150-86-7 MolWeight:296 RetIndex:2045
CompName:Phytol



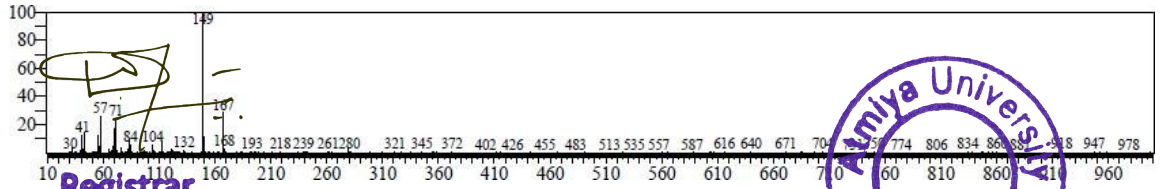
Line#:16 R.Time:20.915(Scan#:4184)
MassPeaks:625
RawMode:Averaged 20.910-20.920(4183-4185) BasePeak:99.05(19629)
BG Mode:Calc. from Peak Group 1 - Event 1 Q3 Scan



Hit#:1 Entry:202664 Library:NIST17.lib
SI:86 Formula:$C_{21}H_{40}O_2$ CAS:96168-15-9 MolWeight:324 RetIndex:2258
CompName:4,8,12,16-Tetramethylheptadecan-4-olide



Line#:17 R.Time:23.840(Scan#:4769)
MassPeaks:524
RawMode:Averaged 23.835-23.845(4768-4770) BasePeak:149.05(26244)
BG Mode:Calc. from Peak Group 1 - Event 1 Q3 Scan



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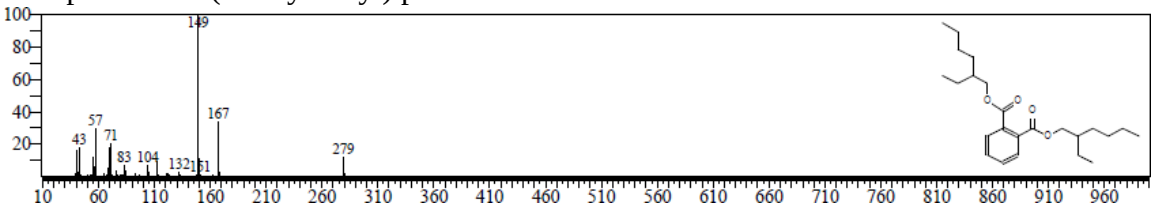
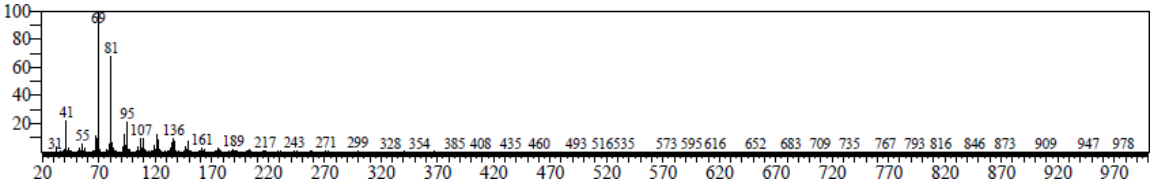
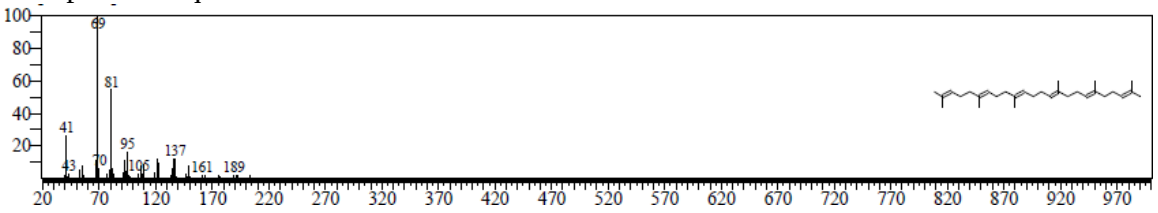
Hit#:1 Entry:259670 Library:NIST17.lib
SI:95 Formula:$C_{24}H_{38}O_4$ CAS:117-81-7 MolWeight:390 RetIndex:2704
CompName:Bis(2-ethylhexyl) phthalate



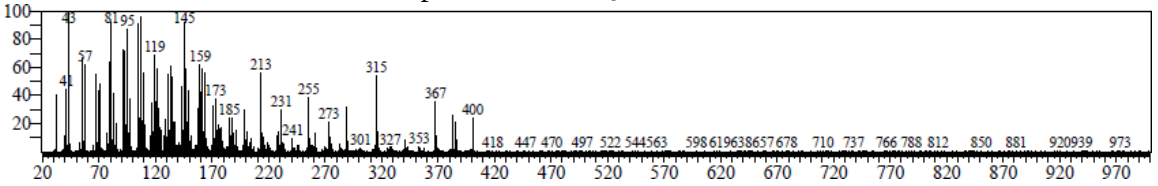
Line#:18 R.Time:28.085(Scan#:5618)
MassPeaks:621
RawMode:Averaged 28.080-28.090(5617-5619) BasePeak:69.05(67141)
BG Mode:Calc. from Peak Group 1 - Event 1 Q3 Scan



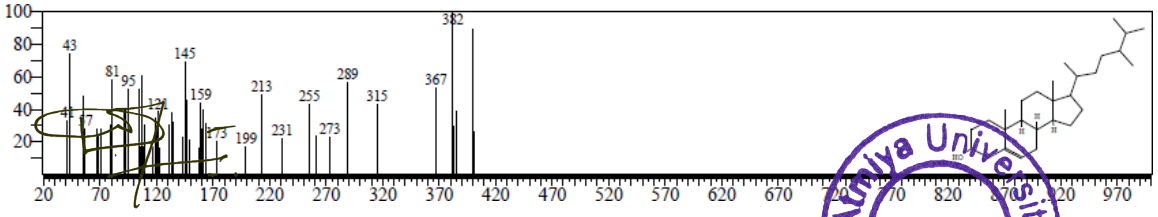
Hit#:1 Entry:270410 Library:NIST17.lib
SI:95 Formula:$C_{30}H_{50}$ CAS:111-02-4 MolWeight:410 RetIndex:2914
CompName:Squalene



Line#:19 R.Time:34.230(Scan#:6847)
MassPeaks:666
RawMode:Averaged 34.225-34.235(6846-6848) BasePeak:43.05(9027)
BG Mode:Calc. from Peak Group 1 - Event 1 Q3 Scan



Hit#:1 Entry:265739 Library:NIST17.lib
SI:80 Formula:$C_{28}H_{48}O$ CAS:474-62-4 MolWeight:400 RetIndex:2632
CompName:Campesterol



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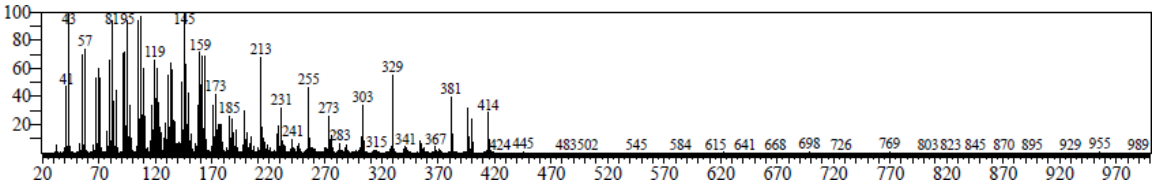
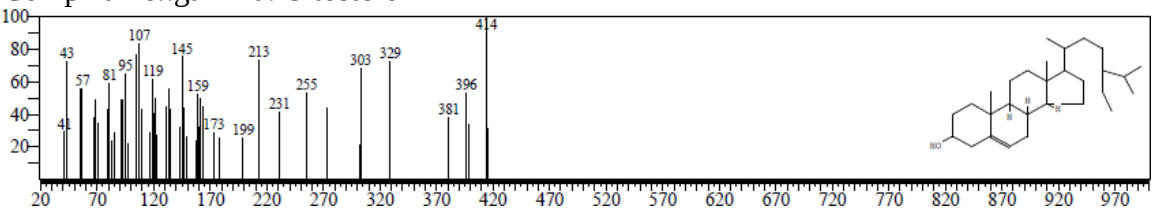
Line#:20 R.Time:35.855(Scan#:7172)
MassPeaks:567
RawMode:Averaged 35.850-35.860(7171-7173) BasePeak:43.05(34507)
BG Mode:Calc. from Peak Group 1 - Event 1 Q3 Scan



Hit#:1 Entry:272488 Library:NIST17.lib
SI:88 Formula:$C_{29}H_{50}O$ CAS:83-47-6 MolWeight:414 RetIndex:2731
CompName:.gamma.-Sitosterol



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3.7 Discussion

Qualitative test of extracts gave positive test with Dragendorff reagent, which suggest the presence of alkaloid. TLC results revealed that presence of alkaloid in *C. papaya* are higher. From this mixture of crude alkaloid, five spots were visible after the derivatization with dragendroff reagent which indicates the presence of five (might be) alkaloids in themixture.

Qualitative test of extracts gave positive test with Lieberman Burchard reagent, which suggest the presence of steroid or triterpenoids. TLC results revealed that unsaponifiable load in *C. papaya* are higher. The unsaponifiable matter was separated through extraction with non-polar solvents like diethyl ether. From the unsaponifiable fraction, one triterpene, one diterpene and two steroid compounds were identified in saponifiable fraction; the mixed fatty acids were liberated by addition of 5N sulphuric acid. It was difficult to separate higher fatty acids through simple chemical methods; hence, they were converted into their methyl esters which were amenable to separation through various chromatographic techniques like adsorption TLC, reversed phase TLC and GC-MS. In the present study GC-MS technique has been employed to study the unsaponifiable and saponifiable matter in the test plant. The comparison of the mass spectrums with the database gave more than 95% match as well as confirmatory compound structurematch.

Chapter: 4
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“Analysis of Tool Life, MRR and Surface roughness during turning of D2 steel by using CERMET insert”

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TABLE OF CONTENTS

Title Page		I
Certificate		ii
Compliance Certificate		iii
Paper Publication Certificate		iv
Thesis Approval Certificate		v
Declaration of Originality		vi
Acknowledgements		vii
Table of Contents		viii
List of Figures		xi
List of Tables		xii
Nomenclature		xiii
Abstract		xiv
CHAPTER 1: INTRODUCTION		**1-8**
1.1	Introduction to manufacturing process	1
1.2	Classification of manufacturing process	1
1.3	Classification of machining process	3
1.4	Turning Process	3
1.5	Classification of Turning Process	4
1.6	Dynamics of turning	5
1.7	Workpiece Introduction	6
1.7.1	Properties of D2 steel	6
1.7.2	Chemical Composition of D2 steel	6
1.7.3	Application of D2 steel	7

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Rajkot

1.8	Tool insert	7
1.8.1	Introduction of cermet insert	7
1.8.2	Application of cermet insert	8
CHAPTER 2: LITERATURE SURVEY		**9-20**
2.1	Problem Identification	9
2.2	Literature Review	10
2.3	Literature Mapping	18
2.4	Literature Summary	19
2.5	Objectives	20
CHAPTER 3: METHDOLOGY		**21-23**
CHAPTER 4: DESIGN OF EXPERIMENT		**24-25**
CHAPTER 5: EXPERIMENTAL SETUP AND WORK		**26-46**
5.1	CNC Machine	26
5.2	Tool insert	28
5.3	Selection of workpiece for turning	29
5.4	Analytical Calculation for Turning Operation	30
5.5	Surface Roughness Tester	31
5.6	Experimental Setup	32
5.7	CNC Program	32
5.8	Experimental Procedure	35
5.9	Material Removal Rate	36
5.10	Tool life	38
5.11	Surface Roughness	43
CHAPTER 6: RESULT AND DISCUSSIONS		**47-48**
CHAPTER 7: CONCLUSIONS AND FUTURE SCOPE		**49-50**
7.1	Conclusions	49

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7.2 Future Scope 50

REFERENCES **51-54**

APPENDIX A: Review Card **55**

APPENDIX B: Compliance Report **61**

APPENDIX C: Acceptance Letters **62**

APPENDIX D: Standard **63**

APPENDIX E: Standard Result **65**

APPENDIX F: Plagiarism Report **68**

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LIST OF FIGURES

FIG. NO.	TITLE	PAGE NO.
1.1	Schematic Representation of Turning Operation	4
2.1	Year Wise No. of Literature	18
2.2	Publication Wise % of Literature	19
2.3	Domain wise % of literature	19
3.1	Flow Chart for followed methodology	22
5.1	DX 150 CNC Machine	26
5.2	Cermet Insert	28
5.3	Surface roughness tester	30
5.4	Workpiece Setup	31
5.5	Turning operation	34
5.6	Workpiece after Machining	35
5.7	Flank Wear at different Cutting Speed	39
5.8	Flank wear vs Machining Time	40
5.9	Logarithmic Scales	41
5.10	Surface Roughness Setup	42
5.11	Close view of tip touch of roughness tester	43
5.12	Checking Surface roughness Value	43

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LIST OF TABLES

TABLE NO.	TITLE	PAGE NO.
1.1	Classification of manufacturing process	2
1.2	Classification of Machining Process	3
1.3	Composition of D2 steel in %	7
4.1	Process Parameters	23
4.2	Process parameters and its range	23
4.3	Design of Experiment	24
5.1	Specifications of DX150 CNC Machine	26
5.2	Specification of Cermet insert	27
5.3	Size of workpiece	28
5.4	Analytical Calculations for cutting speed 100m/min and time interval 25min	29
5.5	Specification of MITUTOYO SJ/210	31
5.6	Material Removal Rate Calculations	37
5.7	Maximum Flank wear width observed	39
5.8	Logarithmic Values	41
5.9	Average Surface Roughness	45
6.1	Effects of input parameters on output parameters	46

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NOMENCLATURE

MRR	Material Removal Rate
R_a	Surface Roughness
v	Cutting Speed
f	Feed Rate
ASTM	American Society for Testing and Materials
DOC	Depth of Cut

"Analysis of Tool Life, MRR and Surface Roughness during Turning of D2 Steel by Using Cermet Insert"

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ABSTRACT

The use of engineering materials has increased to a great extent in industries. So it is required to find the optimum parameters in order to have easy and economical machining. Turning operation is most important in the machining process. Especially of hard materials it is difficult sometimes to do so. For better results, the selection of proper process parameters is very important. This dissertation work presents, the effect of process parameters on various materials while performing turning operation and been validated by various methodology techniques. It also highlights on the effect of input controllable parameters over the required output values. According to ISO 3685 design of experiment was carried out. Tool life was calculated according to different cutting speed and machining time keeping feed rate and depth of cut constant. Optimum values were obtained and the effect of cutting speed on tool life was studied.

Keywords: Turning operations, Cermet, Tool life, MRR, Surface roughness, ISO 3685

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CHAPTER 1

INTRODUCTION

1.1 Introduction to manufacturing process:

As we can see in the manufacturing process raw materials or semi-finished products is been converted into final finished product. It is basically the process of converting raw material into finish product. For these different types of tools, machines, equipment are used to produce the finished goods. It is the important steps in production process. It mainly focuses with the change of form of material or the dimensions being produced. When manufacturing process is carried out, there is a change in its physical properties of work material. In today's competitive market manufactured parts should be carried out at lowest possible cost having best possible quality and customer requirement.

The primary aim of manufacturing process is to produce a product that have a useful form. In the production process, manufacturing process is important. The steps like transportation, handling or storage are not the part of manufacturing process because they are not involved in the change of the shape or size of the workpiece by which required dimensional accuracy and surface finish is achieved.

Workpiece of various shapes and dimensions are being produced in the manufacturing industry. Manufacturing process is classified basically into two groups, the group of cutting and that of non-cutting.

1.2 Classification of manufacturing process:

In industry many of the materials are fabricated in the desired shape by any one of the following methods viz: casting, forming, machining and welding. The selection for a particular technique depends upon the different factors which may be include the shape and size of the component, required precision, material, cost and also on its availability. Sometimes one specific process can be used to achieve the desired object. However, more often it's possible to have choice between the processes available for making end product.

Among available options economy plays the important decisive role in making the final choice.

Table 1.1: Classification of manufacturing process [31]

Sr. No.	Based on function of process	Sub classification of manufacturing process
1.	Machining Process	Turning, drilling, milling, grinding, etc.
2.	Casting Process	Sand casting, Permanent mold casting, Die casting, Centrifugal casting
3.	Shearing and forming process	Punching, Blanking, Drawing, bending, forming
4.	Metal working process	Rolling, forging, extrusion, wire drawing, etc.
5.	Joining Process	Welding, brazing, soldering, joining
6.	Surface finishing process	Lapping, honing, super finishing

1) **Machining process:**

   With single or multiple cutting edges the excess material over a workpiece is removed in the form of chips by forcing a cutting tool into the workpiece.

2) **Casting process:**

   It is the one type of process in which a solid is been heated up to an appropriate temperature so that it gets dissolved into a liquid and it is been added to mould cavity.

3) **Shearing and forming process:**

   They are used for sheet metal work. Products manufactured by this process is pots and pans, door and window hardware, metal cabinets and automobile bodies.

4) **Metal working process:**

   It is the process in which the deformation of the material takes place due to the flow of material under the condition of strain rate and temperature.

5) **Joining process:**

This process defines as joining of two or more metals which are joint to each other or repair the broken parts. The joints made may be permanent like welding or may be temporary like soldering, riveting, soldering, etc.

6) **Surface finishing process:**

This processes are used to improve appearance or to manufacture smooth surface or to provide a protective coating.

1.3 Classification of machining process:

Machining process are classified into two main parts as shown in table below:

Table 1.2: Classification of machining process [31]

Conventional Machining	Non-Conventional Machining
Conventional machining processes are done by shearing action between workpiece and cutting tool by direct contact.	Non-conventional machining processes are carried out by abrasion, corrosion, melting of material in small amount without contact of work piece and cutting tool.
The conventional machining processes are listed below: • Turning • Drilling • Boring • Planning • Slotting • Milling	The non-conventional machining processes are listed below: • Ultrasonic machining • Abrasive jet machining • Water jet machining • Electro discharge machining • Laser beam machining • Plasma Arc Machining

There are various types of conventional machining processes used as of now a days. From which turning process is taken into consideration for the dissertation work.

1.4 Turning process:

In the operation of machine shop, CNC turning process are used to make cylindrical parts, where cutting tool is moved in a linear fashion while the work piece rotates. The rotation is performed basically using a lathe, in which turning process reduces diameter of workpiece, typically for specifying dimension and for producing a smooth surface finish. This process generally uses single point cutting tools. The material removed or the bits of waste metal while turning operations is known as chips (North America) or swarf (Britain).

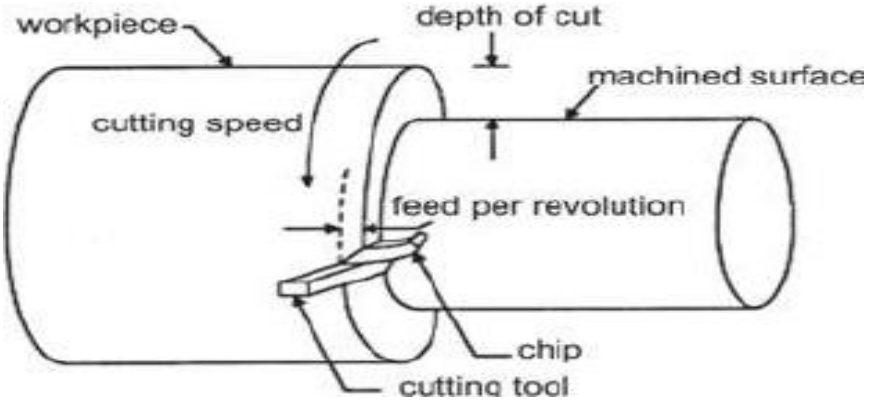

Figure 1.1: Schematic Representation of Turning Operations [31]

Turning process is widely used process. It is useful for basic change in form or dimensions being produced. It helps the product to get in required shape or for making surface smooth before any other process. This turning process was considered as important aspect in this dissertation work because of its importance in today's manufacturing arena.

1.5 Classification of Turning process:

The general process of turning process involves rotation of workpiece/part while a single point cutting tool is moved parallel to the axis of rotation. This process can be done on external surface of part as well as on the internal surface (process known as boring). The starting material is generally a workpiece generated by other processes such as extrusion, forging, casting or drawing.

Turning process specific operations include:

- **Tapered turning:**

  This operation produces a cylindrical shape that gradually show decrease in diameter from one end to the other.

- **Spherical Generation:**

  This operation generally produces a spherical finished surface by turning a form around a fixed axis of revolution.

- **Hard turning:**

  This process is intended to replace or limit traditional grinding operations. Hard turning when is applied for purely stock removal purposes, competes favorably with rough grinding. However, when it is being applied for finishing where dimension and form is critical, grinding is superior.

- **Facing:**

  Facing in the context of turning work involves moving the cutting tool at right angles to the axis of the rotation of the rotating workpiece. It can be performed by the operation of the cross slide, if one is fitted, as the distinct from the longitudinal feed (turning). It is basically the first operation performed in the production of the workpiece, and often the last hence the phrase “ending up”.

- **Parting:**

  Parting also called as parting off or cutoff, is usually used to create deep grooves which will remove a part complete or completed component from its parent stock.

- **Grooving:**

  Grooving is like parting, except that grooves are cut to a specific depth of instead of serving a completed/part-complete component from the stock. It can be performed on external/internal surfaces, as well as on the face part (trepanning or face grooving).

1.6 Dynamics of turning:

- **Forces:**
  - The forces in turning operation is important in the design of machine tools.
  - The tools and components must be able to withstand these forces without causing significant vibrations, deflections or chatter during the operation. Mainly three principle forces in turning process.

- The cutting or tangential forces acts downwards on the tool tip allowing deflection of the workpiece upward. This force supplies the energy required for cutting operation. This force depends on the materials.
- The feed or axial force acts in the longitudinal direction. Its also called feed force because it acts in the direction of feed by the tool. It tends to push away the tool from the chuck.
- The radial or thrust force acts in the radial direction and tends to push the tool away from the workpiece.

- **Speed:**

  Speed for turning is chosen purely based on work piece material, cutter material, setup rigidity, machine tool rigidity, and coolant choice and spindle power.

- **Feed:**

  The distance, the tool advances into material in one revolution is called as "Feed". Unit of feed is mm per revolution (mm/rev).

1.7 Workpiece:

D2 steel development coincides with the part with the inventions of stainless steel as well as high speed steel. This steel is a part of tool steel category known as "High Carbon, High Chromium" steels.

1.7.1 Properties of D2 steel:

- D2 steel is an air hardening, high carbon, high chromium, tool steel.
- It has high wear and abrasion resistant properties. It is heat treatable and will offer a hardness in the range 55-62 HRC, and is machinable in the annealed conditions.
- D2 steel gives little distortion on correct hardening.
- D2 steels high chromium content gives it mild corrosion resisting properties in the hardened condition.

1.7.2 Chemical Composition of D2 steel:

According to standard specification for tool steel alloy chemical requirements of D2 steel in % are shown in table below:

Table 1.3: Composition of D2 steel in % [29]

Composition	% requirement
Carbon	1.40-1.60
Manganese	0.10-0.60
Phosphorous	0.030
Sulfur	0.030
Silicon	0.10-0.60
Chromium	11.00-13.00
Vanadium	0.50-1.10
Molybdenum	0.70-1.20

1.7.3 Application of D2 steel:

Typical applications for D2 steel are as follows:

- Stamping or Forming Dies
- Punches
- Forming Rolls
- Knives, slitters, shear blades
- Tools
- Scrap choppers
- Tyre shredders

1.8 Tool insert:

1.8.1 Introduction to Cermet Insert:

A cermet is a composite material made of ceramic (cer) and metal (met) materials. It is ideally designed to have optimal properties of both metal, such as the ability to undergo plastic deformation and that of ceramic, such as high temperature resistance and hardness. The metal is used as a binder for an oxide, carbide or boride. The metallic elements used are nickel, molybdenum, and cobalt. Depend on the physical structure of material, cermet can be metal matrix composites, but cermets are usually less than 20% metal by volume.

1.8.2 Applications of cermet insert:

- Cermets are used in machining on cutting tools.
- Cermets are used as ring material in high quality line guides for fishing rods.
- Cermets are used in dentistry as a material for fillings.

CHAPTER 2

LITERATURE SURVEY

This chapter includes the identification of problem and the objectives settled after referring to various research papers. Literature survey includes the basic idea of overall dissertation base idea that from where data is been collected and according to it is standardized value or not. According to literature we got information that the most affecting cutting parameters while turning operations are cutting peed, feed rate and depth of cut. The parameters range was selected according to standard ASM Specialty handbook: Tool materials. The various journals referred during this dissertation are as follows:

1. Journals of Materials Processing Technology: Elsevier.
2. Material & Design: Elsevier.
3. Materials and Manufacturing Process: Taylor & Francis.
4. Journal of Manufacturing Process & Alloys & compounds: Elsevier.
5. International J Advance Manufacturing Technology: Springer.
6. Standard Specification for tool steel Alloy: ASTM A681 international Standard, 2015.
7. ASM Specialty Handbook: Tool materials, 1995.
8. Standard STN ISO 3685: Tool life testing with single point cutting tools, 1993.

2.1 Problem Identification:

- The main aim of this research project has been to study the machinability on D2 steel with hard turning process.
- On referring more research paper it was noted that turning operation on D2 steel was not been reported by using cermet inserts. And it has been studied that improper parameters can lead to poor surface roughness quality.
- To maximize material removal rate with compromise in roughness up to an acceptable level in order to increase production rate. The selection of optimum

process parameters is very important with determining the values of these parameters.

- MRR and surface roughness are dependent on cutting parameters like speed, feed, and depth of cut.

2.2 Literature Review:

Tugul Ozel, Yigit Karpat, J. Paulo Davim [1] investigated that tool nose design has effect on surface finish and productivity in finish hard turning process. Experimental result indicated that surface roughness R_a values as low as 0.18-0.20 µm is achievable with wiper tools. Surface roughness and tool flank wear was carried out and was compared with a non-training experimental data.

J. Paulo Davim, Luı´s Figueira [2] mentioned that the hard turning is generally performed without a coolant.The results of the test showed that with a appropriate cutting parameters choice is possible to obtain a surface roughness that allows to elimite cylindrial grinding operations.

R. Ferreira, D. Carou, C. H. Lauro & J. P. Davim [3] investigated in the Hard Turning of Steel by using Ceramic Tools, Materials and Manufacturing Processes. The input parameters were considered as cutting speed, feed rate, and the type of tool. The experiment allowed recognition of the influence of feed rate and type of tool on the surface quality.

Wenbin Ji, Bin Zoua, Shuai Zhang et .al [4] evaluated the cutting performance of gradient cermet composite cutting inserts, effects of cutting speeds on the tool life and surface roughness was investigated during dry turning continuously. The developed cermet composite cutting inserts showed longer tool life and better machining quality than Ti cermet inserts under the same cutting conditions. Cutting speed plays a important effect on both tool life. It contributed to high surface hardness, good wear resistance of surface layer.

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Sarmad Ali Khan, Muhmmad Umar et. al [5] to evaluate the effect of wiper inserts micro geometry for critical hardness regime of D2 steel material. Work piece hardness plays an important role for tool life whereas for surface roughness, and feed rate is found to be more dominant. At highest feed and depth of cut combination, material pull-out was revealed as the major microstructural damage.

N. López-Luiz, O. Jiménez Alemán et. al [6] stated that signal to noise ratios and the response surface methodology had been used to optimize maximum flank wear and surface roughness of cutting tool when turning a hardened steel AISI D2. And by employing regression models, cutting speed, cutting depth and feed rate, which optimized maximum flank wear and surface roughness, they concluded that the depth of cut was the main parameter that affected on the surface roughness, where the feed rate was the most influential parameter on the flank wear.

Ashok Kumar Sahoo, Bidyadhar Sahoo [7] it deals with a comparative study on flank wear, tool life and surface roughness in turning high carbon high chromium AISI D2 steel with coated and uncoated carbide inserts under dry cutting environment. And concluded that carbide tools is capable of reducing machining costs and performs better that uncoated carbide inserts in machining steel.

Bin Zou, Huijun Zhou et. al.; [8] developed Ti(C_7N_3)/WC/TaC cermet cutting tool using a hot pressed technology. A standard orthogonal array was considered to investigate the cutting performance of this newly developed insert in the high-speed turning of 17-4PH martensitic and 321 austenitic stainless steels. The effects of the cutting parameters on the tool life and surface quality were analysed to examine the performance of the inserts based on Taguchi method. The mechanisms of tool damage and machined-surface generation and their relationships were also thoroughly discussed to understand the machinability of different stainless steels. The considered cutting parameters are as follows: a cutting speed, feed and a depth of cut which is considered to be a notably efficient parameter for machining stainless steel. They experimented and found the longest tool life which exceeded 46 min and the best surface roughness of 0.58µm.

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XU Kaitaio, Zou Bin et. al.; [9] studied the cutting performance of C-276 nickel based alloy machines by newly developed Ti(C_7N_3) based cermet insert manufactured by hot-pressing method. Based on orthogonal experiment method, the influence of cutting parameters on tool life, MRR and surface roughness was investigated. Notch wear, flank wear, chipping at the tool nose, built-up edge (BUE) and micro-cracks are found when Ti(C_7 N_3)-based cermet insert turned Haste alloy C-276. They also concluded that Flank wear, chipping and cracking was the dominant tool failure modes when machining Haste alloy C-276 with Ti(C_7 N_3)-15(WC+TaC) cermet tools at the lower cutting speed. With increase in the cutting speed, the notch and catastrophic fracture of the edge occurred to decrease the tool life. The adhesion/attrition, abrasive, oxidation and diffusion were the main wear mechanisms of Ti(C_7 N_3)-based cermet tools.

Anshuman Das, Saroj Kumar Patel et. al.; [10] described the experimental and statistical analysis of flank wear, material removal rate, tool tip temperature, surface roughness parameters, chip morphology, chip thickness and dimensional deviations. For experimental design taguchi's L_{27} orthogonal array was elected whereas to study the significance of cutting parameters of the responses ANOVA was been used. For each response, mathematical model was been developed with regression analysis. The optimal combination of machining parameters has been obtained using neuro-genetic algorithm.

Anshuman Das, Nirmal Tirkey et. al.; [11] evaluated mist cooling and dry cutting effects on cutting force, chip morphology, flank wear, crater wear, surface roughness and micro hardness of chip during hard turning operation of EN-24 grade steel having hardness of 48 HRC. Water-soluble oil is applied for cooling and lubricating purposes in mist cooling, and a comprehensive comparative analysis was performed with dry machining environment. They concluded good surface finish in mist cooled turning as compared to dry turning.

Raman Kumar, Paramjit Singh Bilga et. al.; [12] optimized the active power consumed by the machine for rough and finish turning of EN 353 alloy steel. The Taguchi L_{27} orthogonal array was used for design of experiments and the effect of cutting speed, feed rate, depth of cut and nose radius along with their interactions has been studied. The

multi-layer coated tungsten carbide inserts are used for rough turning operation and cermet inserts are used for finish turning operation. The regression models have been developed with RSM. The results also reveal that the machine tools for finish turning operation with lower nominal power motors can be used for batch/mass production. It can reduce the installation and operating cost of the new machine tools.

Prafulla B. Pawar, Uday A. Dabade; [13] investigated the experimental study related to the optimization of cutting parameters in turning of AISI D2 steel by coated carbide inserts using Response surface methodology (RSM). The relationship between cutting parameters i.e. cutting speed (m/min), feed (mm/rev) and depth of cut (mm) and the response parameter i.e. surface roughness (µm) is analyzed using the contour plots. The influence of each parameter is studied through ANOVA. Cutting speed and depth of cut are found to be significant parameters for surface roughness.

Murat Tolga Ozkan et. al.; [14] carried out experiment in which 50CrV4 (SAE 6150) steel was subjected to machining tests with coated carbide and cermet cutting tool in turning operation. They carried out tests at various cutting speeds, feed rates and cutting depths. In the light of these parameters, cutting forces were surface roughness values were determined. Components of cutting forces were measured during the tests using a dynamometer, while the machined surface-roughness values were determined using a surface roughness measuring unit. The relations between the cutting force and the surface-roughness values were also defined. The forces were higher when machining the softer steel.

T. Sreenivasa Murthy et. al.; [15] investigated the optimal setting of process parameters which influences the surface roughness during the machining operation of EN41B alloy steel with cermet tool. Experiments were carried out by using taguchi design. They said that the surface roughness is considered as quality characteristics while the process parameters considered are speed, feed and depth of cut. The results of the machining experiments was used to characterize the main factors affecting surface roughness by ANOVA. A regression model was developed for surface roughness. The developed model is reasonably accurate and can be used of prediction within limits.

M. Aruna and V. Dhanlakshmi; [16] carried out turning operation on Inconel 718, a nickel based super alloy using cermet inserts. This paper was concerned with the optimization of the surface roughness. The approach is based on Response surface method (RSM). They developed second-order quadratic models for surface roughness, considering the cutting speed, feed and depth of cut as the cutting parameters, using central composite design. The machining parameters were optimized and been validated experimentally, and it was observed that the response values are in reasonable agreement with the predicted values. They concluded that cutting speed has the strongest effect on the surface roughness among the selected parameters and it is inversely proportional to response. They also found out that the surface roughness could be controlled in the design stage which is the most effective and inexpensive way.

Anshuman Das, S. K. Patel et. al.; [17] compared the performances of coated carbide and coated cermet inserts for varied machinability aspects throughout the machining of hardened steel (AISI 4340, 48 HRC) in the dry cutting surroundings. Cutting speed, feed, and depth of cut were thought of as major governing parameters. Work piece surface temperature, machining forces, and tool flank wear were taken as measures to check the performance estimation of various cutting inserts during this work. ANOVA, regression analysis, and main effect plots were accomplished using the MINITAB-16 software. Flank wear of both carbides and cermets was mainly influenced by cutting speed and feed. The coating helps in improvement of the performance of the cermet inserts. And also concluded that tool wear, cutting force, and temperature are less when coated cermets are used instead of uncoated carbides.

Anshuman Das, Saroj Kumar Patel et. al.; [18] investigated machinability and estimated cost during the finish dry turning of AISI 4340 steel with untreated and cryo treated cermet inserts. The input variables were optimized using response surface methodology (RSM) to evaluate the tool life for the economic analysis. Machining with optimal input parameters reduced the cost effectively.

Aminollah Mohammadi et. al.; [19] investigated the effects of cutting speed, feed rate, hardness and cutting tool material on cutting region temperature and surface finish in hard turning process. A L36 Taguchi's standard orthogonal array was applied as

experimental design. Machining tests were conducted under controlled conditions. AISI 4340 alloy steel which has numerous industrial applications was used to perform machining experiments. Main effects of the factors and their interactions are considered in this study using ANOVA (Analysis of variance) method. Also predictive models are derived by regression. Furthermore, optimal factor levels are obtained through S/N (signal to noise) ratio analysis in order to increase the machining efficiency. Workpiece hardness and other interactions do not exhibit significant effects on surface finish. They concluded that all factors and two-way interactions have significant effect on the cutting region temperature. Confirmation tests were conducted to verify the adequacy of predictive models. Optimal amount of factors were obtained through "signal to noise ratio (S/N) analysis. Plot of main effects showed that tool material and workpiece hardness dramatically influence the sensitivity of the system to noise in relationship to surface finish. Verification tests were conducted to confirm the validation of optimization process for surface roughness and cutting temperature.

R. Suresh, S. Basavarajappa et. al.; [20] investigated machinability on hardened AISI 4340 steel using coated carbide insert. An attempt has been made to analyze the influence of cutting speed, feed rate, depth of cut and machining time on machinability characteristics such as machining force, surface roughness and tool wear using response surface methodology(RSM) based second order mathematical models during turning of AISI 4340 high strength low alloy steel using coated carbide inserts. The experiments were planned as per full factorial design (FFD). The interaction plots suggest that employing lower cutting speed with lower feed rate can reduce tool wear. Chip morphology study indicates the formation of various types of chips operating under several cut-ting conditions. Analysis of variance has been carried out to check the adequacy of the proposed machinability models. They concluded that Based on the operating cutting conditions, various chips such as short broken irregular shaped, loose arc, continuous, long continuous tubular structured coiled and short saw toothed loose arc thick types are formed. The chip breaking is observed at high cutting speeds.

Ramanuj kumar, Ashok kumar Sahoo et. al.; [21] focused on investigation of flank wear, average roughness of surface and chip-tool interface temperature in the machine turning of heat treated AISI D2 grade tool steel using indexable multi-layer coated

carbide inserts. Response surface methodology (RSM) based models and Artificial-Neural-Network (ANN) models are implemented for forecasting the responses in hard-turning. Comparative assessment between actual and predicted results has been carried. ANN model for flank wear generated more accurate results compare to RSM Model whereas for surface finish and chip-tool interface temperature, the accuracy of RSM based prediction is more precise compared to ANN. They concluded that RSM based empirical relations have been made for responses flank wear, surface roughness and chip-tool interface temperature.

E. Aslan; [22] carried out experimental investigation of cutting tool performance in high speed cutting of hardened X210 Cr12 cold-work tool steel. The study explored the performance and wear behavior of different cutting tools in end milling of X210 Cr12 cold-work tool steel hardened to 62 HRC. The purpose of the experiments reported in this paper is to investigate the wear of TiCN coated tungsten carbide, TiCN + TiAlN coated tungsten carbide, and TiAlN coated cermet, mixed ceramic with Al2O3+ TiCN and cubic boron nitride (CBN) tools. Tool performance evaluation was based on the surface finish and tool flank wear. The highest volume of metal removal was obtained with CBN tool. The best cutting performance was obtained with CBN tool. Ceramic tool was not as good as CBN.

Manu Garg Munish Kainth et. al.; [23] determined the optimum process parameters during turning of CNC lathe of EN8 and EN24 steels using taguchi method and ANOVA. Cemented carbide coated tool insert was used in the dry condition and the combination of the optimal levels of the parameters was obtained. In study MRR and machining time is also analyze by using Taguchi approach. In order to study the performance characteristics in turning operation the Signal-to-Noise ratio and Analysis of Variance (ANOVA) were employed.

H. Aouici, H. Bouchelaghem et. al.; [24] investigated machinability in hard turning of AISI D3 cold work steel with ceramic tool using response surface methodology. The effects of cutting speed, feed rate, and depth of cut on surface roughness, cutting force, specific cutting force, and power in the hard turning were experimentally investigated. Analysis of variance is used to check the validity of the model. Experimental

observations show that higher cutting forces are required for machining harder work material. This cutting force gets affected mostly by feed rate followed by depth of cut. Feed rate is the most influencing factor on surface roughness. Optimum cutting conditions are determined using response surface methodology (RSM) and the desirability function approach. Verification experiments carried out show that the empirical models developed can be used for machining of AISID3 steel.

Ranganatih M. S., Vipin Harshit; [25] predicted surface roughness model for CNC turning of EN8 steel using response surface methodology. Manufacturing requires highly reliable models and methods for the prediction of output performance (surface roughness) in the machining process. The model was developed in the form of multiple regression equations correlating dependent parameter surface roughness, with cutting speed, feed rate and depth of cut, in a turning process. The box behnken design was used to plan the experiment.

A. V. N. L. Sharma, K. Venkatasuibbaiah et. al.; [26] discussed an investigation into the use of taguchi parameter design and regression analysis to predict and optimize the surface roughness and material removal rate in turning operation using CVD cutting tool. A set of experiments are conducted on the workpiece EN353 with CVD and PVD cutting tools to evaluate the effect of machining parameters such as speed, feed and depth of cut on surface roughness and material removal rate. Regression model is able to predict values for responses in comparison with experimental values within reasonable limits and Taguchi approach is used to obtain the optimal settings of these process parameters, finally ANOVA is used to analyze the influence of these cutting parameters during machining.

R. K. Suresh, P. Venkataramaiah et. al.; [27] experimentally investigated on turning of AISI 8620 alloy steel using PVD coated cemented carbide CNMG insert. The main focus of experimentation was to optimize the process parameters namely spindle speed, feed and depth of cut for desired response characteristics i.e. surface roughness, VMRR, and interface temperature. To study the performance characteristics orthogonal array, ANOVA and analysis of means (ANOM) were employed. The experiment was carried

out on AISI 8620 alloy steel. Taguchi design is an effective way in finding optimal process parameters.

2.3 Literature Mapping:

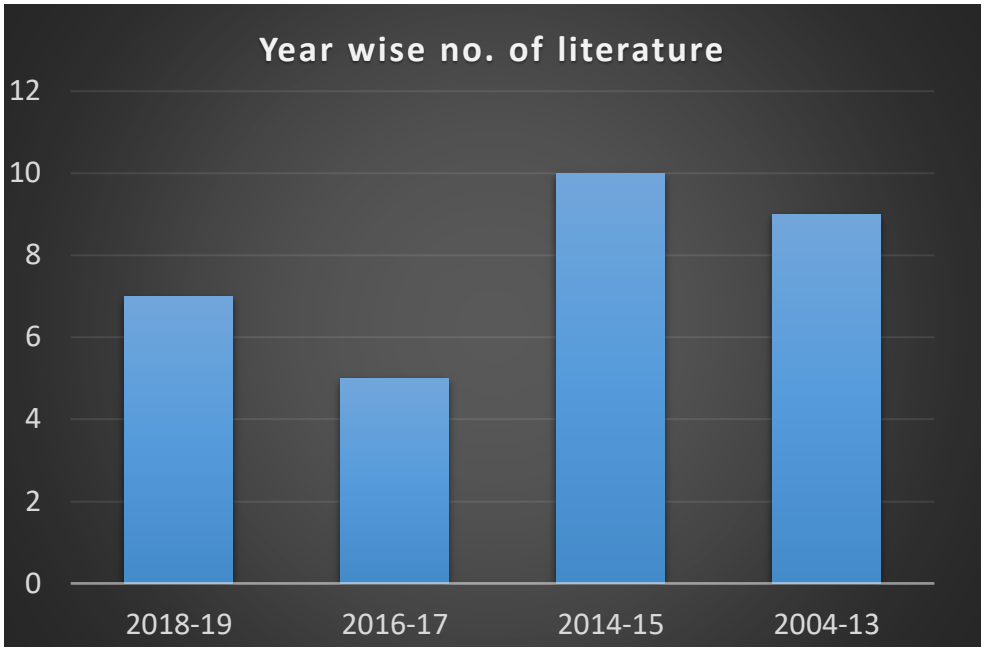

Figure 2.1: Year Wise No. of literature

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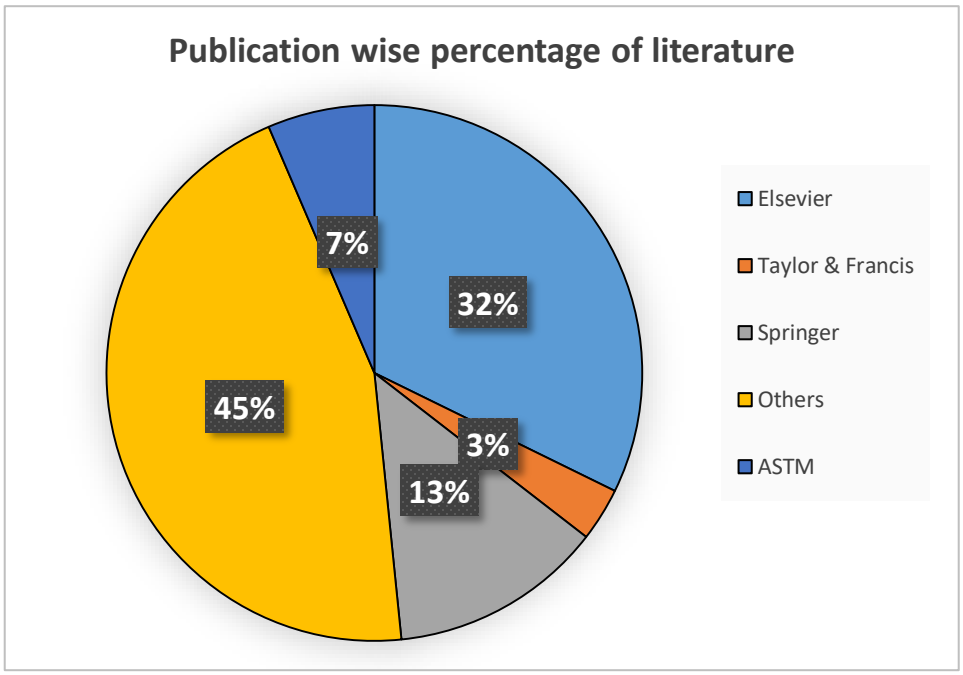

Figure 2.2: Publication Wise % of literature

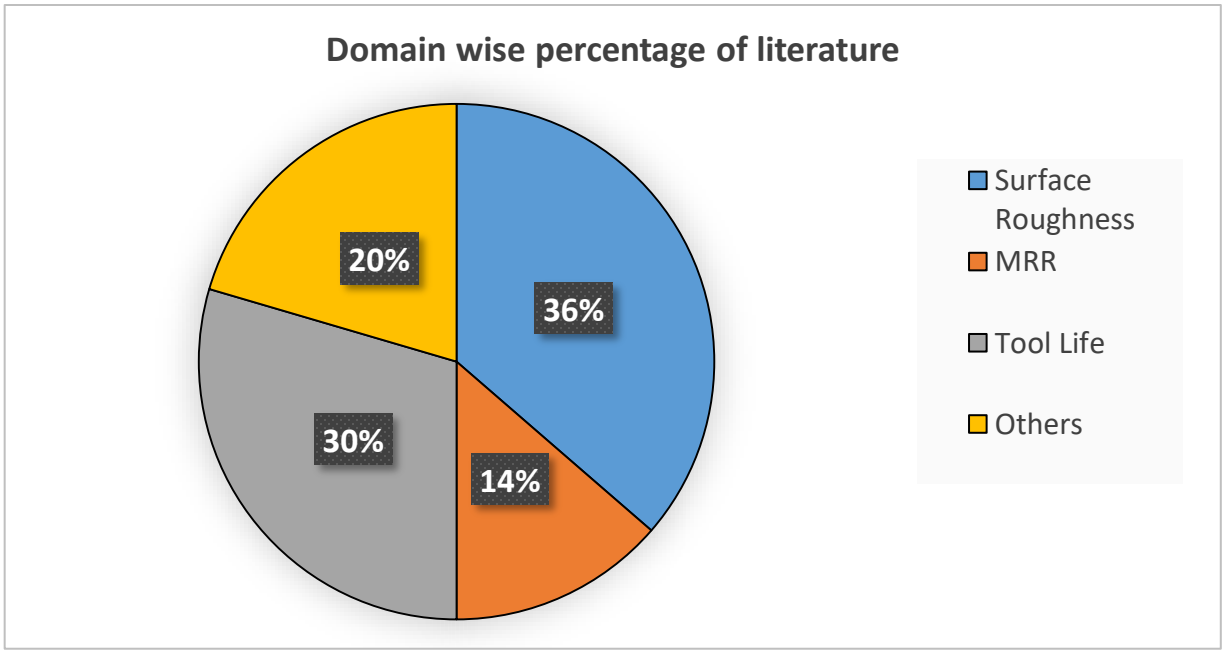

Figure 2.3: Domain Wise % of literature

2.4 Literature Summary:

From the above referred literature review, literature summary is described below:

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- Turning operation is done on various types of materials like SS304, carbon steel, D2, D3, OHNS, H11, etc.
- With priority analysis most affecting parameters on Material Removal Rate (MRR), and surface roughness are cutting speed, feed rate, and depth of cut (DOC).
- Minimum surface roughness is obtained at low feed rate, high cutting speed and low depth of cut.
- The cutting speed has the most dominant effect on the tool life during machining.
- Machining with optimal input parameters reduced the cost effectively.
- Surface roughness is inversely proportional to depth of cut.

2.5 Objectives:

1) To identify the most affecting cutting parameters on surface roughness and material removal rate of turning operation of D2 steel while using cermet insert.
2) To identify process parameters which gives maximum tool life.
3) To investigate the tool life of cermet insert by turning operation on D2 steel.
4) To evaluate MRR and surface roughness value of cermet insert by turning on D2 steel.

CHAPTER 3

METHODOLOGY

The Showcased below are the step followed during the entire dissertation:

1. **Selection of proper work material and checking the feasibility of it during turning on it:**

   Before carrying out turning operation selection of proper workpiece is an important criteria that should be fulfill. Workpiece was selected on the basis of chemical requirements mentioned in Standard Specification for tool steel Alloy.

2. **Selection of input and output process parameters for getting easiness in manufacturing and reducing the cost of product:**

   Based on various literature papers referred we got idea about the most affecting input parameters over various output parameters.

3. **Selection of process parameters range:**

   After selection of process parameters its range is to be identified. According to ASM specialty handbook the cutting parameters range was identified accordingly.

4. **Create design of experiment for the checking of input parameters:**

   Based on input parameters and output parameters and the range selected for machining design of experiment is to be done. With the help of ISO 3685:1993 the design of experiment was carried out accordingly to the requirement.

5. **Creating programming for turning operation:**

   After all the parameters being set and after the design of experiment. Programming is to be done with necessary outcome results and appropriate programming is to be done for machining to carry out turning operation based on the input parameters selected.

6. **Perform the experiments respectively using the selected values of input parameters:**

   Next step after creating programming turning operation is to carry out machining over the selected values and for different time intervals. All the time intervals is been noted

to check it with analytical calculation carried out and to check for actual difference in time intervals.

7. **Testing for tool wear:**

   After turning operation is been finished and machining is been done. The corners of insert is been tested in optical microscope for finding out the width of flank wear generated due to machining over the surface of the insert.

8. **Checking for surface roughness value:**

   After tool wear is been calculated, its surface is to be checked and it was required as an output parameter. Surface roughness was measured using surface roughness tester SJ-210.

9. **Calculating material removal rate after machining:**

   This is the required output parameter which is to be calculated mathematically. Based on the mathematical formula available for calculating MRR, for every different set of parameters it is been calculated.

10. **Check for the optimum value satisfying material removal rate and surface roughness:**

    After getting all the output values based on calculations and testing facilities carried out. All the values are compared with each other to find the best suitable input parameter for getting required output value.

The figure 3.1 shows the flowchart of the entire work done during the entire dissertation project study respectively.

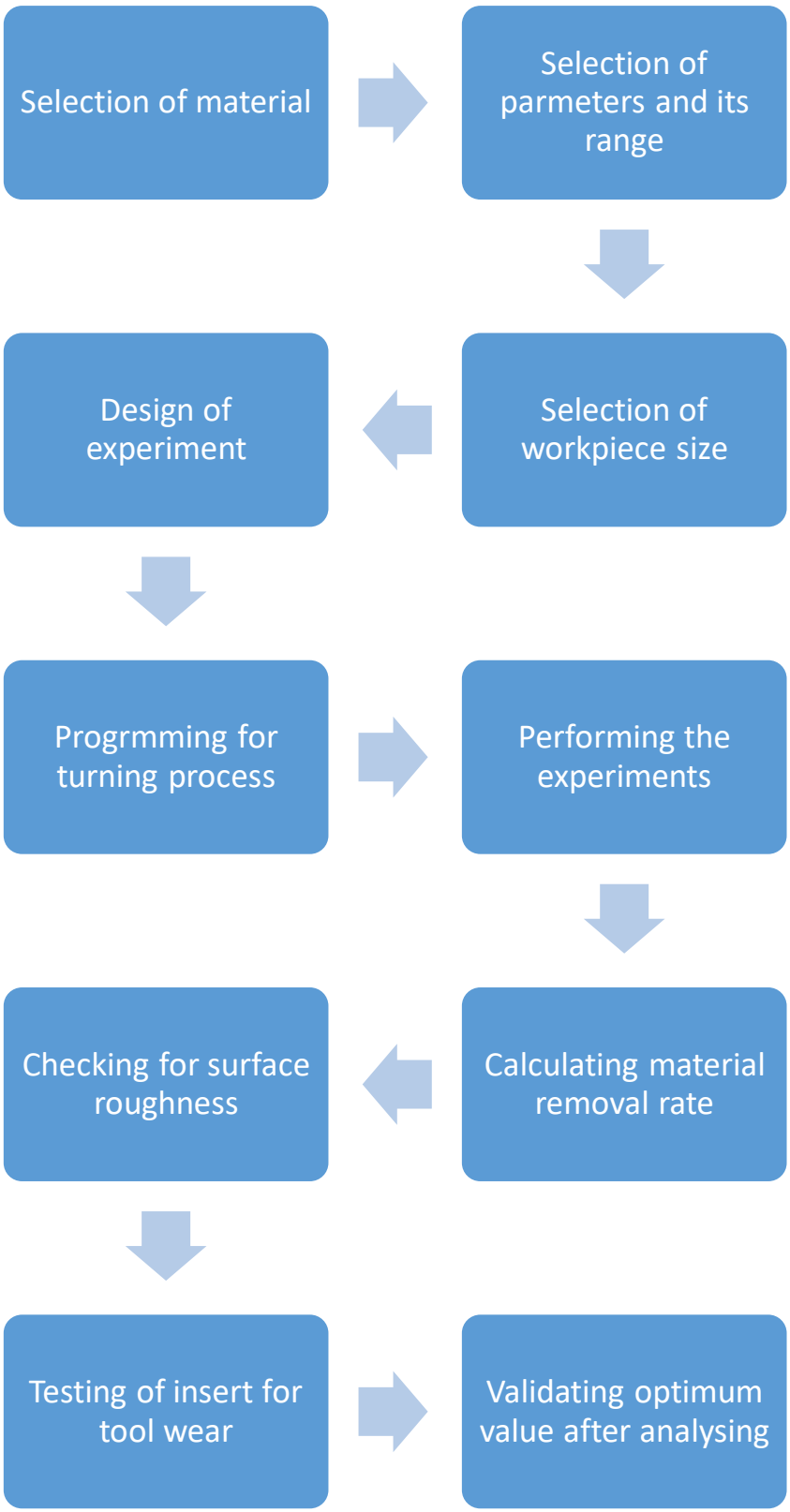

Figure 3.1 Flow chart of followed methodology

CHAPTER 4

DESIGN OF EXPERIMENT

After analyzing the literature and establishing the most dominant affecting parameter are shown in table below:

Table 4.1: Process Parameters

Input Parameters	Output Parameters
• Cutting Speed • Feed Rate • Machining time • Depth of cut	• Tool life • Surface roughness • Material Removal Rate

After selection of process parameters, range is to be identified for experimentation. Based on ASM Specialty handbook for tool material range of process parameters is selected.

Table 4.2: Process Parameters and its range [28]

Level Factors	Selected parameters	Range			
1.	Cutting Speed	100m/min	150m/min	200m/min	
2.	Feed Rate	0.2mm/rev			
3.	Depth of Cut	0.5mm max.			
4.	Machining Time	9min	15min	20min	25min

Based on range of parameter been selected design of experiment was carried out according to ISO3685:1993.

Experimental design is shown in table as follows:

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Table 4.3: Design of experiment [26, 28]

Sr. No.	Cutting Speed (m/min)	Feed Rate (mm/rev)	Depth of cut (mm)	Machining time (min)
1.	100	0.2	0.5	25
2.	100	0.2	0.5	20
3.	100	0.2	0.5	15
4.	150	0.2	0.5	25
5.	150	0.2	0.5	20
6.	150	0.2	0.5	15
7.	200	0.2	0.5	25
8.	200	0.2	0.5	20
9.	200	0.2	0.5	9

CHAPTER 5

EXPERIMENTAL SETUP AND WORK

5.1 CNC Machine:

CNC machine is the automated control of machining tools. A CNC machine processes a piece of material to meet the required specifications by following a coded programmed instructions and without a manual operator. It is a motorized maneuverable tool and mostly a motorized maneuverable platform, which are controlled by computer, according to the specific input applied instructions.

Instructions are delivered to a CNC machine in the form of a sequential program of machine control instructions followed by G-code and M-code, and then it is executed. The program can be written by a person or far, mostly generated by graphical CAD software.

Experiment is to be conducted on DX 150 computerized numerical control machine. DX 150 is high performance machine suitable for varied application, with rigid headstock and spindle, hydraulic chucking, and with 90^{o} vertical unique structure.

Figure 5.1: DX 150 CNC M/c

- Specifications of DX150 CNC machine:

  The specification of DX150 CNC machine are shown below:

Table 5.1: Specifications of DX150 CNC machine

Description	Units	Values
Weight	Kg	3000
Dimension length	Mm	1950
Width	Mm	1375
Height	Mm	1950
Tailstock		
Quill diameter	Mm	75
Quill stroke	Mm	100
Thrust adjustable	Kgf	300
Turret		

No. of Station		8
Max. boring bar diameter	Mm	32
Tool size	Mm	20*20
Slides		
X axis travel	Mm	150
Z axis travel	Mm	350
Rapid feed rate (X&Z axis)	m/min	24
Main Spindle		
Spindle motor power	Kw	10.5/7
Spindle bore	Mm	50
Spindle nose		A2 5
Max bar capacity	Mm	38
Spindle speed range	Rpm	50-4500

5.2 Tool insert:

Insert used for performing the experiment is of Kyocera Company.

Specification of Cermet insert:

Table 5.2: Specification of cermet insert

Part Number	TNMG160408HQ
Material type	TN6020

- Part No specification:

  T – Triangle

  N - Relief angle 0 degree

  M - Corner height, thickness

  G – Hole (Yes), two sides

  16 – Edge length symbol

  04 – Thickness symbol

  08 – Corner symbol

HQ – Manufacturers option

Figure 5.2: Cermet insert

5.3 Selection of workpiece for turning:

Size of workpiece is selected that it should maintain L/D ratio as per ISO3685:1993 (As per ISO3685:1993 – The length/Diameter ratio greater than 10 is not recommended) Different sizes of workpiece material selected are as follows:

Table 5.3: Sizes of workpiece

Sr. No.	Cutting Speed (m/min)	Size of workpiece (Diameter X Length in mm)	Quantity (Nos.)
1.	100	50 x 250	1
2.	150	60 x 250	1
3.	200	60 x 250	1

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5.4 Analytical Calculation for turning operation:

After workpiece material dimensions was selected. Calculations has to done according to given parameters for carrying out turning operations. Based on this analytic calculations was carried out to calculate rpm required while machining and to check for no. of pass it will occur while machining workpiece for over a time interval of 25min, 20min, 15min and 9min.

Based on the all the parameters considered analytical calculation for cutting speed 100m/min and for time internal 25min is as follows:

Table 5.4: Analytical Calculations for cutting Speed 100m/min and time interval 25min

Pass a	L b	Length c	Diameter d	Rpm e	Feed (mm/min) (f=0.2*e)	Time (g=b/f)	time (sec) (h=g*60)	Cumulative time
1	240	240	58.5	1088.239	217.6478	1.102699	66.16194	1.102699
2	240	480	58	1097.62	219.5241	1.093274	65.59645	2.195973
3	240	720	57.5	1107.165	221.433	1.083849	65.03097	3.279823
4	240	960	57	1116.877	223.3754	1.074425	64.46548	4.354247
5	240	1200	56.5	1126.761	225.3521	1.065	63.89999	5.419247
6	240	1440	56	1136.821	227.3642	1.055575	63.33451	6.474822
7	240	1680	55.5	1147.063	229.4125	1.04615	62.76902	7.520973
8	240	1920	55	1157.49	231.4981	1.036726	62.20353	8.557698
9	240	2160	54.5	1168.11	233.6219	1.027301	61.63805	9.584999
10	240	2400	54	1178.926	235.7851	1.017876	61.07256	10.60288
11	240	2640	53.5	1189.943	237.9887	1.008451	60.50707	11.61133
12	240	2880	53	1201.169	240.2339	0.999026	59.94159	12.61035
13	240	3120	52.5	1212.609	242.5218	0.989602	59.3761	13.59995
14	240	3360	52	1224.269	244.8538	0.980177	58.81061	14.58013
15	240	3600	51.5	1236.155	247.231	0.970752	58.24513	15.55088
16	240	3840	51	1248.274	249.6548	0.961327	57.67964	16.51221

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17	240	4080	50.5	1260.633	252.1266	0.951903	57.11415	17.46411
18	240	4320	50	1273.24	254.6479	0.942478	56.54867	18.40659
19	240	4560	49.5	1286.101	257.2201	0.933053	55.98318	19.33964
20	240	4800	49	1299.224	259.8448	0.923628	55.41769	20.26327
21	240	5040	48.5	1312.618	262.5236	0.914203	54.85221	21.17748
22	240	5280	48	1326.291	265.2582	0.904779	54.28672	22.08225
23	240	5520	47.5	1340.252	268.0504	0.895354	53.72123	22.97761
24	240	5760	47	1354.51	270.902	0.885929	53.15575	23.86354
25	240	6000	46.5	1369.075	273.815	0.876504	52.59026	24.74004
26	240	6240	46	1383.956	276.7912	0.86708	52.02477	25.60712

As we can see from above table no of passes to achieve time interval of 25mins is 26 and it will require an rpm of 1385 for machining.

Similarly for different time interval and different cutting speed analytical calculations was carried out before experimentation.

5.5 Surface roughness tester:

Surface roughness tester was used for measurement of surface of workpiece after machining by MITUTOYO SJ-210 Company.

Surface roughness was carried out in host institute.

Figure 5.3 Surface roughness Tester [32]

Table 5.5: Specifications of Surface Roughness Tester

Specifications	
Model	**MITUTOYO SJ-210**
Measuring Motion	Start measuring from detector retracted state
Measuring Range	200 µm to 150 µm
Stylus Tip Radius	2 µm
Measuring Force	0.75 MN
Stylus Tip Material	Diamond

5.6 Experimental Setup:

Figure 5.4: Workpiece setup

5.7 CNC Program:

- Below shown programming is of a flat round D2 steel material bar which is being machined on CNC m/c having length of 240 mm and outer diameter of 48mm and is being machined for 25 minutes till inner diameter 41mm having cutting speed of 100 m/min and spindle speed having 1384 rpm.

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- CNC program for experimental work having cutting speed 100m/min and time interval 25mins. Is as follows:
- N10 G90 G53 G64 G71 G95;
  N20 M03;
  N30 G96 S100 LIMS=1384 M03;
  N40 T1;
  N50 M16 D1;
  N60 M08;
  N70 G00 X50.5 Z2;
  N80 X48;
  N90 G01 Z-240 F0.2;
  N100 G00 X50 Z2;
  N110 X47.5;
  N120 G01 Z-240;
  N130 G00 X49.5 Z2;
  N140 X47;
  N150 G01 Z-240;
  N160 G00 X49 Z2;
  N170 X46.5;
  N180 G01 Z-240;
  N190 G00 X48.5 Z2;
  N200 X46;
  N210 G01 Z-240;
  N220 G00 X48 Z2;
  N230 X45.5;
  N240 G01 Z-240;
  N250 G00 X47.5 Z2;
  N260 X45;
  N270 G01 Z-240;
  N280 G00 X47 Z2;
  N290 X44.5;

N300 G01 Z-240;

N310 G00 X46.5 Z2;

N320 X44;

N330 G01 Z-240;

N340 G00 X46 Z2;

N350 X43.5;

N360 G01 Z-240;

N370 G00 X45.5 Z2;

N380 X43;

N390 G01 Z-240;

N400 G00 X45 Z2;

N410 X42.5;

N420 G01 Z-240;

N430 G00 X44.5 Z2;

N440 X42;

N450 G01 Z-240;

N460 G00 X44 Z2;

N470 X41.5;

N480 G01 Z-240;

N490 G00 X43.5 Z2;

N500 X41;

N510 G01 Z-240;

N520 G00 X43 Z2;

N530 X200 Z150;

N540 M05;

N550 M30;

- Experiments are performed with turning of D2 steel at 100m/min cutting speed, 0.2mm/rev feed rate and 0.5mm depth of cut.
- This experiment is repeated for every time intervals using different corners of cermet insert.

Figure 5.5: Turning Operation

5.8 Experimental procedure for different cutting speed:

- Every workpiece was reduced by 1.5mm for smooth surface and through rotation.
- For cutting speed 100 m/min:
  - Size of workpiece diameter 48.5mm X 250mm length.
  - Initially turning process is carried out for 25 min and upto 240 mm length.
  - Next operation is performed for 20 min and upto 220mm length.
- Now time is reduced to 15 min and upto 200mm length.
- For cutting speed 150 m/min:
  - Size of workpiece diameter 58.5mm X 250mm length.
  - Initially turning process is carried out for 25 min and upto 240 mm length.
  - Next operation is performed for 20 min and upto 220mm length.
- Now time is reduced to 15 min and upto 200mm length.
- For cutting speed 200 m/min:
  - Size of workpiece diameter 58.5mm X 250mm length.
  - Initially turning process is carried out for 25 min and upto 240 mm length.
  - Next operation is performed for 20 min and upto 220mm length.
  - Now time is reduced to 9 min and upto 200mm length.
- Figure 5.6 shown is of workpiece after machining.

- First round bar shows machining at 100m/min cutting speed, second of 150m/min cutting speed whereas third round bar indicates machining at 200m/min cutting speed.

Figure 5.6: Workpiece after Machining

5.9 Material Removal Rate:

MRR is the amount of material removed in the form of swarf (chips in North America) from the workpiece per unit of time.

MRR denotes the cutting speed of machining of workpiece.

High machining rate is always required because it is directly related to productivity.

Unit of Material removal rate is mm^3/min.

Mathematically MRR can be shown as,

$$MRR = vfd$$ [31]

Where, v = Cutting Speed

f = Feed Rate

d = Depth of Cut

Depth of Cut (d) is given by,

$$d = \frac{do - di}{2}$$

Where, d_o = Outer Diameter

d_i = Inner diameter

Here, considering process parameters selected for calculating MRR,

For e.g. consider cutting speed 100m/min, feed rate as 0.2mm whereas diameter before and after machining as 48.5 mm and 41 mm respectively.

MRR can be calculated as,

$$MRR = vfd$$

$$= 100 \text{ X } 0.2 \text{ X } (48.5\text{-}41)/2$$

$$= \mathbf{75 \text{ X } 10^3 \text{ mm}^3/\text{min}} \qquad [1m= 1000mm]$$

Based on above calculation, MRR can be calculated for every process parameters selected

We calculated MRR for all the dimensions listed in table 5.6.

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Table 5.6: Material Removal Rate Calculations

Machining Time	Cutting Speed, v (m/min)	Feed Rate, f (mm/rev)	Outer Diameter, d_o (mm)	Inner diameter, d_i (mm)	Depth of cut, $d=(d_o-d_i)/2$ (mm)	MRR (mm^3/min)
25 min	100	0.2	48.5	41	3.75	$75X10^3$
20 min	100	0.2	41	33	4	$80X10^3$
15 min	100	0.2	33	24.5	4.25	$85X10^3$
25 min	150	0.2	58.5	49	4.75	$142.5X10^3$
20 min	150	0.2	49	39	5	$150X10^3$
15 min	150	0.2	39	28	5.5	$165X10^3$
25 min	200	0.2	58	46.5	5.75	$230X10^3$
20 min	200	0.2	46.5	31.5	7.5	$300X10^3$
9 min	200	0.2	31.5	20	5.75	$230X10^3$

As we can see from above table that MRR continuously increases with increase in cutting speed.

Also Maximum MRR for different speed is attained at cutting speed of 200 m/min for every time interval.

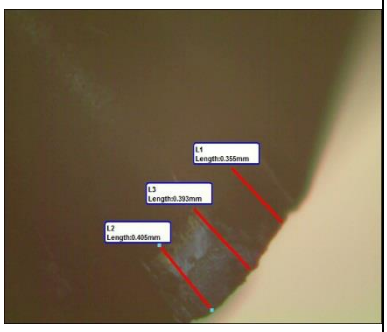
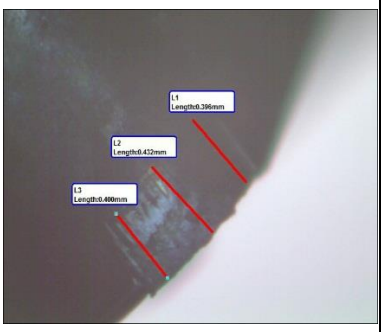
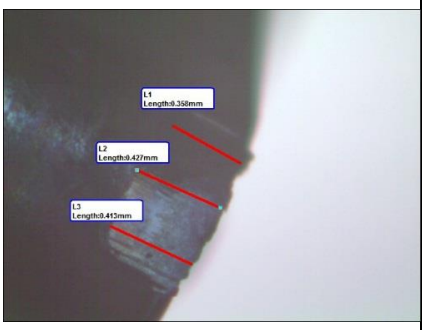
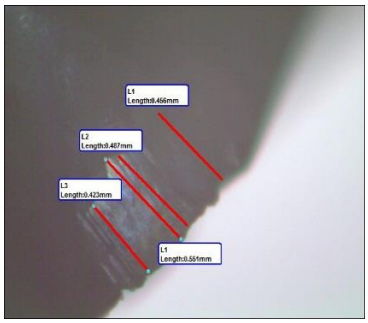
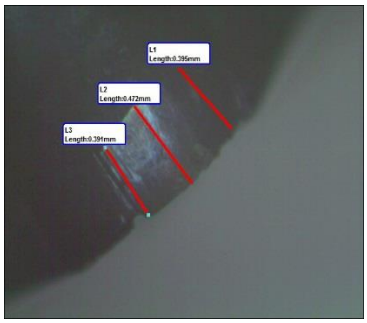
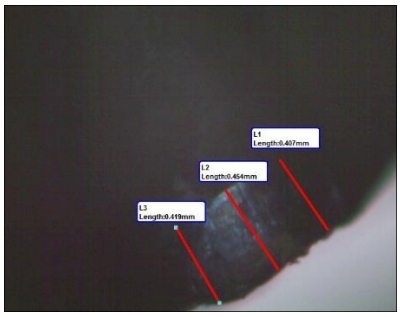
5.10 Tool life:

For analyzing tool life, tool wear has to be found out by using testing instrument.

Tool wear was captured by using optical microscope available in testing laboratory. They had lenses ranging from 5x to 1000x.

According to ISO 3685:1993 for calculating tool life graph of flank wear (V_b) is to be plotted against machining time as shown in figure 5.7.

Flank wear of different cutting speed at different machining time is shown in figure 5.7.

Cutting Speed = 100m/min		
Wear at 25min	Wear at 20min	Wear at 15min
		
Cutting Speed = 150m/min		
Wear at 25min	Wear at 20min	Wear at 15min
		
	Cutting Speed 200m/min	

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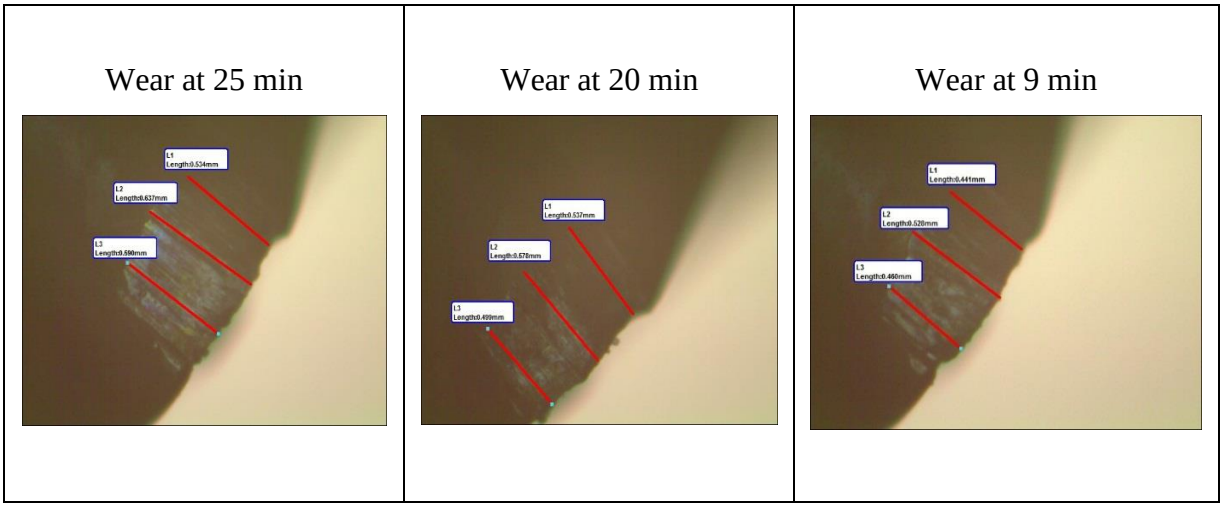

Figure 5.7: Flank Wear at Different Cutting Speed

As captured with the help of optical microscope, tool distant points were taken one at the edge and other till the wear occurred over insert.

Three to four different wear length was marked to calculate the maximum flank wear occurred.

Maximum flank wear occurred over different insert is shown in table below:

Table 5.7: Maximum Flank wear width observed

Sr. No.	Cutting Speed (m/min)	Machining Time (min)	Flank Wear V_b (mm)
1.	100	25	0.445
2.		20	0.432
3.		15	0.427
4.	150	25	0.551
5.		20	0.472
6.		15	0.454

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7.	200	25	0.637
8.		20	0.578
9.		9	0.460

According to ISO 3685:1993 graph of width of flank wear with respect to machining time was plotted as shown in figure below:

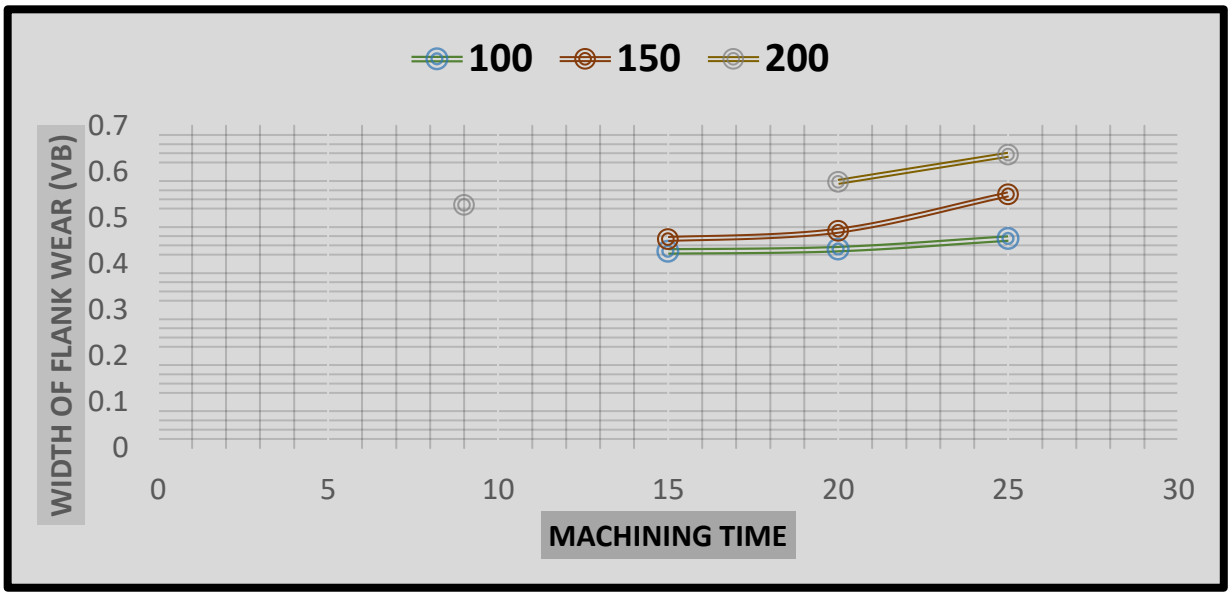

Figure 5.8: Flank Wear Vs Machining Time

- Tool life criterion for cermet insert is 0.6.
- So, the line which crosses or touches the 0.6 criterion point gives us the tool life for this insert.
- As we see from figure that 200m/min touches the criterion point at 22.5 minutes.
- Whereas, if we go increasing the machining time for cutting speed 100m/min as well as for 150m/min it will touch the criterion point.
- As on extending line it touches the criterion line at 53.5 min and 26 min respectively.
- According to Taylor's tool life equation $VT^n = C$, to find the values of constant "n" and constant "C" logarithmic chart is to be plotted to calculate values of n and C.

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- As we calculated tool life for cermet insert and we also had different cutting speed, logarithmic values of it are taken to plot values in chart as shown in figure 5.9.
- Table below shows the calculated logarithmic values of cutting speed and tool life.

Table 5.8: Logarithmic Values

Cutting Speed (v)	Tool life (T)	Log(v)	Log(T)
100	53.5	2	1.7284
150	26	2.1761	1.415
200	22.5	2.301	1.3522

- Based on logarithmic values of cutting speed and tool life, logarithmic scale chart is been plotted according to ISO3685:1993

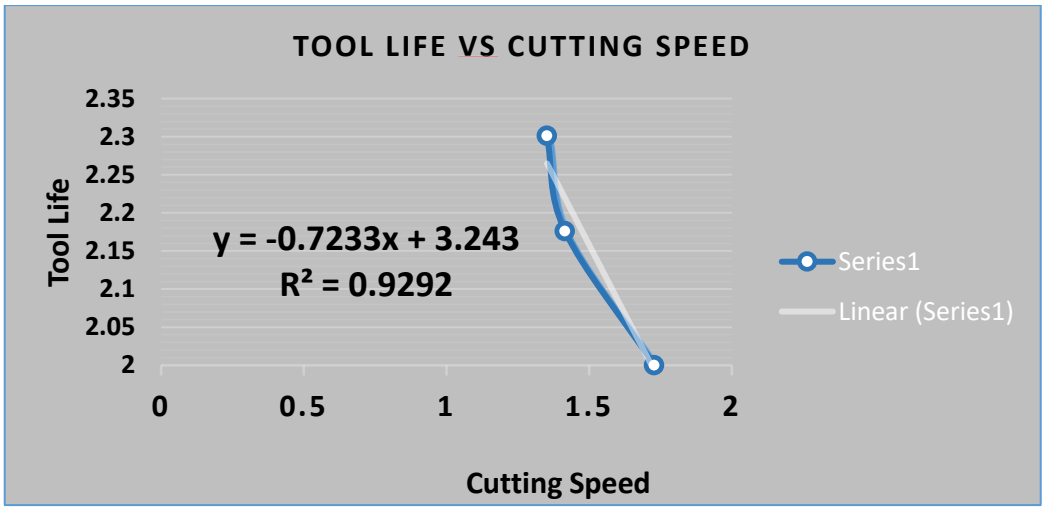

Figure 5.9: Logarithmic scales (Tool life vs Cutting Speed)

- As we can see from figure 5.9 slope of line denotes the value of constant "n" whereas the value of constant "C" is given by the point at which it touches Y axis.
- We can conclude from figure 5.9 that values of constant "n" and "C" are 0.723 and 1749.85 respectively.

5.11 Surface Roughness:

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- Surface roughness is usually referred to as roughness, and is also a component of surface texture.
- Surface roughness can be quantified by the direction of the normal vector of real surface from its original ideal form.
- If the deviations are small, then we can say that the surface is smooth, whereas if the deviations are high then we can say that the surface is rough.
- Surface roughness plays major role in prediction of how a real object will interact with its surrounding environment.
- Roughness is always a good predictor of performance of mechanical component.
- High roughness value is always undesirable because it may be costly to control surface roughness from manufactured parts.
- Decreasing the surface roughness, usually increases manufacturing cost.
- Surface roughness was measured using instrument Surface roughness tester of Mitutoyo company model SJ 210.
- Surface roughness tester setup is shown in figure 5.10

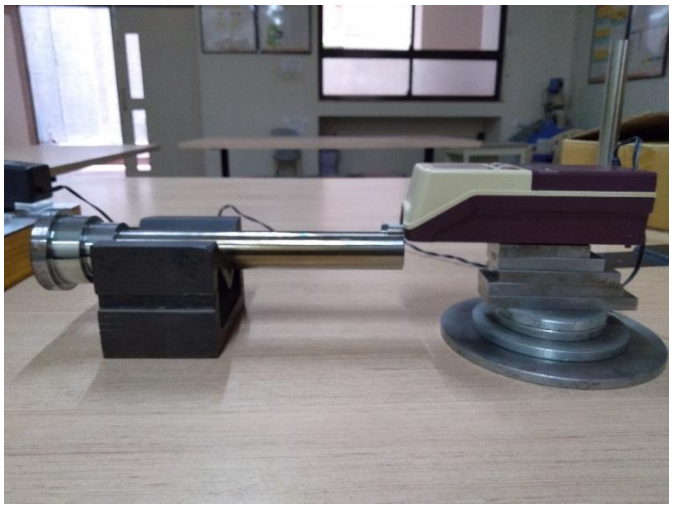

Figure 5.10: Surface roughness Setup

- Below shown figure was captured with close view of tip touch to the workpiece.

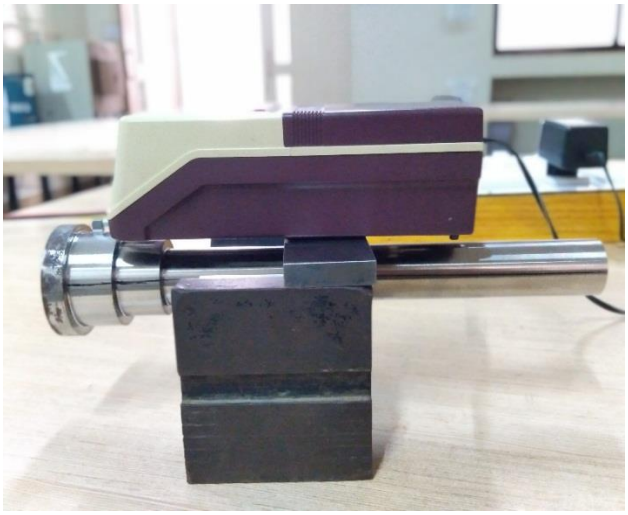

Figure 5.11: Close view of tip touch of roughness tester

- Figure was captured while taking noting down and taking readings from surface roughness tester while measuring surface roughness.

Figure 5.12: Checking and noticing Surface roughness value

- Below shown table are the results obtained while measuring surface roughness using roughness tester:

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Table 5.9: Average Surface Roughness

Cutting Speed = 100 m/min	
15 min	2.1225 μm
20 min	2.835 μm
25 min	3.1525 μm
Cutting Speed = 150 m/min	
15 min	1.98 μm
20 min	2.4775 μm
25 min	3.04 μm
Cutting Speed = 200 m/min	
9 min	1.6925 μm
20 min	3.875 μm
25 min	2.315 μm

- As we can see from above table that average surface roughness value we obtained for cutting speed 100m/min and for machining time intervals 15min, 20min and 25min are 2.1225 μm, 2.835 μm and 3.1525 μm respectively.
- For cutting speed 150m/min average surface roughness value we obtained for machining time intervals 15min, 20min and 25min is 1.98 μm, 2.4775 μm and 3.04 μm respectively.

- At last for cutting speed 200m/min average surface roughness value we obtained for machining time intervals of 9min, 20min and 25min is 1.6925 μm, 3.875 μm and 2.315 μm respectively.

CHAPTER 6

RESULTS AND DISCUSSION

- All the output parameters was calculated as shown in chapter 5.
- Below shown table 6.1 shows the effect of input parameters over output parameters.

Table 6.1: Effects of input parameters over output Parameters

Cutting speed (m/min)	Feed (mm/rev)	Depth of cut (mm)	Machining time (min)	Tool life (minutes)	Average Surface Roughness (μm)	MRR (mm^3/min)
100	0.2	0.5	25	53.5	3.1525	$75X10^3$
	0.2	0.5	20		2.835	$80X10^3$
	0.2	0.5	15		2.1225	$85X10^3$
150	**0.2**	**0.5**	**25**	**26min**	**3.04**	**$142.5X10^3$**
	0.2	**0.5**	**20**		**2.4775**	**$150X10^3$**
	0.2	**0.5**	**15**		**1.98**	**$165X10^3$**
200	0.2	0.5	25	22.5min	2.315	$230X10^3$
	0.2	0.5	20		3.875	$300X10^3$
	0.2	0.5	9		1.6925	$230X10^3$

- As we calculated tool wear on results we can say tool life at considered cutting speed.
- Tool life obtained for cutting speed 100m/min, 150m/min, 200m/min is 53.5min, 26min and 22.5min respectively.

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- According to Taylor life equation we obtained value for n and C as 0.723 and 1749.85 respectively.
- As we can notice from obtained results that optimum value for good surface finish is obtained at cutting speed 150m/min.
- Obtained surface roughness value for different machining time is for 25 min, 20 min, and 15 min is 3.04µm, 2.475µm, 1.98µm respectively.
- MRR continuously increases wit increase in cutting speed and we can indicate that MRR is directly proportional to cutting speed. Higher the cutting speed, higher is the MRR, and vice versa.
- Good surface requirement is majorly concerned in now a day's arena. We observe hat optimum surface finish is obtained at cutting speed 150m/min, followed by MRR142.5X10^3, 150X10^3 & 165X10^3, respectively for machining time having surface finish of 3.04µm, 2.475µm, and 1.98µm.

CHAPTER 7

CONCLUSION AND FUTURE SCOPE

7.1 Conclusions:

- From the above dissertation work we can concluded some that suggestions were given to the industry about the selection of input parameters range for doing the analyzation of tool life. The following conclusions can be made listed below:
- The most affecting parameter or we can say the influence parameters while turning operation which has been used in manufacturing department are cutting speed (v) which affects tool life.
- All the project work is carried out according to ISO 3685:1993, Standard specifications of tool steel alloy and ASM specialty handbook for tool materials.
- With the help of ISO 3685:1993 tool life was calculated and been validated by optical microscope.
- Tool life obtained for various cutting speed is 53.5min, 26min and 22.5min respectively
- Obtained surface roughness value for different machining time is for 25 min, 20 min, and 15 min is 3.04µm, 2.475µm, 1.98µm respectively.
- MRR continuously increases with increase in cutting speed and we can indicate that MRR is directly proportional to cutting speed. Higher the cutting speed, higher is the MRR, and vice versa.
- Good surface requirement is majorly concerned in now a day's arena. We observe hat optimum surface finish is obtained at cutting speed 150m/min, followed by MRR142.5X10^3, 150X10^3 & 165X10^3, respectively for machining time having surface finish of 3.04µm, 2.475µm, and 1.98µm.

- We can conclude at cutting speed 100m/min MRR and surface finish can be achieved and their values also can be recommended for usage.

7.2 Future Scope:

- Various inserts like CBN, ceramic, etc. can be used.
- Input parameters like temperature, cutting force, tool nose radius can be considered for machining.
- Tool life of different insert can be compared with each other while turning operation of workpiece material.
- Coated cermet can be compared for validation of tool life with uncoated cermet.
- Instead of machining under dry conditions, coolant can be used.

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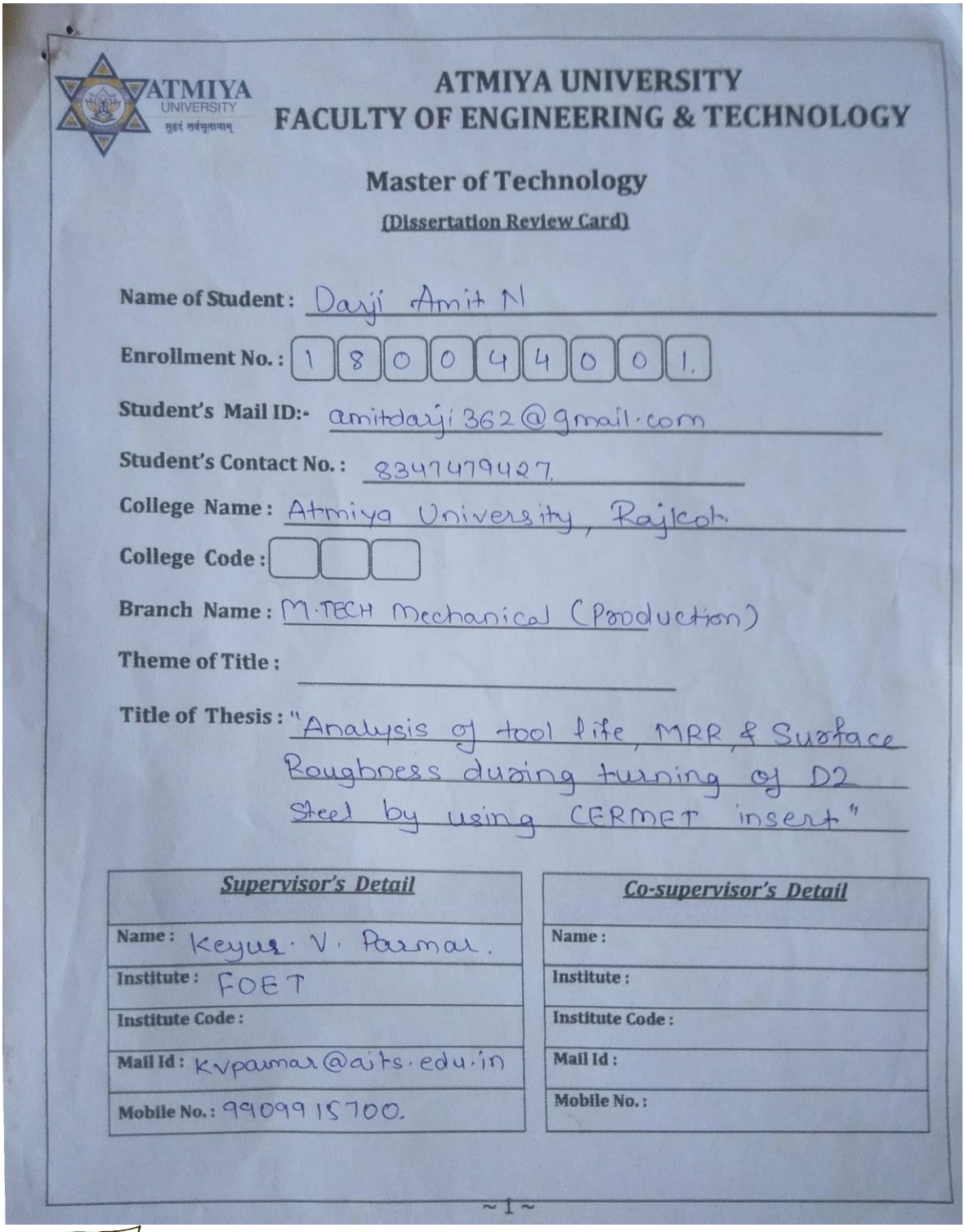
Appendix A: Review Card



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सुखं सर्वभूतानाम्

ATMIYA UNIVERSITY
FACULTY OF ENGINEERING & TECHNOLOGY

Master of Technology

(Dissertation Review Card)

Name of Student : Dayji Amit N

Enrollment No. : 1 8 0 0 4 4 0 0 1.

Student's Mail ID:- amitdayji362@gmail.com

Student's Contact No. : 8347479427.

College Name : Atmiya University, Rajkot.

College Code :

Branch Name : M.TECH Mechanical (Production)

Theme of Title :

Title of Thesis : "Analysis of tool life, MRR & Surface Roughness during turning of D2 Steel by using CERMET insert"

Supervisor's Detail	
Name :	Keyur V. Parmar.
Institute :	FOET
Institute Code :	
Mail Id :	kvparmar@aits.edu.in
Mobile No. :	9909915700.

Co-supervisor's Detail	
Name :	
Institute :	
Institute Code :	
Mail Id :	
Mobile No. :	

~1~

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❖ **Comments For Internal Review ( ) (Semester 3)**

Exam Date : 25/09/'19

Sr. No.	Comments given by Internal review panel (Please write specific comments)	Modification done based on Comments
1.	Study fandeamentals of CNC turning process.	— done —
2.	Exhaustive literature review is needed.	Doing it in regular interval.
3.	Refer Standered Journals and Data book for process parameters and material properties.	ASTM and ASM standerds used for his study.

(Guide Sign.)

Particulars	Internal Review Panel	
	Expert 1	Expert 2
Name :	Shivang · S · Jani	Pratik · P · Kikani
Institute :	FOET	FOET
Institute Code :	–	–
Mobile No. :	8000322128	9879858594
Sign :		

Particulars	Internal Guide Details	
	Expert 1	Expert 2
Name :	Keyur · V · Parmar	
Institute :	FOET	
Institute Code :		
Mobile No. :	9909915700	
Sign :		

~2~

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Enrollment No. of Student : 1 8 0 0 4 4 0 0 1

❖ Comments of Dissertation Phase-1 (18MMEPDC305 (Semester 3)

Exam Date : 12 / 10/ '19

Title : "Analysis of tool life, MRR & Surface Raughness during turning of D2 steel by using CERMET inseat"

1. Appropriateness of title with proposal. (Yes/ No) Yes
2. Whether the selected theme is appropriate according to the title ? (Yes / No) Yes
3. Justify rational of proposed research. (Yes/ No) Yes
4. Clarity of objectives. (Yes/ No) Yes.

~3~

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Enrollment No. of Student : 1 8 0 0 4 4 0 0 1

Exam Date : 12/10/19

Sr. No.	Comments given by External Examiners (DP-I) : (Please write specific comments)	Modification done based on Comments
–	To Identify the Research parameters as per standard experiment – literature review is to be ~~reviewed~~ improve.	Research parameters Identified. – done.

5/3/20.
(Internal Guide Sign.)

- *Approved* ☐
- *Approved with suggested recommended changes* ☑
- *Not Approved* ☐

Please tick on any on. If approved/approved with suggession then put marks ≥ 50 %.

➢ ***Details of External Examiners :***

Particulars	*Full Name*	*University / College Name & Code*	*Mobile No.*	*Sign.*
Expert 1	Hitesh Vinani	SLTIET(089)	8866740201	
Expert 2				

~4~

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Enrollment No. of Student : 1 8 0 0 4 4 0 0 1

❖ **Comments of Mid Sem Review (**18mmEPCC401 **(Semester 4)**

Exam Date : 07/03/2020 .

Sr. No.	**Comments given by External Examiners :** i) The appropriateness of the major highlights of work done; State here itself if work can be approved with some additional changes. ii) Main reasons for approving the work. iii) Main reasons if work is not approved.	Modification done based on Comments
	- Experiment work is pending - Results are to be derived. -	- done -
		Internal Guide Sign.

- *Approved* ☐
- *Approved with suggested recommended changes* ☑
- *Not Approved* ☐

Please tick on any on. If approved/approved with suggession then put marks ≥ 50 %.

➢ ***Details of External Examiners :***

Particulars	*Full Name*	*University / College Name & Code*	*Mobile No.*	*Sign.*
Expert 1	Hitesh Viseni	SLTIET (089)	8866740201	
Expert 2				

~5~

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Enrollment No. of Student : 1 8 0 0 4 4 0 0 1

❖ Comments of DP-II Review (18MMEPC0403 (Semester 4)

Exam Date : 07/07/2020.

Sr. No.	Comments given by External Examiners : i) Main reasons for approving the work. ii) Main reasons if work is not approved.	Modification done based on Comments
	Work is Satisfactory	

- *Approved* ☑
- *Not Approved* ☐

Please tick on any one.

If approved then put marks ≥ 50 %.

➢ ***Details of External Examiners :***

Particulars	*Full Name*	*University / College Name & Code*	*Mobile No.*	*Sign.*
Expert 1	Hitesh Vizani	SLTIET (089)	8866740201.	
Expert 2				

~ 6 ~

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Appendix B: Compliance Report

Comments given during Dissertation Phase-1 and Mid-Semester Review are given below with required actions taken for their fulfilment:

- **Comments for Dissertation Phase-1:**

Sr. No.	Comments Given	Actions
1	To identify the research parameters as per standard experiment	Research parameter identified.
2	Literature Review is to be improve	Done

- **Comments for Mid-Semester Review:**

Sr. No.	Comments Given	Actions
1	Experiment work is pending	Done
2	Results are to be derived	Done

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Appendix C: Paper Publication

STM JOURNALS

Consortium e-Learning Network

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ACCEPTANCE LETTER

Dear Amit Darji,

Greetings from STM Journals!!!

We feel glad to inform you that your manuscript entitled **"Evaluation of process paramters of various materials by turning operation using different methodology techniques-A review"** has been accepted for publication in the **"Trends in Mechanical Engineering & Technology", ISSN: 2231-1793, Volume 10 Issue 3, 2020.**

Have A Great Future Ahead.

Thanking you with best regards

Archana Mehrotra

Dr. Archana Mehrotra
Director
Publication Management Team –
STM Journals
Division of Consortium eLearning Network Pvt. Ltd.
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Appendix D: Standard

INTERNATIONAL STANDARD

ISO 3685

Second edition
1993-11-15

Tool-life testing with single-point turning tools

Essais de durée de vie des outils de tournage à partie active unique

Reference number
ISO 3685:1993(E)

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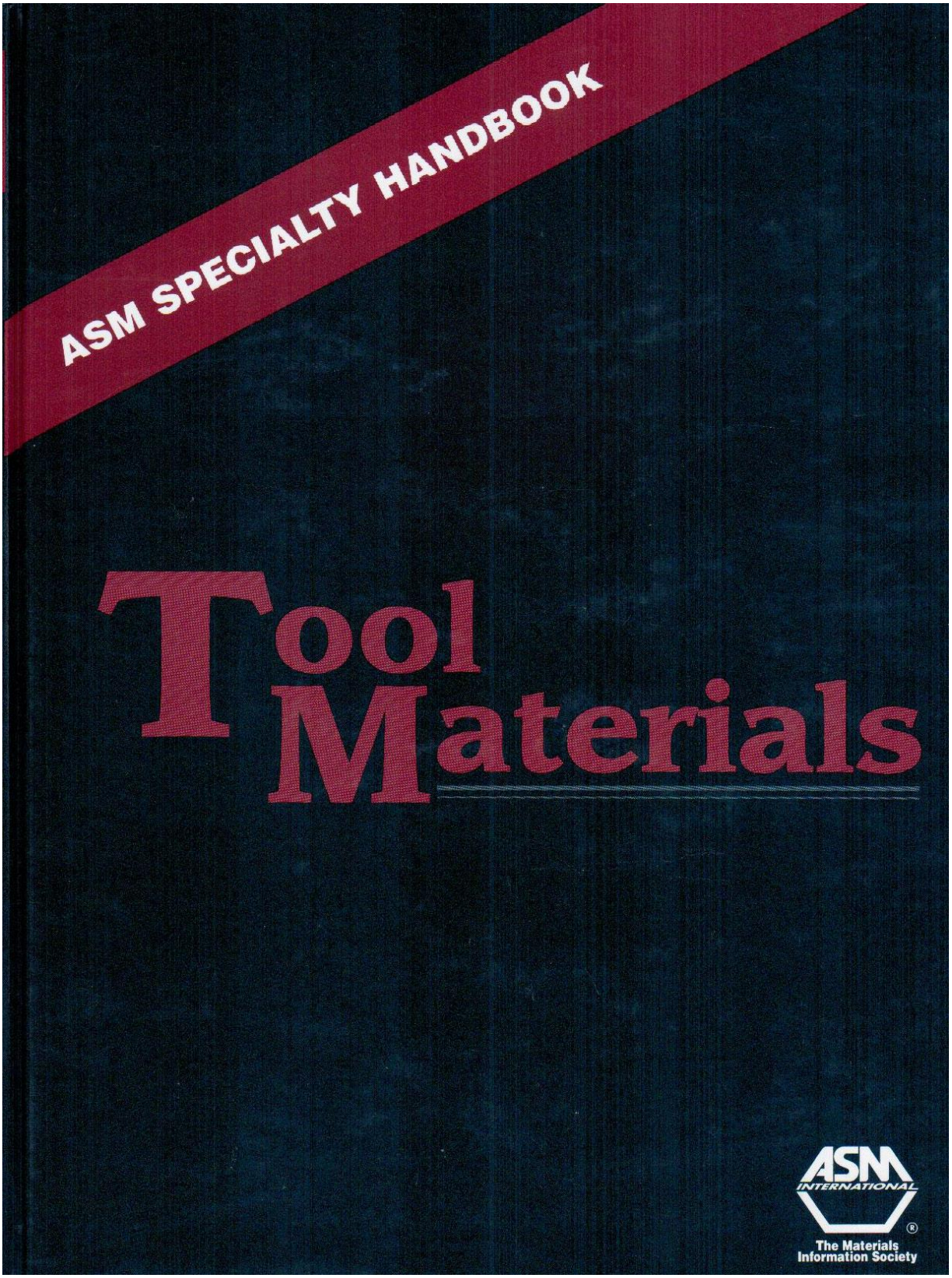

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Appendix E: Standard Result

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TC-5212

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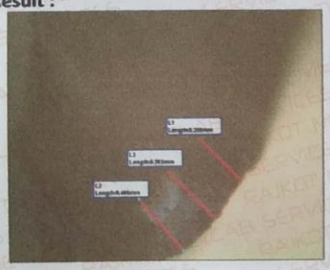
TEST REPORT

Customer Name :	Darji Amit N.	ULR - TC521220000010775F	
Address	: Near, Kalavad Rd, Yogidham, Gurukul, Rajkot- Gujarat India	Report No	: LMF-0876.1
		Date of Reporting	: 27/06/2020
		Sample Received Date	: 27/06/2020

Type of Test	: Coating Thickness by Microscopic Examination
*Customer's Reference	: Nil
*Condition of sample	: Test Piece
*Identification of sample	: Insert wear-100
*Material Specification	: --
Date of Testing	: 27/06/2020
Instrument Utilized	: Optical Microscope Model: NIM-1000X
Test Method	: ASTM B487-85(RA2013)

Result :



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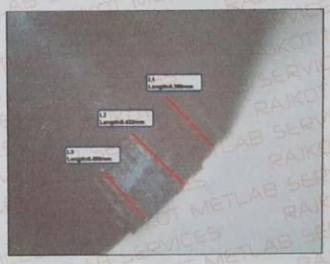
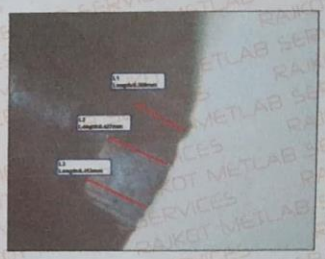


100-2



100-3

Result (mm)		100-1	100-2	100-3
1	:	0.355	0.396	0.358
2	:	0.393	0.432	0.427
3	:	0.405	0.4	0.413
Avg.	:	0.384	0.409	0.399

Remarks: --

Vishal
Tested By

RAJKOT METLAB SERVICES RAJKOT

Authorized Signature
Ankur (QM)

Witnessed By

Terms & Conditions :
1) The results relate only to the sample tested, Sample(s) drawn by party.
2) Test certificate shall not be re-produced except in full without the written approval of Laboratory.
3) RMS has made their best endeavors to provide accurate and reliable information,
RMS is not responsible for any financial liability due to any act of omission or error made.
4) samples are preserved for 15 days, any ambiguity in test results should be brought forward to the lab mgt within this period.
* Information Provided by Customer

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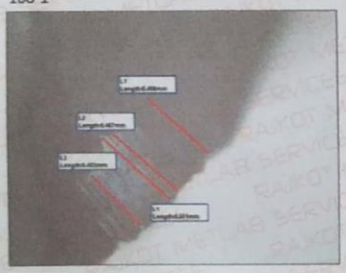
TEST REPORT

Customer Name : Darji Amit N.	ULR - TC521220000010776F
Address : Near, Kalavad Rd, Yogidham, Gurukul, Rajkot- Gujarat India	Report No : LMF-0877.1
	Date of Reporting : 27/06/2020
	Sample Received Date : 27/06/2020

Type of Test	: Coating Thickness by Microscopic Examination
*Customer's Reference	: Nil
*Condition of sample	: Test Piece
*Identification of sample	: Insert wear-150
*Material Specification	: --
Date of Testing	: 27/06/2020
Instrument Utilized	: Optical Microscope Model: NIM-1000X
Test Method	: ASTM B487-85(RA2013)

Result :

100-1



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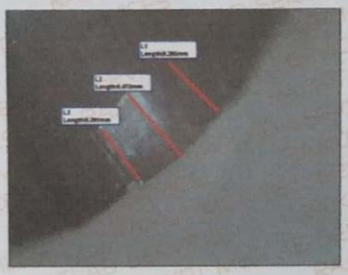

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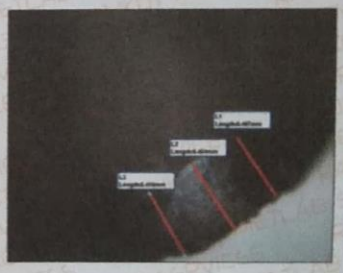

150-3

Result (mm)		150-1	150-2	150-3
1	:	0.551	0.395	0.407
2	:	0.487	0.472	0.454
3	:	0.423	0.391	0.419
Avg.	:	0.487	0.419	0.427

Remarks: --

Vishal
Tested By

RAJKOT METLAB SERVICES RAJKOT

Authorized Signature
Ankur (QM)

Witnessed By

Terms & Conditions :
1) The results relate only to the sample tested, Sample(s) drawn by party.
2) Test certificate shall not be re-produced except in full without the written approval of Laboratory.
3) RMS has taken their best endeavors to provide accurate and reliable information,
RMS is not responsible for any financial liability due to any act of omission or error made.
4) Samples are preserved for 15 days, any ambiguity in test results should be brought forward to the lab mgt within this period.
* Information provided by Customer

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*** END OF REPORT ***

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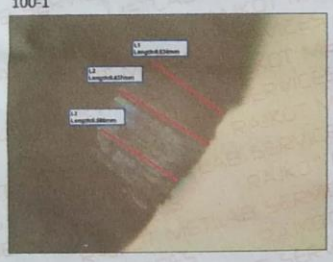
TEST REPORT

Customer Name :	Darji Amit N.	ULR - TC521220000010777F	
Address	: Near, Kalavad Rd, Yogidham, Gurukul, Rajkot- Gujarat India	Report No	: LMF-0878.1
		Date of Reporting	: 27/06/2020
		Sample Received Date	: 27/06/2020

Type of Test	: Coating Thickness by Microscopic Examination
*Customer's Reference	: Nil
*Condition of sample	: Test Piece
*Identification of sample	: Insert wear-200
*Material Specification	: --
Date of Testing	: 27/06/2020
Instrument Utilized	: Optical Microscope Model: NIM-1000X
Test Method	: ASTM B487-85(RA2013)

Result :

100-1



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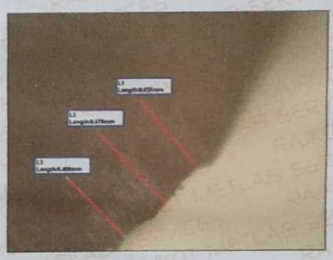
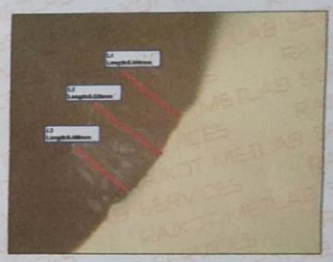


200-2



200-3

Result (mm)		200-1	200-2	200-3
1	:	0.534	0.537	0.441
2	:	0.637	0.578	0.528
3	:	0.59	0.499	0.46
Avg.	:	0.587	0.538	0.476

Remarks: --

RAJKOT METLAB SERVICES RAJKOT

Vishal
Tested By

Authorized Signature
Ankur (QM)

Witnessed By

Terms & Conditions :
1) The results relate only to the sample tested, Sample(s) drawn by party.
2) Test certificate shall not be re-produced except in full without the written approval of Laboratory.
3) RMS has made their best endeavors to provide accurate and reliable information,
RMS is not responsible for any financial liability due to any act of omission or error made.
4) samples are preserved for 15 days, any ambiguity in test results should be brought forward to the lab mgt within this period.
* Information Provided by Customer

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*** END OF REPORT ***

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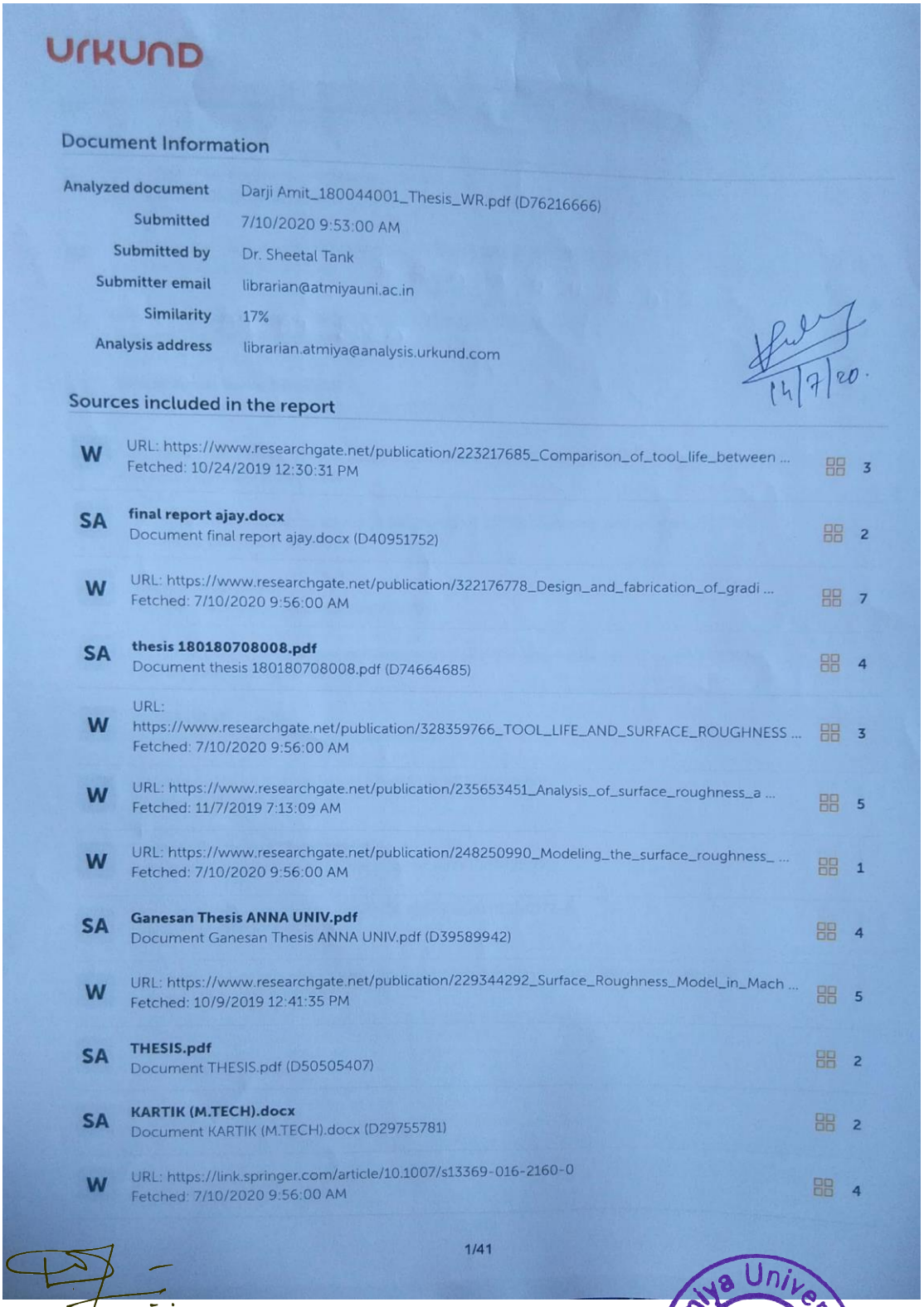
Appendix F: Plagiarism



URKUND

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Analyzed document	Darji Amit_180044001_Thesis_WR.pdf (D76216666)
Submitted	7/10/2020 9:53:00 AM
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Similarity	17%
Analysis address	librarian.atmiya@analysis.urkund.com

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Sources included in the report

W	URL: https://www.researchgate.net/publication/223217685_Comparison_of_tool_life_between ... Fetched: 10/24/2019 12:30:31 PM	3
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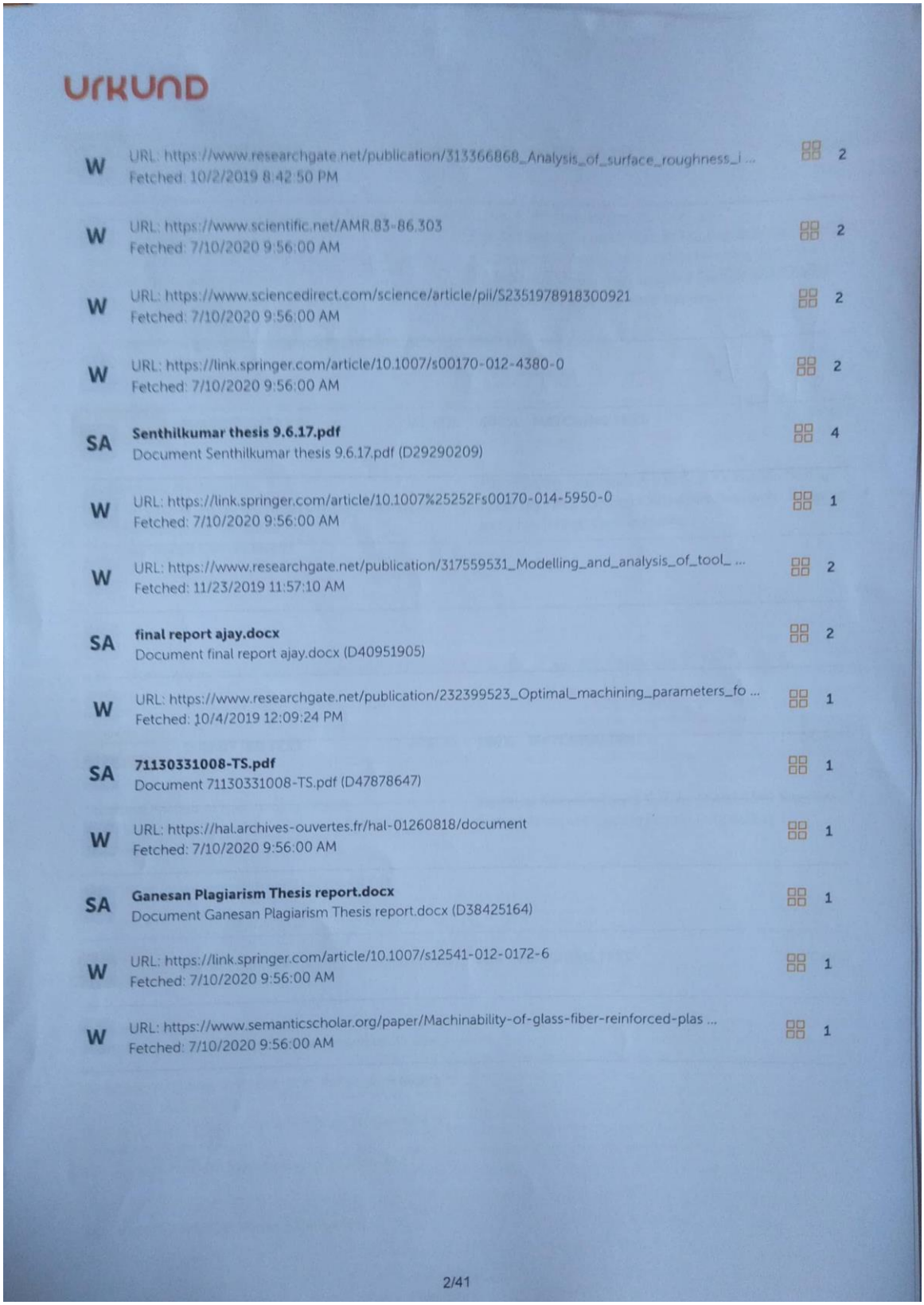

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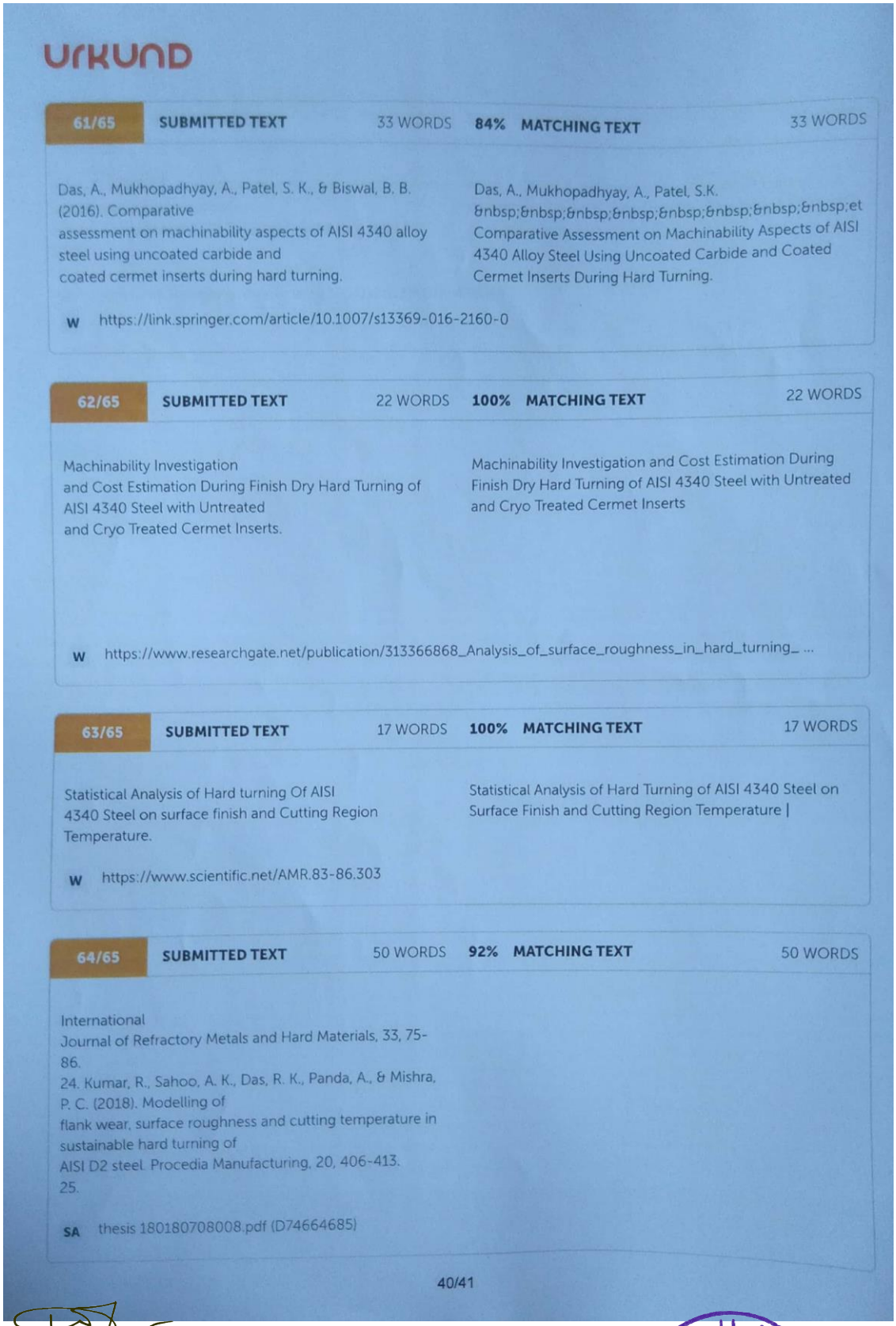

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Das, A., Mukhopadhyay, A., Patel, S. K., & Biswal, B. B. (2016). Comparative assessment on machinability aspects of AISI 4340 alloy steel using uncoated carbide and coated cermet inserts during hard turning.

Das, A., Mukhopadhyay, A., Patel, S.K.   et Comparative Assessment on Machinability Aspects of AISI 4340 Alloy Steel Using Uncoated Carbide and Coated Cermet Inserts During Hard Turning.

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Statistical Analysis of Hard turning Of AISI 4340 Steel on surface finish and Cutting Region Temperature.

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International Journal of Refractory Metals and Hard Materials, 33, 75-86.
24. Kumar, R., Sahoo, A. K., Das, R. K., Panda, A., & Mishra, P. C. (2018). Modelling of flank wear, surface roughness and cutting temperature in sustainable hard turning of AISI D2 steel. Procedia Manufacturing, 20, 406-413.
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Aslan, E. (2005). Experimental investigation of cutting tool performance in high speed cutting of hardened X210 Cr12 cold-work tool steel (62 HRC).	Aslan E (2005) Experimental investigation of cutting tool performance in high speed cutting of hardened X210 Cr12 cold-work tool steel (62 HRC).

W https://link.springer.com/article/10.1007/s00170-012-4380-0

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ISOLATED DC-DC CONVERTER FED DC MOTOR FOR BIDIRECTIONAL ELECTRICAL VEHICULA APPLICATION

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ATMIYA University in Partial Fulfillment of the Requirements for

the Degree of Master of Technology in [PEED]

June -2020

Electrical Engineering Department,

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COMPLIANCE CERTIFICATE

It is certified that the work contained in this dissertation thesis entitled "**Isolated Dc-Dc Converter Fed Dc Motor For Bidirectional Electrical Vehicular Application**" submitted by **Hiral A Vaja (180043006)** studying at Electrical Engineering Department, Faculty of Engineering & Technology for partial fulfillment of M.Tech Electrical Engineering (PEED) degree to be awarded by Atmiya University. He has compiled the comments of the Dissertation Progress Review-I, Dissertation Part I as well as Dissertation Progress Review-II with my satisfaction.

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THESIS APPROVAL CERTIFICATE

It is certified that the work contained in this dissertation thesis "**Isolated Dc-Dc Converter Fed Dc Motor For Bidirectional Electrical Vehicular Application**" submitted by **Hiral A Vaja (180043006)** studying at Electrical Engineering Department, Faculty of Engineering & Technology for partial fulfilment of M.Tech Electrical Engineering (PEED) degree to be awarded by Atmiya University.

Date:

Place: Atmiya University, Rajkot

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Hiral A Vaja

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TABLE OF CONTENT

Contents

ACKNOWLEDGEMENT 2

ABSTRACT 7

1.Introduction 8

1.1 Indian scenario of electric vehicles 10

1.2 Scopes of electric vehicles in India 11

1.3 Electric Vehicles to be 35% of Global new car sales by 2040 12

1.4 Electric vehicle technology impacts on energy 13

2. Features 14

3. Application 15

4. literature survey 16

5. Dc-Dc converter 19

5.1 Introductions 19

5.2 Types of dc to dc converter 19

5.3 Isolated full bridge converter 19

5.3.1 Block diagram 19

5.3.2 Power module 20

5.3.2.1 Full-Bridge Inverter 21

5.3.2.2 Full-Bridge Rectifier 22

6. Permanent Magnet DC motor 24

6.1. Speed Control of D.C Motor 27

6.2 PMDC motor control using PWM techniques 28

7. Design Of Converter 31

7.1 operation and control principle 31

7.2 Design of LC Filter 35

7.3 Calculation of inductor and capacitor 37

7.4 Design of Transformer 38

Registrar
Atmiya University
Rajkot

Atmiya University
Rajkot

7.5 Specification of Hardware 41
7.6 Gate Driver circuit 42
8.Simulation & Result 44
8.1 MATLAB Simulink Model of Converter with RLE load 44
8.2 Result and Discussion 45
9. Conclusion 51
Future work 51
References 51

LIST OF FIGURE

Figure 1 car sales per year in graphical manner 12
Figure 2 block diagram of system..... 20
Figure 3 full bridge isolated converter..... 20
Figure 4 Full-Bridge Inverter..... 22
Figure 5 Full-Bridge Rectifiers..... 23
Figure 6 construction of Permanent magnet (PM) motors 25
Figure 7 Equivalent Circuit of Permanent Magnet DC Motor 26
Figure 8 PWM pulse at various duty cycle..... 29
Figure 9 mode 1 31
Figure 10 mode 2 32
Figure 11 mode3 32
Figure 12 mode 4 33
Figure 13 wave form of isolated Bi Directional DC DC Converter 34
Figure 14 Gate Driver Circuit..... 42
Figure 15 MATLAB Simulink Model Of Converter with RLE load 44
Figure 16 Gate pulse..... 45
Figure 17 voltage across switch..... 46
Figure 18 Capacitor voltage..... 47
Figure 19 Inductor current 47
Figure 20 Transformer secondary side voltage..... 48
Figure 21 Armature current of dc motor..... 48
Figure 22 field current of dc motor..... 49
Figure 23 Speed of dc motor..... 49
Figure 24 Electrical Torque 50

Registrar
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LIST OF TABLE

Table 1 Stages of Operation of The Converter on Buck Mode 33
Table 2 Design Specification..... 40
Table 3 Specification of Hardware 41
Table 4 Component required for Gate Driver Circuit 43

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ABSTRACT

In this project isolated dc-dc converter fed dc motor for Bidirectional Electric Vehicle. An Isolated dc-dc converter is implemented through bi-directional full bridge converter having transformer which segregate input and output. The input side is the main battery side with relatively high voltage up to 310V and the output side with low voltage of 220V to achieve step down voltage power conversion. A dc-dc converter developed is composed with two stages inverter and rectifier stage. Sinusoidal pulse width modulation technique is used for triggering the switches. This paper presents switching technique applied in full-bridge converter. This technique reduces the over voltage across semiconductor devices. Simulation results are verified by MATLAB/Simulink.

Keywords: Isolated DC-DC Converter; Electric Vehicle; power converter; Isolation Transformer; Separately Excited DC Motor; PWM technique; snubber less converter.

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1.Introduction

In people's lives, urbanization has had several consequences that have left people rely on cars. As a consequence, the density of cars is rising day by day in city centers. The exhaust contaminants emitted by Internal Combustion Engines (ICE) when fuels like petrol or diesel are used are hydrocarbons, nitrogen oxides and carbon monoxide. These emissions cause a variety of complications, such as lung disease, respiratory symptoms, irritation, indifferent body parts, blood pressure, etc. Such pollutants often affect animal organisms.

An electric car is quite flexible, apart from a traditional vehicle. This is because of the smaller number of moving parts that are needed for a traditional vehicle to operate. The number of mechanical components in an electric car is reduced to only one, the motor. It can be controlled by various control mechanisms. Electric cars have been on a huge rise in recent years, and there are many causes behind it. The most noticeable for them being their contribution to emission control. In 2009, 25 per cent of greenhouse gases emitted by energy-related industries were accounted for by the transport industry. Battery, motor and electric engine are the core elements of an electric car. Essentially, the overall benefit of the electric vehicle is advantageous for consumers. In addition, EVs would have the ability to have a significant effect on electricity, climate and transport, as well as promotion of hitech, the growth of new industries and economic development. For emerging nations such as India, which already has a potential EV demand for two wheel, three wheel vehicles and buses, electric vehicle mobility is ideally suited. Electric cars add a variety of strong economic growth opportunities, like any new technology. With regards to the climate, EVs would have emission-free commuter rail. EVs can provide the energy market with effective, detailed and sustainable energy options that are efficient and eco friendly, such as the use of several types of renewable energy sources. [1].

New studies into renewable energy for the road transport is becoming pretty prevalent among research teams in numerous fields. In this sense, because of their charging storage infrastructure and charging services from the conventional grid system, plug-in hybrid electric vehicles (PHEVs) have a bright future. So many analyses have shown that electrification of the transport system could achieve a substantial emissions reduction and a growing dependency on oil. The main unsustainable source of energy, based on liquid fossil fuels, has

been transport in recent days. Studies show that over 55% of oil is presently used by the transportation sector and about 25% of CO2 is released in total (Howey, 2012). The second big effect concerning the rise of CO2 emissions, though, is known to be high oil consumption or economic downturns. It is impossible to predict that these recent developments can hardly reverse in the future on the basis of recent results. Assuming the current trend, we note that the lower average sales prices of vehicles in emerging economies and the rapid rise in gross domestic product (GDP) values have boosted the total travel rates of vehicles in emerging economies [2].

In various climates, road conditions, and landscape, electric vehicle (EV) drives are used, which are usually subject to regular start and stop requirements. EV drives used primarily in automotive manufacturing lines are mostly run in controlled conditions and at constant speeds. The most key part of any EV propulsion unit is the motor drive. An electric motor, a power converter and a electronic controller are the key components of the drive mechanism. Motor drives should be designed to follow a number of characteristics, such as high torque capacity, high performance, regenerative braking, and good thermal and cooling systems, which allow the propulsion unit to perform effectively. Leading to their beneficial impact on the atmosphere by low CO2 emissions, electric and hybrid cars are essential factors in improving a healthier environment. With oil prices increasingly rising, the need for alternative sources of energy is increasing. Electric and electric hybrid cars provide the greatest opportunity for new renewable sources of electricity to be used. In the implementation of different job conditions and practices, electric drive applies to the transfer of electrical to mechanical energy. Electric drives use about half of the electrical energy generated. Due to the minimum requirement for speed control in their operation, approximately 75 percent-80 percent of these electrical drives run at constant speed. Electric drives that can respond to variable speed and torque to balance the mechanical load are required for the remaining 20%-25% [3].

1.1 Indian scenario of electric vehicles

Compared to four wheeler vehicles, two wheeler vehicles are mostly seen on roads in India, as 2W is more time- and fuel-efficient and ICE-driven. The usage of 4W is very low, aside from special occasions such as marriage ceremony or family meeting. India is the second largest 2-W market after China, and will remain the preferred transport option until 2035.At the pace of 60000 new registrations / day, there are around 300 million traditional vehicles increasing. Compared with only 221 EV stations, there are 70799 conventional fuel stations. As per the Community of Electric Vehicle Manufactures, 354017 units of EVs have been sold to date. By 2040, India plans to introduce 31 million EVs.The tender for 10,000 EVs to replace government vehicles along with 4,000 EV chargers was recently won by Tata motors. In 2015, the Faster Adoption & Manufacturing of Electric Vehicles (FAME) scheme was introduced to promote the manufacture of Eco-Friendly Vehicles.Any of the benefits expected include the availability of free EV charging points, neighborhood charging stations, limited charging rates and battery swapping. The aim of India is to make sure that all public transport and 30 percent of private cars are electric by 2030. This was one of the main decisions made at the New Delhi Summit on Global Mobility.On electric vehicles, the Government offers a lower GST of 12% while the Government levies 28% GST plus cess on petrol and diesel cars[4]. Via the Automotive Research Association of India, the Indian Space Research Organization is supplying the new lithium-ion battery technologies to commercial players. With India introducing an electric mobility future, over 65 percent of electricity demand for road transport & 35 percent of carbon emissions can be avoided. Saving carbon dioxide will allow India to comply with its Paris Climate Agreement obligations [4].

1.2 Scopes of electric vehicles in India

Due to different reasons, the electric vehicle demand in India is much smaller compared to ICE vehicles. The introduction of EVs resulted in range anxiety due to the lack of charging infrastructure capacity. The lack of suitable and reliable EV charging facilities is a limiting factor in the rapid adoption of Electric vehicles. Present infrastructure for battery charging uses off-board charging stations that need extensive urban space and require substantial investment. The charging time is usually high, even with the on-board charging capacity. Conductive charger shortcomings include charging time, location near an EV, potential road block, and station queue. It has a physical connection between the power grid and the EV, consisting of a PFC rectifier, DC-DC converter, or low-frequency AC to high-frequency AC converter. When cars are at rest or driving, wireless charging has protection benefits and ease of charging. It is important for an EV to have a good-performance battery charger with a simpler circuit and control system. There is considerable scope for studies using SRM motors, aside from drives using BLDC and PMSM motors, in the drives section. Voltage quality and harmonics that reduce the output of interconnected renewable energy supplies and smart-grid electrical transmission networks are influenced by EV and charging point rises. The control of peak loads helps energy providers to reshape demand curves, improve energy efficiency and minimize general running costs and carbon emissions. A test and an incentive for power grids will be to increase the penetration of EVs in future smart grids. They will decrease the peak grid demand if perceptively controlled. Power quality challenges concerning the functioning of interconnected renewable energy sources and smart grid electricity transmission networks should be resolved as integrated with EVs. [5].

1.3 Electric Vehicles to be 35% of Global new car sales by 2040

The report, released today, estimates that by 2040, electric car deliveries would surpass 41 million, representing 35 percent of the sales of new light duty vehicles. This will be almost 90 times the comparable amount for 2015, where it is estimated that EV sales were 462,000, up about 60% from 2014. This expected transition would have consequences outside the car industry between now and 2040. The study forecasts that EV development would mean that by that date they constitute a quarter of the cars on the route, displacing 13 million barrels of crude oil every day but consuming 2,700 TWh of electricity. This will be equal to 11% of 2015's global demand for energy.

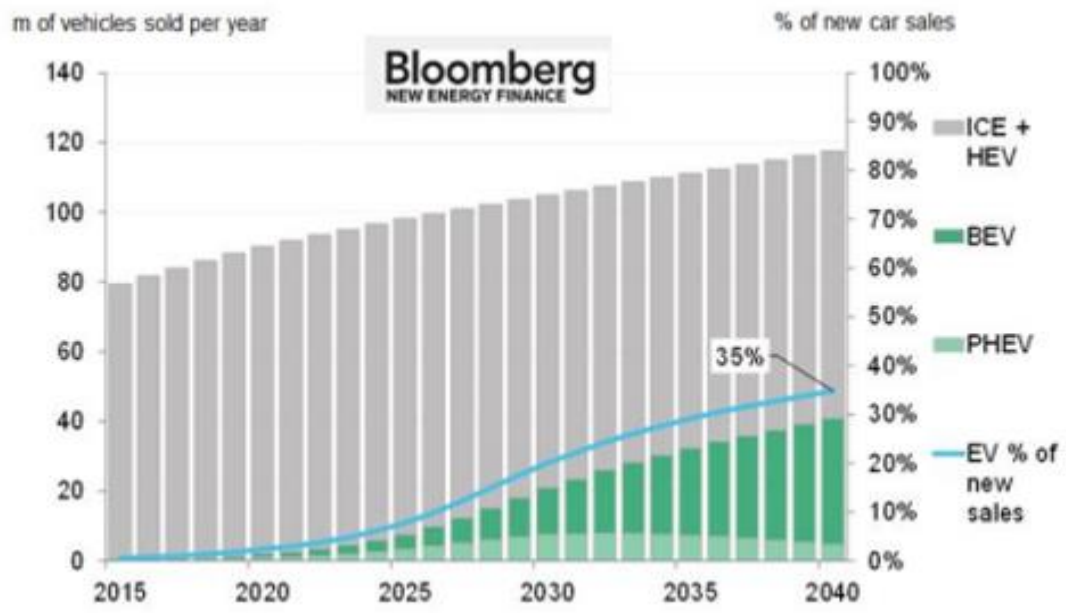

Figure 1 car sales per year in graphical manner

EVs come in two categories: electric battery vehicles, or BEVs, which rely solely on their batteries to provide power; and plug-in hybrid electric vehicles, or PHEVs, which have batteries that can be recharged but are backed up by traditional engines. The Nissan Leaf was the best-selling BEV in the last six years, and the Chevrolet Volt was the best-selling PHEV [6].

1.4 Electric vehicle technology impacts on energy

In various climates, road conditions, and landscape, electric vehicle (EV) drives are used, which are usually subject to regular start and stop requirements. EV drives used primarily in automotive manufacturing lines are mostly run in controlled conditions and at constant speeds. The most critical feature of any EV propulsion unit is the motor drive. An electric motor, a power generator and an electrical controller are the key components of the drive mechanism. Motor drives should be designed to follow a number of characteristics, such as high torque power, high performance, regenerative braking, and good thermal and cooling systems, which allow the propulsion unit to perform effectively. Leading to their beneficial impact on the atmosphere by low CO2 emissions, electric and hybrid cars are essential factors in improving a healthier environment. With oil prices increasingly rising, the need for alternative sources of energy is increasing. Electric and electric hybrid cars provide the greatest opportunity for new renewable sources of electricity to be used. In the implementation of different job conditions and practices, electric drive applies to the transfer of electrical to mechanical resources. Electric drives use about 50 percent of the electrical energy generated. Due to the minimum requirement for speed control in their operation, approximately 75 percent-80 percent of these electrical drives run at constant speed. Electric drives that can adapt to variable speed and torque to balance the mechanical load need the remaining 20 percent-25 percent [7].

2. Features

- Battery space can be reduced by reducing or increasing the available input voltage.
- A device can be driven by bucking or boosting the available voltage. Thus, preventing the damage of the device or breakdown.
- Safety to personnel, isolation prevents input voltage from transmitting to the output in case of internal failure.
- Isolated DC-DC converters can be configured to provide positive or negative outputs from plus or minus rails.
- Voltage transients on the input are not transmitted to the output.

3. Application

- Electric vehicle
- Hybrid vehicle
- Auxiliary power rail generation
- Connecting dc-dc converter outputs in series
- Connecting dc-dc converter input and output in parallel
- High-side gate drive power
- Isolated interface power

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4. literature survey

When going to start new project first question born in my mind is, from where to start, what are the available methods of dc power supplies in electric vehicle, what topology I should use, how can I make my design more efficient etc.

For this I have referred many IEEE papers, magazines and books. From this material I have selected concept isolated dc-dc converter fed dc motor for bidirectional electric vehicular.

1. Matsumori, Hiroaki, et al. "Isolated DC-DC Converter utilizing GaN power device for Automotive Application." 2019 IEEE Applied Power Electronics Conference and Exposition (APEC). IEEE, 2019.

In This paper authors has discussed isolated step-sown DC-DC converter using GAN power device for automotive applications. The works for a power supply from a high voltage main battery with 200V to low voltage auxiliary battery with 13.6V in hybrid electric vehicle. A LLC converter is known as isolated DC-DC converter with high-efficiency. The DC-DC boost-up converter experimentally achieves 99.03% of conversion efficiency at nominal output so that it has no effect on the total system efficiency. Even though adding a DC-DC boost-up chopper to the LLC resonant converter, a power density expected to 10 W/cc.

2. He, Peiwen, and Alireza Khaligh. "Comprehensive analyses and comparison of 1 kW isolated DC–DC converters for bidirectional EV charging systems." IEEE Transactions on Transportation Electrification 3.1 (2016): 147-156.

In this paper author has discussed Isolated DC-DC converters with galvanic isolation are commonly used in electric vehicle (EV) battery chargers. These converters interface between a DC voltage link, which is usually the output of a power factor correction (PFC) stage, and an energy storage unit. In this manuscript, full bridge CLLC (FBCLLC), half-bridge CLLC (HBCLLC), full bridge DAB (FBDAB), and half-bridge DAB (HBDAB) DC-DC converters are evaluated and compared for their suitability for EV chargers. All the converters are

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designed with optimal soft switching features. The operating principles, design methodologies and design considerations are presented.

3. Dhabe, Pratik, Manish Kumar Agrawal, and Milind Rode. "Controlled Charging of Ultra Capacitor by PWM Technique for Electric Vehicles." 2018 International Conference on Smart Electric Drives and Power System (ICSEDPS). IEEE, 2018.

In this paper discussed about Ultra capacitor (UC) or Super capacitor(SC) is gaining popularity owing to large values of capacitance, high power density, high energy density and fast charging. UC has found applications in many industries as a reliable energy storage device. This paper is aimed at presenting the charging characteristics of UC when charged using PWM technique .Other methods of charging UC, like constant voltage and constant charging method, pose certain limitations and increase the charging time. A comparison is drawn when UC is charged using constant current charging method and PWM technique. The proposed method facilitates relatively faster charging of UC in a controlled manner.

4. Tredeau, Frank P., and Ziyad M. Salameh. "Evaluation of lithium iron phosphate batteries for electric vehicles application." 2009 IEEE Vehicle Power and Propulsion Conference. IEEE, 2009.

In this paper Cycle tests and capacity measurements were done on eight cells over the course of 50 full cycles lasting several weeks. Cycles were to 100% Depth of Discharge (DOD) at 20°C.The profile of the realistic road test is described. The road test profile was done on both cells four times at each of four ambient temperatures: -20°C, 0°C, +20°C and +40°C. The resulting conclusion is that the LiFePO4 cells are superior to the previously tested LiCoO2 cells for use in EVs and are recommended for future designs.

[5] Ge, Junjie, Xing Huang, and Hailian Xie. "Fast equivalent model of isolated bidirectional dc-dc converters for dc microgrid study." IECON 2015-41st Annual Conference of the IEEE Industrial Electronics Society. IEEE, 2015.

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In this paper, a novel fast equivalent model of isolated bidirectional DC-DC converters for DC micro grid study is proposed. It has a simple structure and has the similar harmonic performances with the switching model. Furthermore, it is easy to be set up and can save much calculation time cost. Simulation results in Mat lab/Simulink verify the feasibility and validity of the proposed model, and show superior performances.

[6] Gargies, Sonya, Hongjie Wu, and Chris Mi. "Design and control of an isolated bidirectional dc-dc converter for hybrid electric vehicle applications." Journal of Asian Electric Vehicles 4.1 (2006): 851-856.

This paper mainly focuses on bi directional, isolated dc dc converter for medium power application. hybrid electric vehicle HAS many advantages, like high fuel economy, silent operation and low emission. There are two or more different voltage buses for vehicle operation. By the use of isolated bidirectional dc dc converter to link different dc voltage bus and transfer energy back and forth. The design is based on theoretical analysis, simulation, and hardware implementations. experiments validated the performance shown in simulation result show in the simulation and theoretical analysis. Since this is a preliminary prototype, it is recommended that the next phase is to scale the converter to 10KW with a focus on optimum power density and the use of new power devices such as silicon carbide switches.

5. Dc-Dc converter

5.1 Introductions

A DC-to-DC converter is an electronic circuit or electromechanical device that converts a source of direct current (DC) from one voltage level to another. It is a type of electric power converter.

5.2 Types of dc to dc converter

There are mainly two types of Dc to Dc converter

1) ***Dc to Dc converter without isolation***
   - Buck converter
   - Boost converter
   - Buck-boost converter
2) ***Dc to Dc converter with isolation***
   - Fly back converter
   - Forward converter
   - Full bridge converter
   - Half bridge converter
   - Push-pull converter

5.3 Isolated full bridge converter

5.3.1 Block diagram

the isolated bidirectional DC-DC converter is one of the most famous. Lots of electric equipment in automobile employs power electronics technology with semiconductor power devices. To respond above demand, electronics with higher switching frequency is one of the key technologies. Traditionally, the isolated bidirectional DC-DC converter is one of the most popular converters.

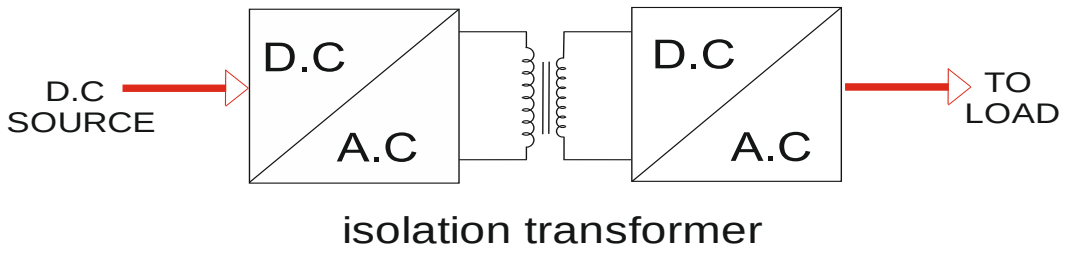

Figure 2 block diagram of system

Bi-directional converters are appropriate for dc power flow in both directions. Isolated DC-DC converters have excessive voltage isolation from quite a few hundreds to thousand volts relying on the kind of standards. In this review, two different configurations are discussed. fig. 1 is Block diagram of an isolated bidirectional DC-DC converter. There are two configurations, one is full-bridge inverter and another is single-phase rectifier.

5.3.2 Power module

Bidirectional dc-dc converters can be divided into two parts: (1) isolated and (2) non-isolated converters. The isolated converter increases system safety and reliability even though it is more expensive than the non-isolated converter. Commonly, single-phase inverters use half bridge or full bridge configuration. Mostly, full-bridge configuration is used in high-power applications due to its low voltage and current stress, minimum VA rating of the high-frequency transformer, and minimal ripple currents at the output filter. Fig.2 illustrate an isolated bidirectional DC-DC step down converter, as mentioned in earlier circuit is divided into two parts. One is full bridge inverter and another is single phase Rectifier. Two converter connected with isolation transformer via interconnected dc link.

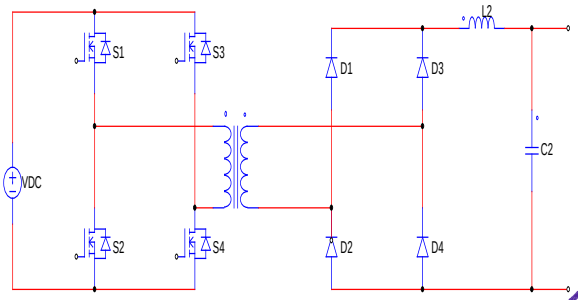

Figure 3 full bridge isolated converter

The primary side is the main battery side with relatively high voltage up to 310V and secondary side is output side with low voltage of 220V. To achieve step down voltage DC DC converter is composed with two stage inverter and rectifier. When a switch turns ON and OFF alternatively, charged capacitor work as the energy storage devices and then after some time release energy. Charge capacitor energy is now delivered to the load, because of this ripple generate at the output side. Ripple magnitude is dependent on the capacitor, load resistance and switching frequency. Constant output voltage required for all applications, so ripple magnitude should be minimum. There are various methods for minimizing ripple magnitude. Out of all the method PWM method are used for minimizing the output ripple magnitude.

For simplifying the circuit following factor should be considered. 1) All semiconductor devices and an isolation transformer considered ideal; 2) The dead band between the switches represents a time that is small enough to neglected.

5.3.2.1 Full-Bridge Inverter

An elementary circuit that transforms DC to AC is the Full-Bridge Inverter. From a DC input, an AC output is generated by an appropriate switching sequence. A DC input voltage in an inverter is converted into an AC output voltage. This transformed AC output voltage on the output side is kept at the desired magnitude and frequency.

Single-phase inverters are widely used for half bridge or full bridge topologies. Fig.3 displays the complete bridge inverter single-phase.

In low and intermediate power applications, square or quasi-square wave performance is used in inverters that are sufficient, but sinusoidal waveform is highly important in high-power applications, so inverters are carefully built to have low distortion sinusoidal output. Inverters are commonly used in commercial and domestic applications.

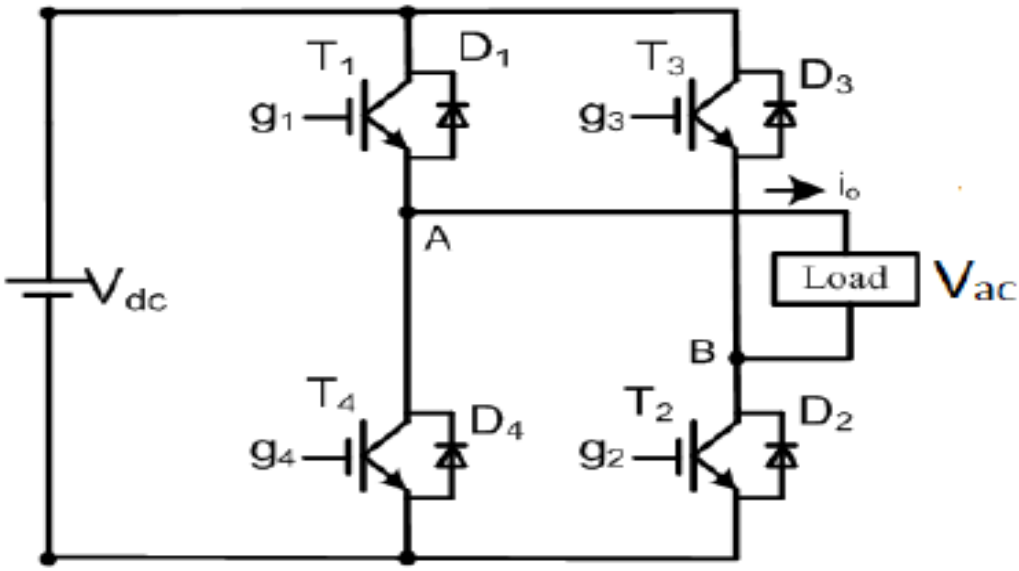

Figure 4 Full-Bridge Inverter

5.3.2.2 Full-Bridge Rectifier

The average DC output voltage is higher than for half-bridge rectifier in full-bridge rectifier, the output of the full bridge rectifier has much less ripple than that of the half-bridge rectifier that provides a smoother waveform output.

Inductive load is incorporated in the circuit arrangement. The inductive load produces a constant and ripple-free load current. Individual upper group switches (S1, S3) are performed for positive half-cycle and for negative half-cycle individual bottom group switches (S2, S4) in the operating theory of single-phase complete bridge rectifier, the necessary demeanour for load current flow.

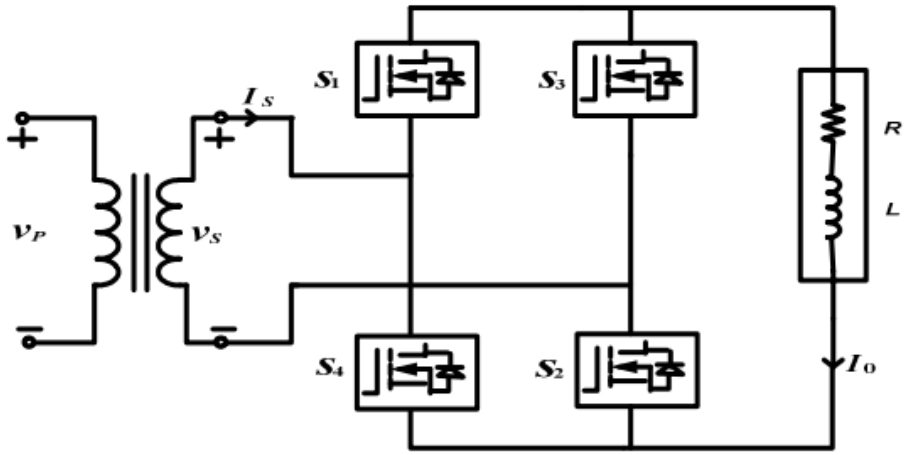

Figure 5 Full-Bridge Rectifiers

The S3 and S4 switches are forward-biased during the negative half-cycle. As switches S3 and S4 are fired, the supply voltage is applied as a reverse blocking voltage through switches S1 and S2. Thus, a bridge rectifier requires electric current to be corrected during both positive and negative half cycles of the incoming AC signal. [8].

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6. Permanent Magnet DC motor

Permanent magnet (PM) motors have been used in recent years in a wide range of applications in the following market sectors, where technical simplicity, high performance and low initial cost are of primary importance. For high speed operations when variable-speed is needed, the PM motor drives are attractive. In a broad variety of operations, they can be configured in various ways and demonstrate high performance. Permanent magnet (PM) motors have been used in recent years in a wide range of applications in the following market sectors, where technical simplicity, high performance and low initial cost are of primary importance. For high speed operations when variable-speed is needed, the PM motor drives are attractive. In a broad variety of operations, they can be configured in various ways and demonstrate high performance. One of three types may be the material used to constant a PM dc motor: ferrite magnets, alnico magnets or rare earth magnets. High-performance DC motor drives use PM motors which require accurate monitoring of complex position-speed reference trajectory, with rapid response, slight steady state error, small overshoot (or undershoot), fast rise time and minimum settling time. One of the key subjects of advanced electronics is operation of electric drives. The issue is the study of speed modulation using adaptive control of a PMDC motor with unknown parameters and unknown external load torque. For the PM brushless DC motor drive system, a steady state reference current determination strategy based on a neural network is proposed to enhance system reaction speed and minimize overflow and oscillation [9].

Without electronic controls, a BLDC motor does not work. The power electronic switches control the terminal voltages on the stator windings of each stage. Two phases are done at any time. Therefore, external circuit and rotor rotation should be combined with the electromagnetic field in order to predict both steady-state and dynamic output for the BLDC motors. Above Fig. shows the construction of the BLDC [10].

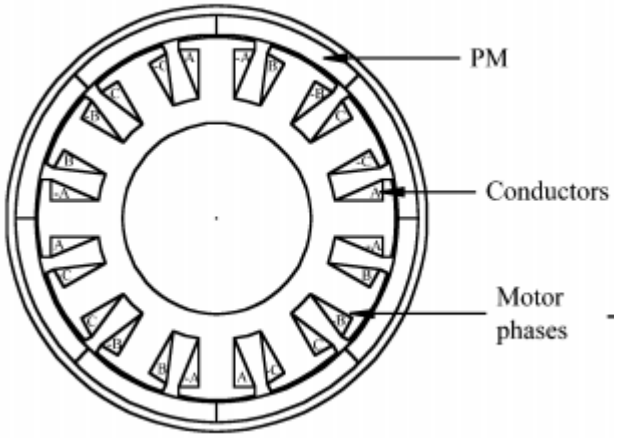

Figure 6 construction of Permanent magnet (PM) motors

A wide number of armature windings, including distributed winding and concentrated winding, can be seen in PMBLDCM. Due to its excellence in performance and expense, concentrated winding is commonly used in multi-slot PMBLDCM. A main magnetic field in the PMBLDCM outer rotor is the armature reaction magnetic field. Therefore, studying the magnetic field of the armature reaction of the PMBLDCM outer rotor is important. There are two main methods used by scholars to solve the problem of analytical calculation of the air-gap magnetic field of slot effect: direct method and indirect technique. The first is to separately solve the magnetic field in the slot area and air-gap magnetic field, then to integrate the magnetic field in the slot and Fourier series air-gap well after solving the Laplacian-Poissonon equation. The direct method's accuracy is relatively high, but the analytical formula is not straightforward and intuitive. The latter, indirect method, refers to the analytical formula of the slotting air-gap magnetic field by multiplying the slotless magnetic field's simple analytical formula by the late permeance of the air-gap. The indirect method has obvious advantages in the simplicity of the formula compared to the direct method, but the accuracy of the result relies on the accuracy of the late permeance function of the air-gap [11].

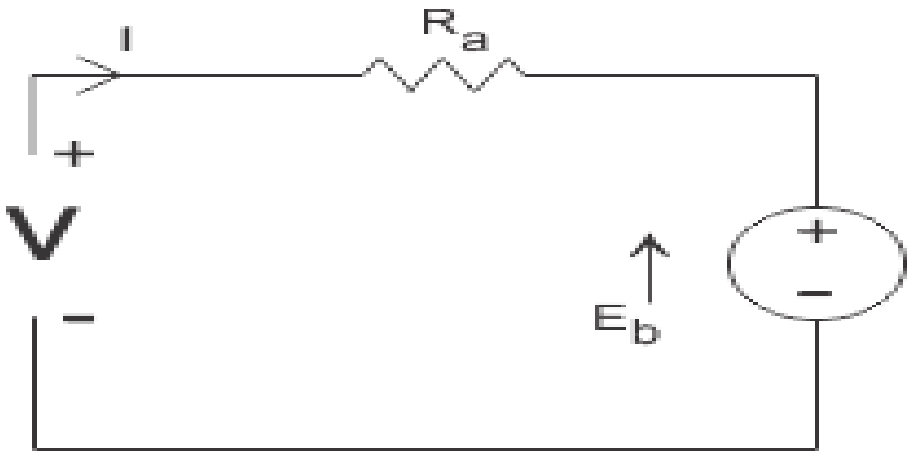

Figure 7 Equivalent Circuit of Permanent Magnet DC Motor

fig. 5 shown The Equivalent Circuit of Permanent Magnet DC Motor in this motor supply voltage to the armature will have armature resistance drop and rest of the supply voltage is countered by back emf of the motor. Hence voltage equation of the motor is given by,

$$V = IR + E_b$$

Where, I is armature current and R is armature resistance of the motor. Eb is the back emf and V is the supply voltage.

For a multitude of industrial applications, such as process control, guided vehicles, paper and steel mills and mining and smelting plants, high performance permanent magnet dc (pmdc) motor drives are used. The essential control objectives of such a drive system are precise, fast, efficient speed reference tracking with minimum overshoot/undershoot and small steady state error. Due to difficulty, involving estimation steps, model sturdiness changes due to discontinuous drive mode of operation, parameter fluctuations, load excursions and noisy input speed and current signals, the use of adaptive and variable structure control had limited performance [12].

6.1. Speed Control of D.C Motor

The above equation indicates that the speed depends on the supply voltage V, the resistance of the armature circuit Ra, and the field flux that the field current produces. The difference of these three variables is, in fact, used for speed control. Thus, there are three common D.C. speed regulation techniques for DC Motors.

1. Variation of resistance in the armature circuit: This technique is called control of armature resistance or control of the Rheostat.

2. Field flux variation: This technique is called regulation of field flux.

3. Variation of the supply voltage: This technique is often called armature voltage control.

Due to reliable, large, simple and continuous control characteristics, direct current (DC) motors have been commonly used in many industrial applications, such as electric cars, steel rolling mills, electric cranes and robotic manipulators. For the speed control of low power dc motors, the conventional rheostatic armature control system has been commonly used [13].

For acceleration and deceleration, DC motors have excellent velocity control. The DC motor power supply connects directly to the motor field, which facilitates precise voltage control and is needed for speed and torque control applications. The Buck converter provides the DC-DC step-down converter with the best efficiency. Force commutated thyristor, power BJT, MOSFET, IGBT and GTO-based chopper can be used for the power semiconductor devices used for a chopper circuit. It has very low switching losses, indicating that they have a total voltage drop of 0.5V to 2.5V DC drives have long been the keystone of industrial applications, due to their flexibility, ease of operation, durability and favourable cost. Compared to AC drives, DC drives are less complex. With low horse power ratings, DC drives are typically less costly. As adjustable speed devices, DC motors have a long tradition of being used and a wide variety of options have emerged for this reason. At constant torque, cooling blowers and inlet air flanges provide cooling air for a large speed range. For applications requiring continuous regeneration for overhauling loads DC regenerative drives are available. It will be more difficult and costly for AC drives with this capacity. There is minimum adequately applied brush and commutator maintenance. DC motors are capable of producing torques starting and accelerating above 400 percent of the rated torques. The primary source of electric traction has long been DC motors. They are also used for mobile devices such as golf carts, mining applications and quarry applications. DC motors are conveniently compact and ideal for particular

applications, such as heavy equipment and machinery that are not easy to control from remote power sources. Speed control techniques in independently excited DC motors are to adjust the armature voltage below the rated speed and to reach speed above the rated speed by varying field flux. [14].

6.2 PMDC motor control using PWM techniques

Electric motors are used for basically all devices in the industry. Most of them are DC motors. In terms of compactness, speed control, fast starting torque, the dc motor is much more advantageous relative to the other motors. The dc series motor is often used for its high starting torque & variable rpm, among all the advantages. They are used to drive constant speed shafts, centrifugal motors, blower pumps, etc. Conventional methods of speed control basically control the voltage via rheostat methods to the armature or to the speed, regulating the flux to the field through the rheostat method. But they are poor in performance, and not specific. They are rejected and the electronic system is implemented to control the speed. The PWM (pulse width modulation) system is the best one of all electronic speed control techniques as it uses the variable conduction period or variable duty cycle to control the speed of the motor. The PWM system is the most effective and acceptable method when the motors are operating from a DC source. [15].

After achieving a nominal speed the torque of these motors is comparatively constant at any speed. In addition to these advantages, these motors have certain drawbacks, like the flux density produced in the air gap is so small and the field flux density created in the air gap is limited, and the Due to an armature reaction, demagnetizing effects are produced in the motor.

In the range below and above its nominal speed, the speed of the PMDC can be controlled. The most popular way of controlling the PMDC's speed is to change the input voltage of the motor. In order to ensure the reliability of the PMDC torque, speed control based on unknown disturbances automatic sensor less speed control based on PMDC compensation features and low rotation speed setting output were investigated. The input voltage of the motor is controlled by adjusting the duty cycle of the motor signal for pulse width modulation (PWM). As an interface between LabView and Arduino, the LINX package is used. Since many devices are involved in controlling the speed, these complicate the control system of this process. By replacing LabView in the architecture, the design can be streamlined [16].

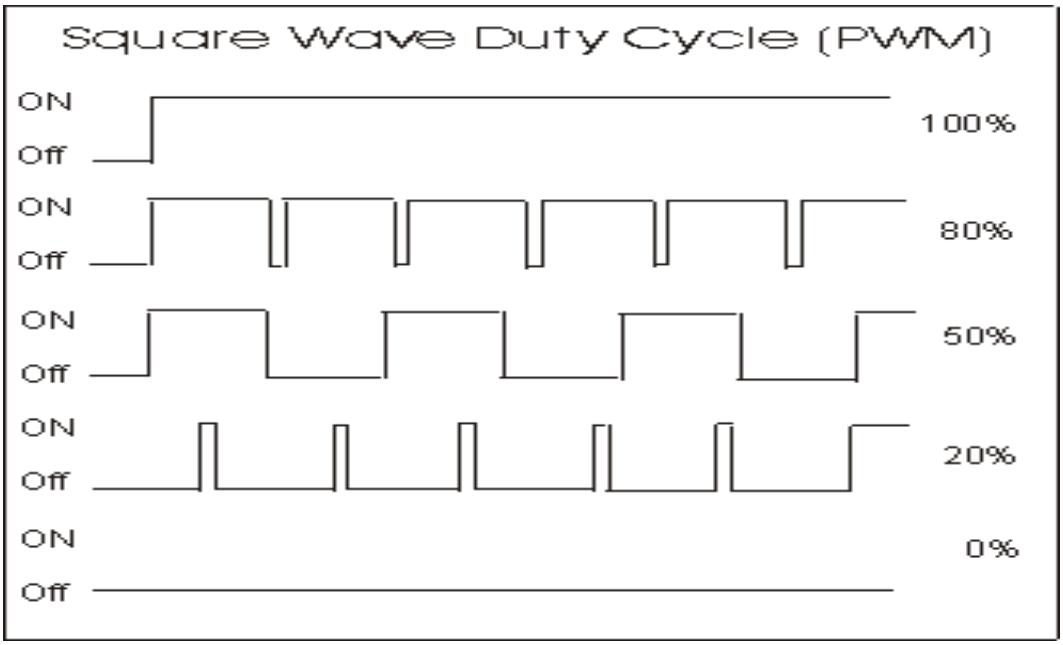

Figure 8 PWM pulse at various duty cycle

Figure 6 shown various duty cycle at different gate signal. The ratio of the ON time to the time period of the pulse is known as duty cycle. If the duty cycle is low, it implies low power. and if the duty cycle is large then it implies high power. Using mechanical or electrical methods, control of the PMDC motor may be obtained. In the previous, DC drive speed controls were often mechanical and required to install large-scale hardware. These drives have been launched by the development back to a place of considerable importance that gives rise to A.C drives. The controlled rectifier and DC chopper made a revolution in modern industrial machinery and variable drives because of the ability to supply continuously variable D.C voltage. By regulating armature or field excitation, adjustable speed drives can be controlled over a large range of drives. The invention of power semiconductors saw the introduction of most of the early variable speed requirements of the D.C drive system. This development has grown to be taken up for future improvement, focusing on the value of easy construction and ease of control. In multiple applications, BJT and GTO and various Analog digital chips used in firing or regulating circuits have made DC drives more available for power. New power devices for variable frequency drives like IGBT have been developed recently in the field of semiconductor technology. Using IGBT in the chopper circuit to control and rotate the motor in the direction of forward and reverse.

- **Benefits of PWM drive technology:**
- High efficiency (97% to 98%).
- Small size.
- Open circuit operation.
- Wide speed range.
- Excellent speed regulations.
- Ride-through capability.
- Operation < 6Hz possible without cogging.
- Low sensitive to line transmission.[17]

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7. Design Of Converter

7.1 operation and control principle

Assuming that V_{in} is the input and V_o is the output, the circuit operates as voltage reducer and acts like non-isolated buck converter in four stages. The principle of the topology is introduced in this mode. the working process of each cycle is divided into four modes. As shown in Fig. 3, dc supply V_{in} powering the bi-directional converter. All the switches on the primary side are gated at duty ratio 0.77 Fig.3 show the various stage of operation during one switching time period T. fig.4 show the theoretical waveforms of converter. Where, VT is transformer across secondary voltage.

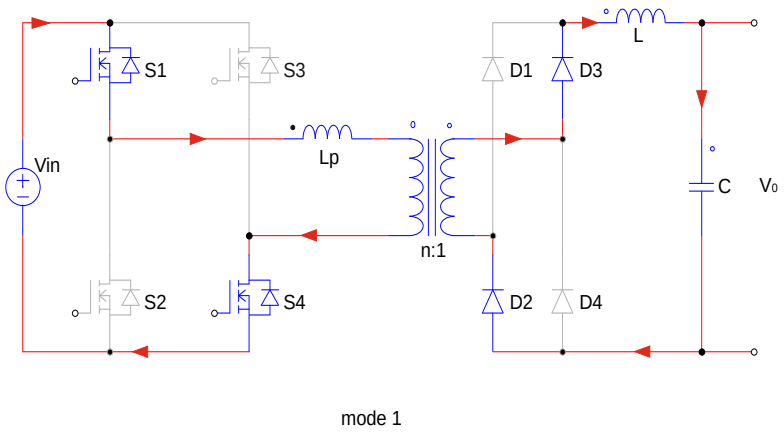

Figure 9 mode 1

(1) Mode 1 [to-t1]: In this mode at interval [t_o – t_1] switch S_1 and S_4 are turned ON. While S_2 and S_3 are turned OFF. A Vin voltage appears across the primary winding and Secondary winding of transformer side semiconductor diode D_2 and D_3 are forward bias and provide rectification to load as a result of charging inductor L and capacitor C. Assume a Vin voltage across the block switch at primary side while reverse diode present voltage equal to V_o. V_L is voltage across inductor and I_L is current through inductor.

$$V_L = V_{in} - V_0 \qquad (1)$$

$$i_L = i_C - i_0 \qquad (2)$$

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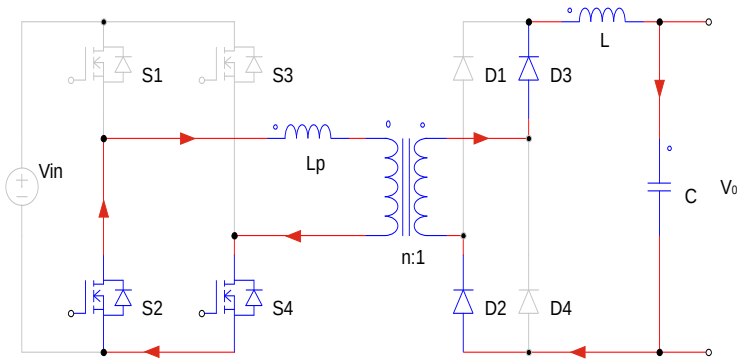

Figure 10 mode 2

(2) Mode 2 [t_1-t_2]: In this mode, the Switch S_2 and S_4 are turned ON. During this mode Zero voltage is given to transformer no power transfer to primary side. The energy stored in inductor result in freewheeling of the current equally through the diode D_2 and D_3 due to the excess current at the transformer switch S_2 and S_4 is turned On, while S_1 and S_3 is turned OFF. It is the best possible way to avoid over voltage across the blocked semiconductor device.

$$v_L = -v_0 \qquad (3)$$

$$i_L = i_C - i_0 \qquad (4)$$

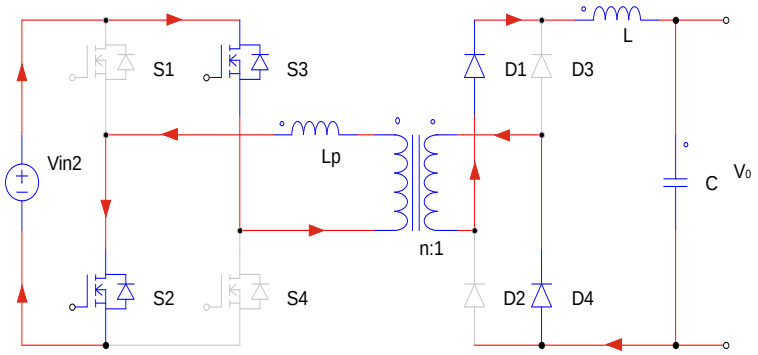

Figure 11 mode3

(3) Mode [t_2-t_3]: In this mode, a switch S_2 is continuously turned ON at t_2 while switch S_1 and S_4 are turned OFF and presents a voltage equal to V_{in}. The operation is similar to that during interval t_o-t_1. but now negative voltage applied to the transform. In this mode diode D_1 and D_4 conducts and provide secondary side rectification while D_2.

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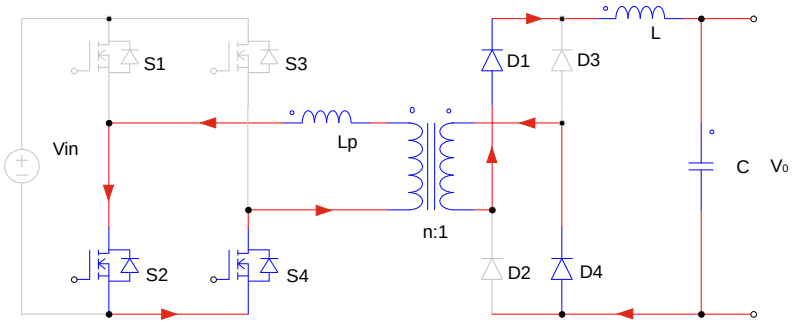
and D_3 are blocked across the voltage equal to V_o. Inductor current increase again as the voltage across inductor increases so, inductor and capacitor charged again. for this mode equation 1 and 2 are valid.



mode 4

Figure 12 mode 4

(4) Mode [t_3-t]: The converter operation during this interval is closely resembles to the interval of (t_1-t_2) again Zero voltage applied to the transformer. S_2, S_4 remains On and S_1 and S_3 are turned OFF. An inductor and capacitor release the energy. Diode D_1 and D_4 are in conduction. Equation 3 and 4 are valid. For sufficient operation of converter average voltage of transformer is should be zero. This is the best way to avoid core saturation.

$$V_L = (V_{in} - V_0)DT + (-v_0)(1 - D)T$$

$$= 0 \qquad (5)$$

State S	Switching interval			
	t_o -t_1	t_1-t_2	t_2-t_3	t_3-t
S1	ON	OFF	OFF	OFF
S2	OFF	ON	ON	ON
S3	OFF	OFF	ON	OFF
S4	ON	ON	OFF	ON
D1	OFF	OFF	ON	ON
D2	ON	ON	OFF	OFF
D3	ON	ON	OFF	OFF
D4	OFF	OFF	ON	ON

Table 1 Stages of Operation of The Converter on Buck Mode

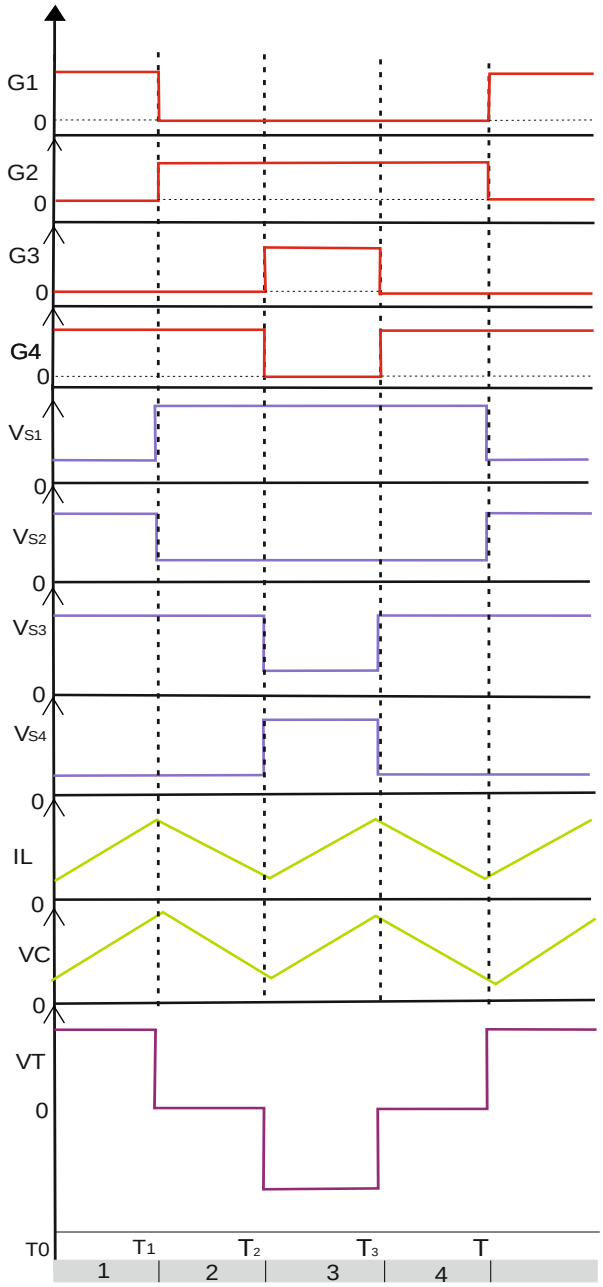


Figure 13 wave form of isolated Bi Directional DC DC Converter

Note that output voltage depends on only the input and duty ratio D. If the input voltage fluctuates the output voltage can be regulated by adjusting the duty ratio appropriately. It must be noted that during the interval [t_o-t_1] and [t_2-t_3] an inductor and capacitor is charged due to

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these instances are referred to as T_{ON}. Interval [t_o-t_1] and [t_2-t_3] are equal for this reason, the duty cycle of converter is $D = \frac{2 \cdot T_{0n}}{T}$

7.2 Design of LC Filter

The equation that determine output filter is found according to theoretical analysis The Inductance is given by,

$$L = v_L \cdot \frac{\Delta t}{\Delta i_L} \qquad (6)$$

In mode 2 and 4 converter is turned OFF so voltage across inductor is V_o. As stated in equation 3 this condition occurs in mode 2 and 4. For the time referring to (1-D) T/2. Due to this it is possible to replace the voltage in inductor $v_L$and Δt equation (6).

$$\mathrm{L} = \frac{\mathrm{v_0}(1 - \mathrm{D})}{2 \cdot \mathrm{f} \cdot \Delta \mathrm{i_L}} \qquad (7)$$

Where, f is switch frequency. The capacitor value is derived by charge variation given by,

$$\Delta \mathrm{Q} = \mathrm{C} \cdot \Delta \mathrm{v_C} \qquad (8)$$

In converter capacitor is charged $^1/_4$ period of operation and the time of current is equal to $\frac{\Delta \mathrm{i_{L2}}}{2}$ so, equation (6) is given by,

$$\Delta \mathrm{Q} = \frac{1}{2} \cdot \frac{\mathrm{T}}{4} \cdot \frac{\Delta \mathrm{i_L}}{2}$$

$$= \frac{\mathrm{T} \cdot \Delta \mathrm{i_L}}{16} \qquad (9)$$

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From equation (7) capacitor value is,

$$C = \frac{\Delta Q}{\Delta v_C} = \frac{T \cdot \Delta i_L}{16 \cdot \Delta v_C} \qquad (10)$$

Equation (7) is that occurs at the moment when converter is turned OFF. In result time period is (1-D) T/2. And $\Delta i_L = \frac{v_0}{L}$

Therefore, the capacitor value is

$$C = \frac{v_0(1 - D)}{32 \cdot \Delta v_C \cdot L \cdot f} \qquad (11)$$

The design of converter has the following parameter (Assuming all ideal component).

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7.3 Calculation of inductor and capacitor

- **Specification:**

  L = output side Inductor

  C = output side Capacitor

  Vs = supply voltage

  Vo = output voltage

  D = duty cycle

  F = switching frequency

  Δi_L = ripple current

  Δv_C = ripple voltage

- **Calculation**

$$L = \frac{v_0(1-D)}{2 \cdot f \cdot \Delta i_L}$$

= 63mH

$$C = \frac{v_0(1-D)}{32 \cdot \Delta v_C \cdot L \cdot f}$$

= 0.419mF

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7.4 Design of Transformer

High voltage (>10kV), high power (>10kVA) suppliers provide a wide range of commercial HV applications, including diagnostic imaging, the aerospace industry and power generation particulate emission control. Via the use of electrostatic precipitator supplies, particulate emission control is accomplished. For this use, traditional converters are based on line frequency approaches and the converters are therefore also wide and large. The development of a new model of power converter, using high switching frequencies (kHz) and high frequency transformers, has been made possible by recent developments in electronic power control techniques. Consequently, there is a significant decrease in the scale and weight of the filters and transformers. In certain applications, such as electrostatic precipitators, where the size and weight of the converter is a primary concern, this is especially useful [18].

the leakage transformer inductances have a heavy effect on switch-supported stresses. They can cause over voltages and additional losses in electronic control switches. Therefore, to ensure that converters can work properly, designers have to predict the values of certain inductances. Unlike magnetizing inductances, it is not possible to predetermine the leakage inductors. Nowadays, designers evaluate their values using either time-consuming finite-element-method (FEM) simulations or measurements in a post conception phase. the impact of ferrite thickness and permeability is investigated to check the validity of the magnetic-image method. Accounting for magnetic material Owing to the zero complete Ampere-turn, the effect of the magnetic core on leakage inductance values is very weak (more frequently less than 5 percent). Nevertheless, in order to achieve the corresponding parameters with sufficient precision, it needs to be taken into consideration, at least approximately.

The magnetic substance is believed to be linear, homogeneous, and isotropic, but can have losses in the following. If the leakage inductances are coupled, transformers with more than two windings can also be computed with parameters representing these properties. The leakage transformer, which is described as providing more than two windings for each transformer, defines the remaining magnetic activity when one winding is short-circuited. It requires inductances of leakage and couplers defining the coupling between these inductances [19].

- **Selecting the Core:**

The first step is the selection of the type of core for the design. To get the precise characteristics and power-handling capabilities for each form and scale of core, you can work with a core maker. A general starting point, therefore, is:

• A silicon steel lamination is commonly used when it is less than 400 Hz.

• Choose a tape-wound or nickel-alloy core at 400 to 2000 Hz.

• Look at ferrite over 2000 Hz.

Note, this is just a guideline; going outside of these ranges is not unusual (e.g., audio transformers can use silicon steel laminations and operate from 20 to 20,000 Hz). Among the cores mentioned above, there are numerous other core styles, and many shapes, forms, and material classes.

The exact core chosen may depend on the spacing of the board, location, type of mounting, or any of a variety of physical and electrical criteria that can only be determined by you. The fundamental constraints of high-level architecture HF voltage transformers are as follows: high voltage transformers (HV) The criteria for insulation, soft magnetic materials Types, number of cores, room for windings, parasites Parasitic inductance and capacitance, cooling Core Losses and Windings. Transformer HV, HF The following design with a nanocrystalline core requires Considerations to be considered [20].

- **Design Specification.**

core	EI-33 , L=33mm, W=12.5mm, H=29mm
Copper wire gauge	19 swg, Diameter =0.91186mm Cross section=0.653mm^2
Effective cross section area (Ac)	118.8mm^2
maximum flux density (Bmax)	1500 gauss
Turns ratio (N)	2.08
Primary turns N(P)	71 turns
Secondary turns N(S)	34 turns
Primary voltage V(P)	100 volt
Secondary voltage V(S)	48 volt
Input voltage(V)	100 volt

Table 2 Design Specification.

- **Calculation**

1) N(p) = (V * 108) / (4*B*f* Ac)

=71 turns

2) N = V(P)/V(s)

=2.08

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3) N(s) = N(p)/N

=34 turns

4) B = (V*108)/4*F*N(p)*Ac

=1492 gauss =1500 gauss

7.5 Specification of Hardware

Sr. no.	Name of Component	Specification of Component
1	DC motor	48V, 2.08 A, 100W, 3000 rpm
2	Inductor (L_2)	63mH
3	Capacitor (C_2)	0.419mF
4	Transformer	Pri: 71 turns, Sec: 9 turns, core: EI-33
5	Gate Driver	IR21 01

Table 3 Specification of Hardware

7.6 Gate Driver circuit

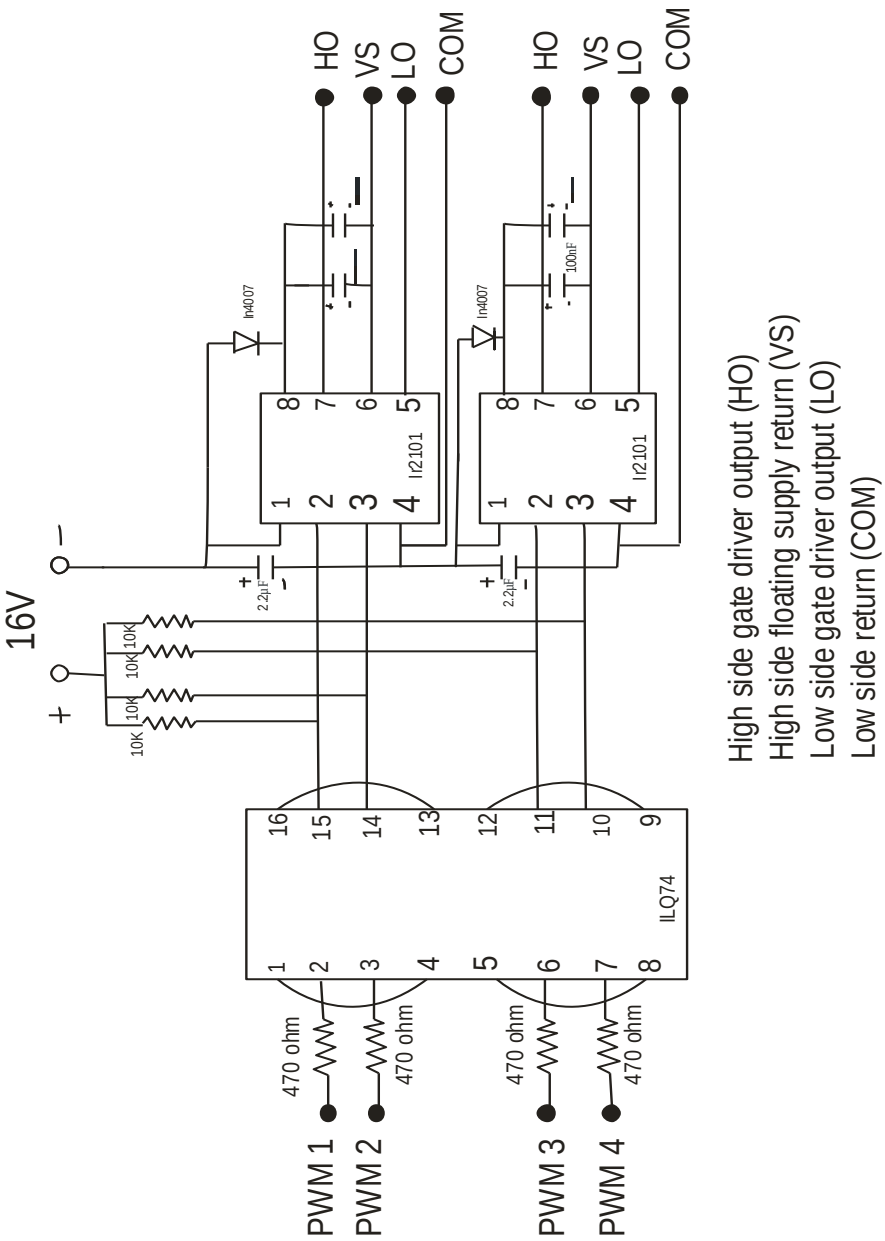

Figure 14 Gate Driver Circuit

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- **Component required for Gate Driver Circuit**

Sr. no.	Name of component	Specification of component
1	Optocoupler	ILQ74
2	Resistor	470ohm,10K
3	Diode	IN4007
4	Capacitor	100nf, 2.2µf ,10µf

Table 4 Component required for Gate Driver Circuit

A gate driver is a power amplifier that accepts a low-power input from a controller IC and produces a high-current drive input for the gate of a high-power transistor such as an IGBT or power MOSFET. Gate drivers can be provided either on-chip or as a discrete module. In essence, a gate driver consists of a level shifter in combination with an amplifier. A gate driver IC serves as the interface between control signals (digital or analog controllers) and power switches (IGBTs, MOSFETs, SiC MOSFETs, and GaN HEMTs). An integrated gate-driver solution reduces design complexity, development time, bill of materials (BOM), and board space while improving reliability over discretely-implemented gate-drive solutions

In this figure show that control signal given to the ILQ74 (optocoupler) through resistor. ILQ74 work as isolator between controller and IR2101. so, electrical signal is passing through to IR2101. IR2101 is gate driver 8pin IC. Its work on active low mode which means when logic 0 is given to HIN pin output is given to the MOSFET. Where LIN pin at logic 1.

At pin no. 1and 8 16volt supply is given through 12volt supply circuit. Output is obtained from pin no.7and 5which is given to the MOSFET.

8.Simulation & Result

8.1 MATLAB Simulink Model of Converter with RLE load

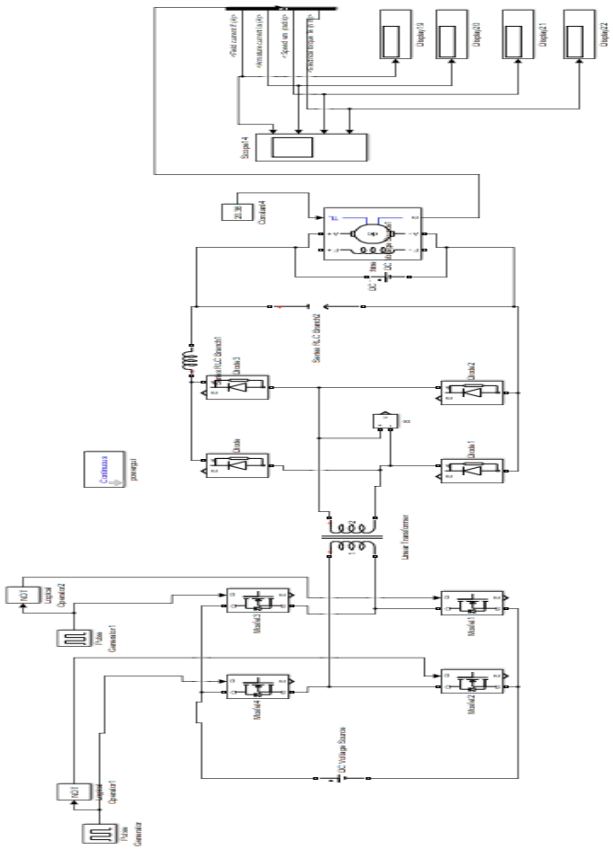

Figure 15 MATLAB Simulink Model of Converter with RLE load

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8.2 Result and Discussion

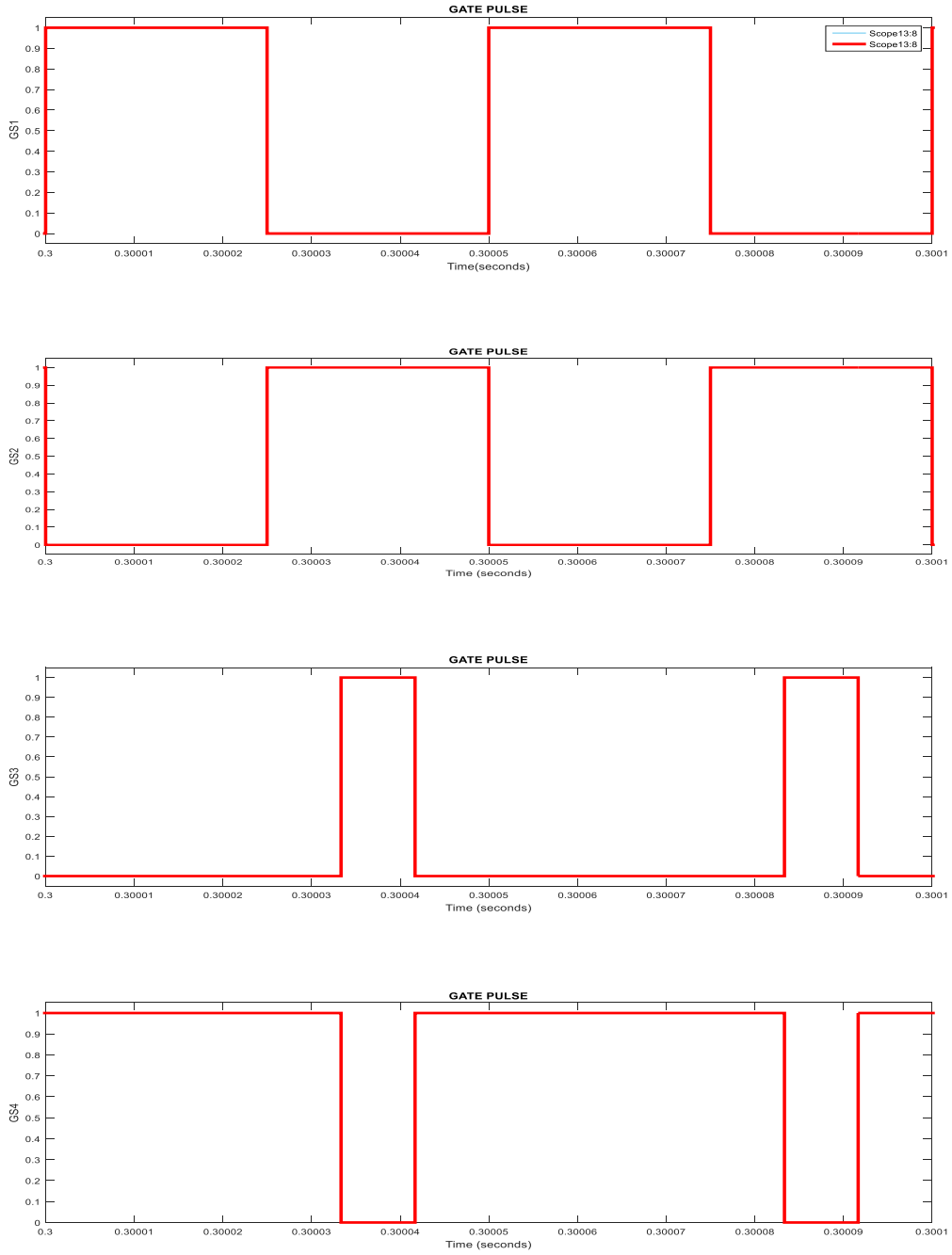

Figure 16 Gate pulse

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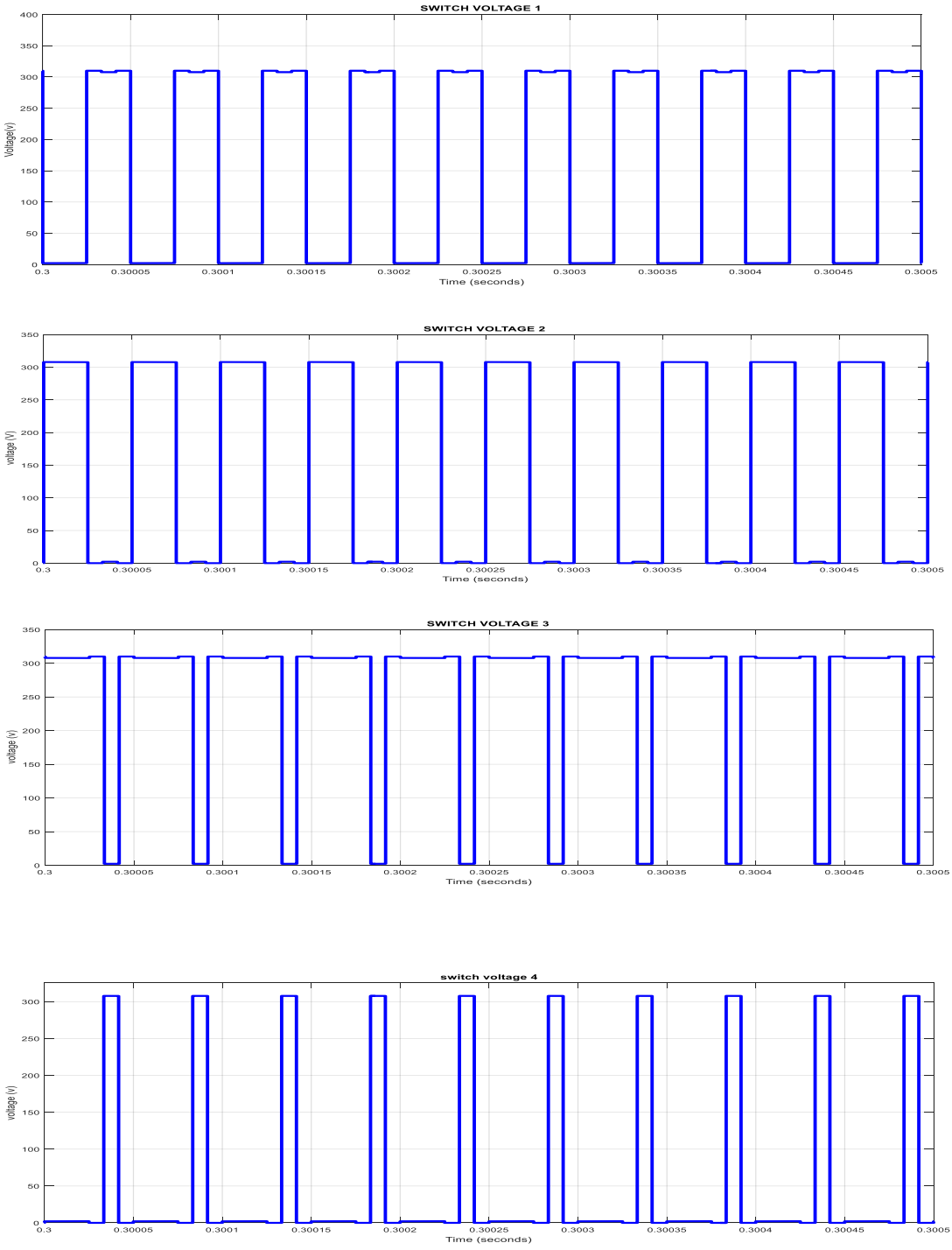

Figure 17 voltage across switch

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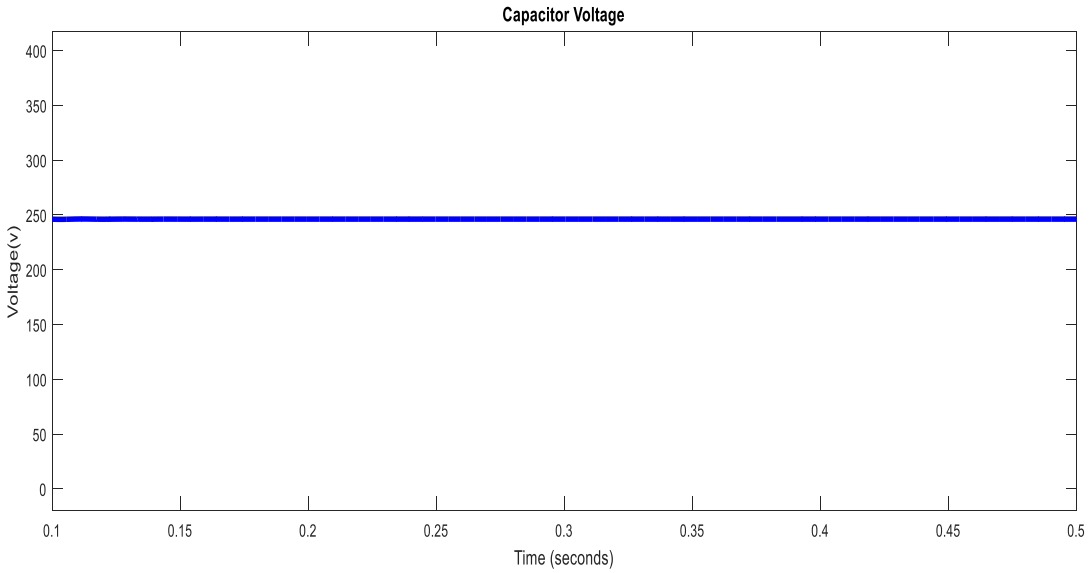

Figure 18 Capacitor voltage

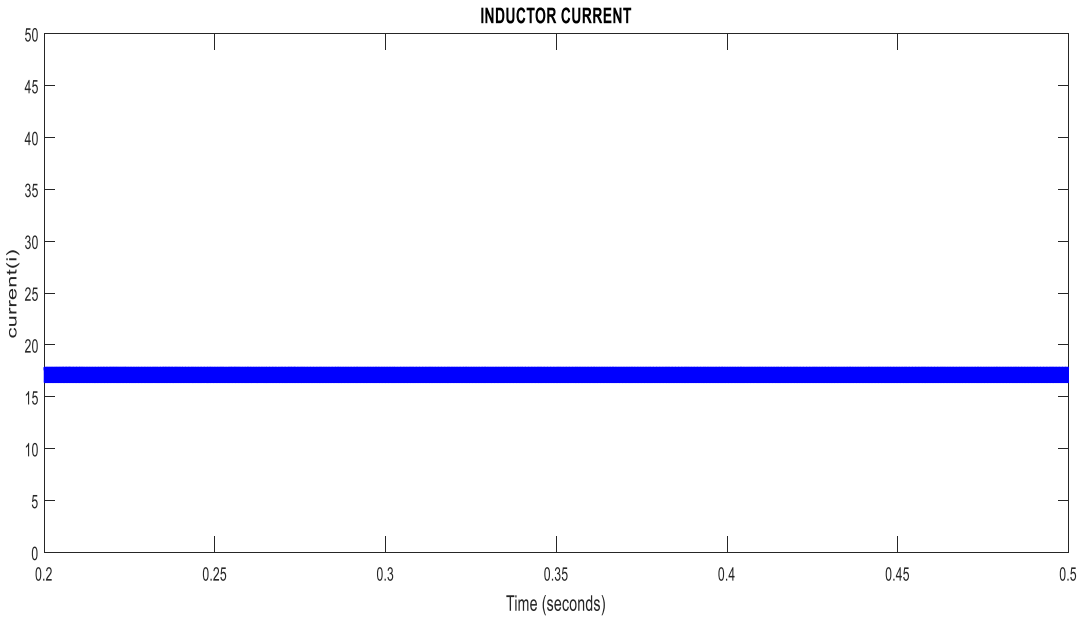

Figure 19 Inductor current

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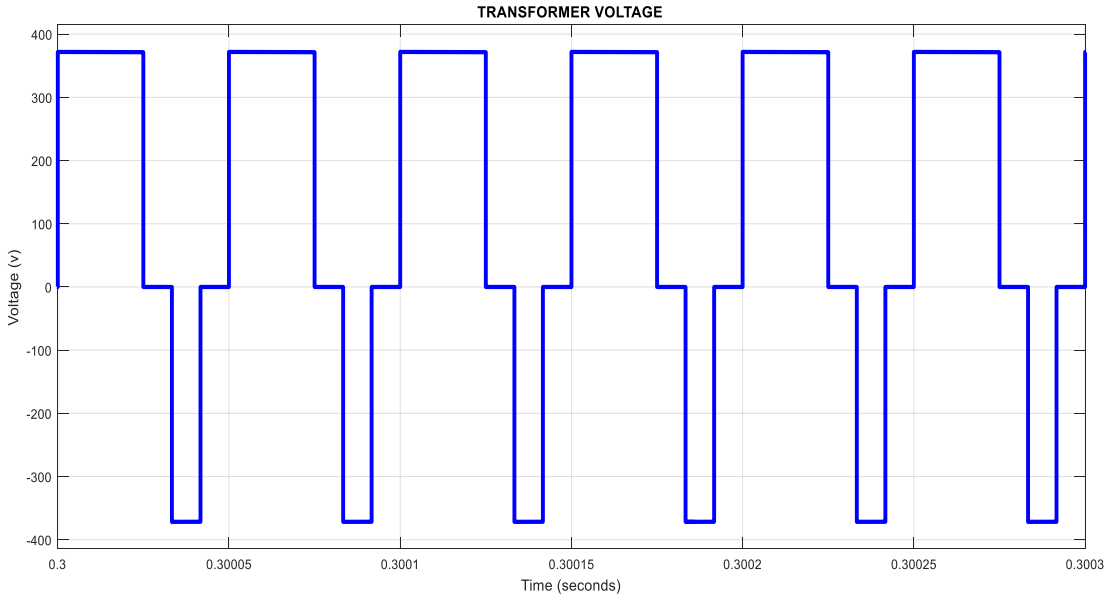

Figure 20 Transformer secondary side voltage

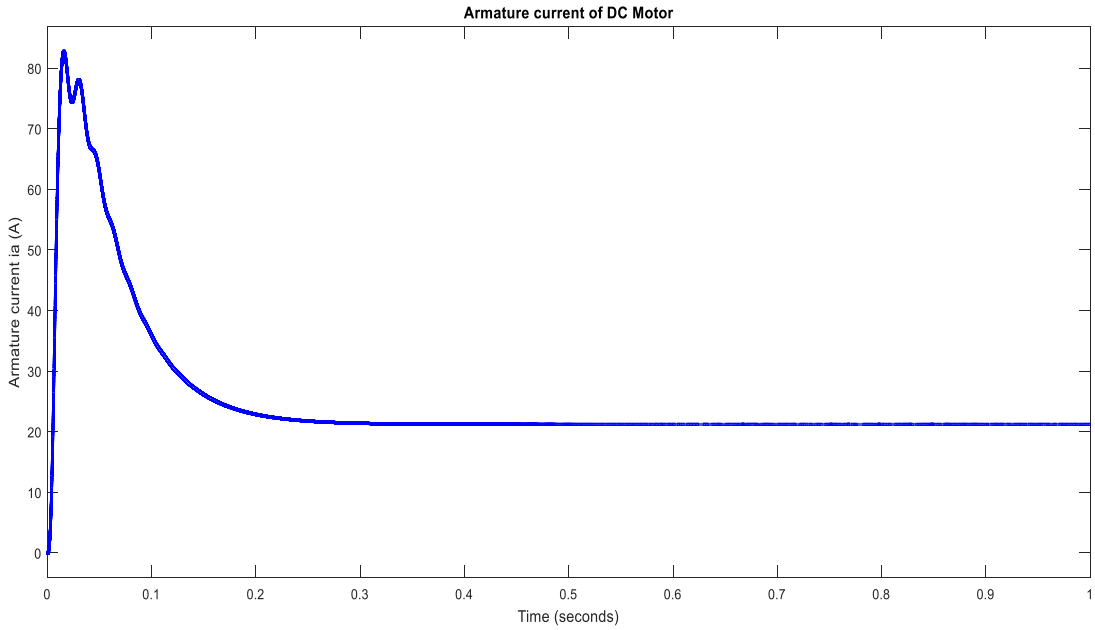

Figure 21 Armature current of dc motor

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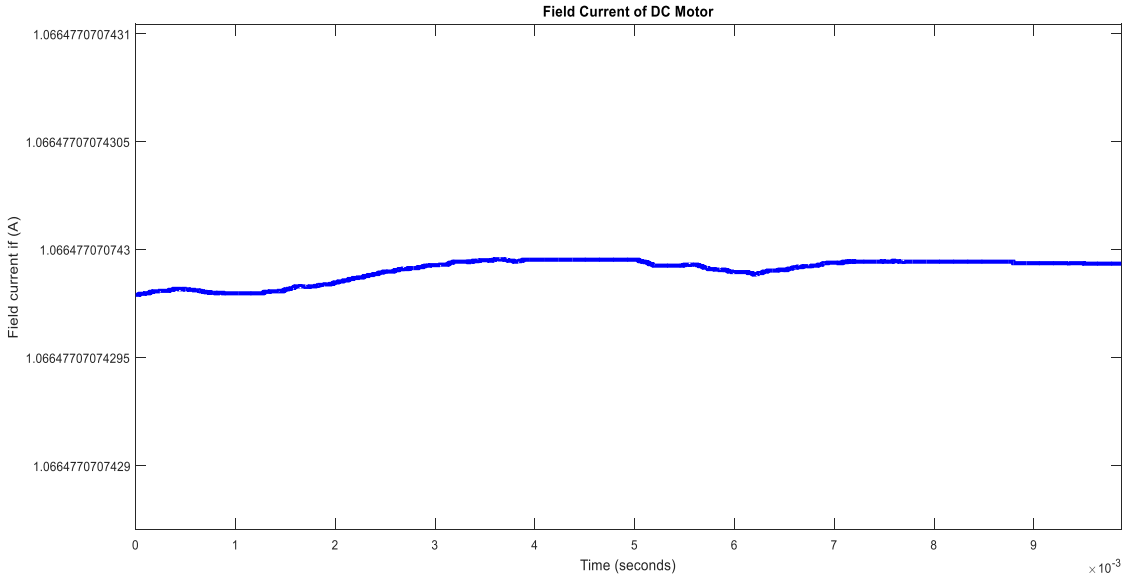

Figure 22 field current of dc motor

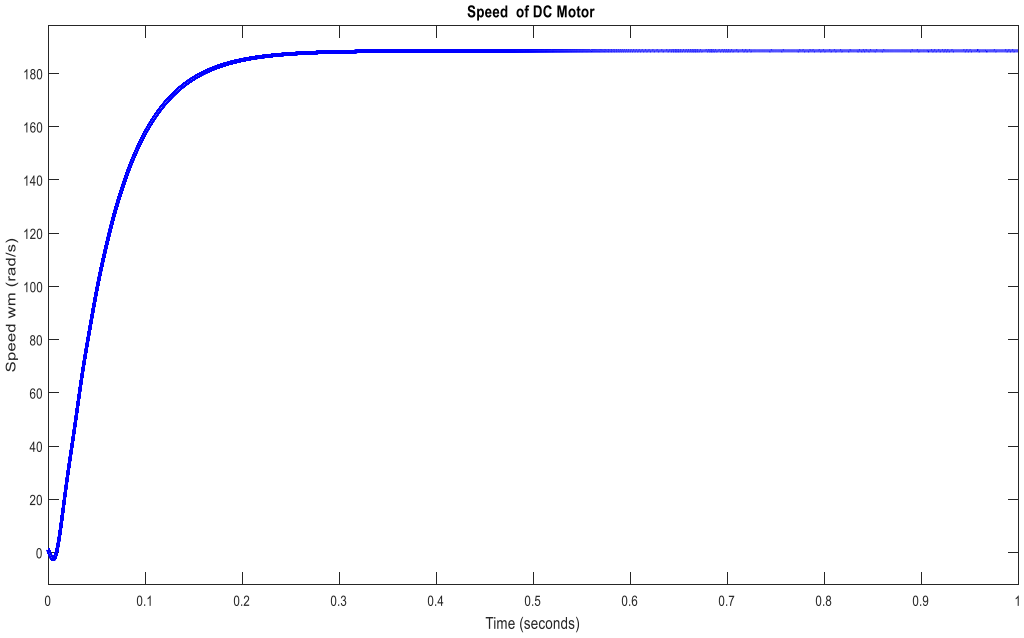

Figure 23 Speed of dc motor

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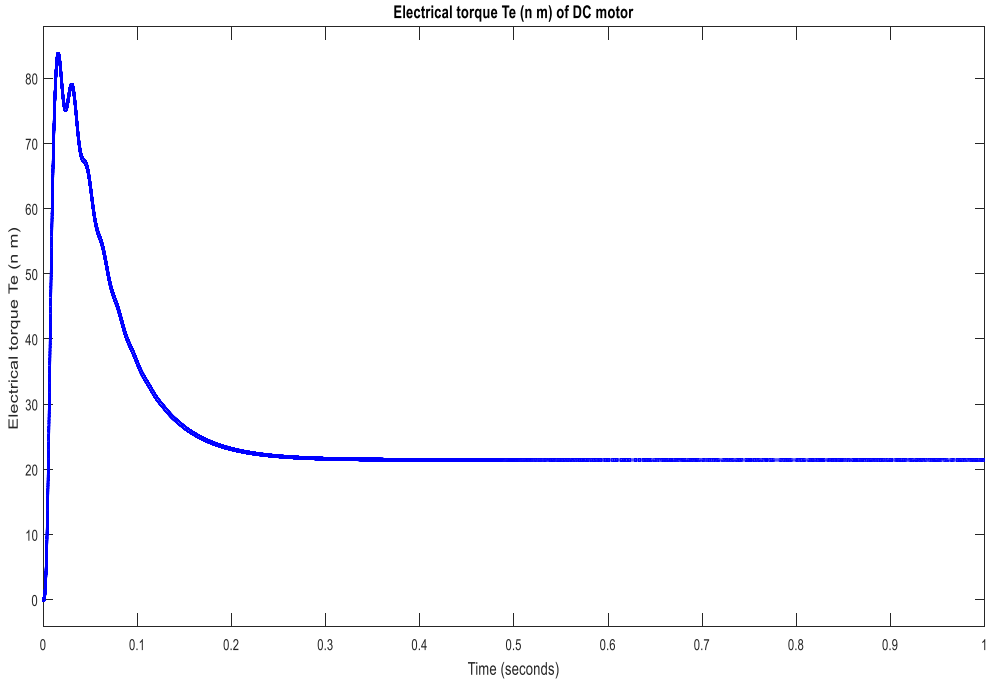

Figure 24 Electrical Torque

According to the fig. 10 is possible to verify that Switches blocked has voltage equal the input voltage so, they do not require use of auxiliary circuit .capacitor across voltage is 250constant and inductor across current is 16A as per the calculation. From fig.13 show the waveform of voltage in secondary side of transformer. by means of these result one can verify the correct operation of the converter by the comparing of theoretical wave form. From fig.14 to 16 motor speed ,Torque, field current , armature current characteristics has been shown.

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9. Conclusion

Observing the waveforms of voltage on the switches and transformer, it is possible to check that the practical results are identical to theoretical waveforms of the converter. This configuration is providing low ripple voltage and current. For this method SPWM technique is used for minimizing the output ripple magnitude. In this way, one of the focuses of this work is the converter becomes relevant for the design of bidirectional converters.

Future work

We will build a more powerful and high performance bidirectional isolated dc dc converter and achieve excellent speed control by exploring new different PWM switching techniques.

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AN
INDUSTRIAL TRAINING REPORT
ON
NILESH ENGINEERS

PREPARED BY
KACHHADIYA JENCY S.

ROLL NUMBER: 22

ENROLMENT NUMBER: 180301064

PROGRAM - B.B.A.
SEMESTER – 4
CLASS – A
ACADEMIC YEAR – 2019-20

GUIDED BY
MS.SAPNA DEVANI

SUBMITTED TO
FACULTY OF BUSINESS AND COMMERCE
DEPARTMENT OF MANAGEMENT
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Rajkot - 360005. (Gujarat) INDIA

वसुधैव कुटुम्बकम्

Date: 25/2/2020

COLLEGE CERTIFICATE

This is to certify that ~~Mr.~~/Miss Jency Kachhadiya of **B.B.A. SEM. - 4** has satisfactorily and successfully completed this Project Report under our guidance and supervision as per university rules and BBA curriculum. During the work he/she has been found sincere.

S. J. Devani

Ms. Sapna J. Devani
(Project Guide)

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Dr. Jayesh N. Zalavadia
(Head of Department)

Atmiya University

Head of Department
Department of Management
Faculty of Business & Commerce
Atmiya University
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CERTIFICATE

To whomsoever it may concern

We have pleased to certify that KACHHADIYA JENCY S., student of Bachelor of Business Administration from Atmiya University has successfully completed her 10 days training.

During her training, she was found to be Sincere, Enthusiastic, Hardworking and very much dedicated to her work. She has good knowledge and taken practical knowledge from our Executives.

We wish her all the best in her future endeavours.

Course: B.B.A.
Sem: 4th

For, ALL TYPES OF THRUST BEARINGS

Authorised Signatory

NILESH ENGINEERS
Sanjay
PROPRIETOR

Date:20th February,2020
Place: Rajkot

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Rajkot

DECLARATION

I undersigned, Jency kachhadiya
The students of B.B.A.SEM-4, hereby declare that Industrial training project report work titled **NILESH ENGINEERS** in this report is my own work and has been carried out under the supervision and guidance of Ms. Sapna Devani of Atmiya University

This work has not been previously submitted to any other university or other examination.

Date: 28/2/2020
Place: Rajkot

Jency Kachhadiya

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Rajkot

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Rajkot

ACKNOWLEDGEMENT

I feel great pleasure to present this Project report before you. I am thankful to members of unit who helped me in guidance and collecting necessary information.

I express my deepest sense of gratitude towards our college Prof: Sana Devani who has guided me in preparing project report and I am sure without their guidance and support my report would be looking very difficult for me to complete a project report with adequate information.

I am very much thankful and heartily grateful to Mr. Sanjay Patel, and employees of "***Nilesh Engineers.***" who have provided as sufficient guidance and necessary information about the firm, which I am incorporated in this report. I am also thankful to our HOD MR. JAYESH ZALAVZDIYA.

Date: 28/2/2020
Place: Rajkot

Jency Kachhadiya

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PREFACE

As per syllabus prescribed by the Atmiya University in B.B.A. course. There is an industrial visit in S.Y.B.B.A. for management course the practical study or practical training is of vital important. The theatrical knowledge and classroom discussion in not enough for a management student to know the various angles of a business unit visit plays very good role to develop the practical view point of student and also making them aware about of student and also making them aware about the problems opportunities and situations of industrial units.

I have prepared the report of the "***Nilesh Engineers***" with visit as my knowledge so there is possibility of mistakes. I collect information regarding various departments.

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INDEX

Sr. No.	Particular	Page No.
1	GENERAL INFORMATION	1-9
2	PERSONNEL DEPARTMENT	10-22
3	MARKETING DEPARTMENT	23-31
4	FINANCE DEPARTMENT	32-52
5	SWOT ANALYSIS	53-54
6	FUTURE PLANS	55-56
7	CONCLUSION	57-58
8	SUGGESTION	59-60
9	BIBLIOGRAPHY	61-62

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GENERAL INFORMATION

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INDEX

Sr. No.	Particular	Page No.
1.	Introduction	3
2.	History & Development	4
3.	Location of the Company	5
4.	Organisation Chart	6
5.	Size of the company	8
6.	Forms of Business Organization	
7.	Company Profile	9

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INTRODUCTION

Introduction is necessary for this unit their make different type of products.

Nilesh Engineers is a small scale business.All the staff member of Nilesh Engineers is very much cooperative they all believe us like a member of a company so I am very much thankful to the management of the company for giving me opportunity to take a industrial training.

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HISTORY OF THE COMPANY

Idea came up in the mind of its promoters from their success story of their brother's company, which was in to the field of manufacturing .

In the year of 1994 they started small factory. In this factory they have made BEARINGS. They start with 2(two) lakhs. They started their factory at Umakant Pandit Udhyognager, B/h Reliable Industry Rajkot- 360002.

NILESH ENGINEERS was incorporated as a PARTNERSHIP FIRM. They were making BEARINGS. Then they stated to make C.P. FLUSH COCKS. And they sold their item in first of all only in Rajkot and then in Saurashtra and then in all over India.

. They stared their sister concern with name of Rajdeep Industry at 2- Samrat Industrial Area, Gokuldham main roadRajkot 360 004.

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LOCATION OF THE COMPANY

The Company decided to locate its plant in Industrial Area due to some benefits provided by and its convenience of other factor which are described as below: -

Labors: -

As the Company requirement of labour are easily available for firm. Like Semi- skilled, unskilled etc., Semi-skilled Staff is easily available in local area, but unskilled labour is also easily available in local as well as out state like, Assam, Bihar, Orissa, etc.

Office:-

2-SAMRAT INDUSTRIAL AREA, NEAR KANERIYA OIL MILL,GOKULDHAM MAIN ROAD, RAJKOT, 360 004.

Factory:-

2-SAMRAT INDUSTRIAL AREA, NEAR KANERIYA OIL MILL,GOKULDHAM MAIN ROAD, RAJKOT, 360 004.

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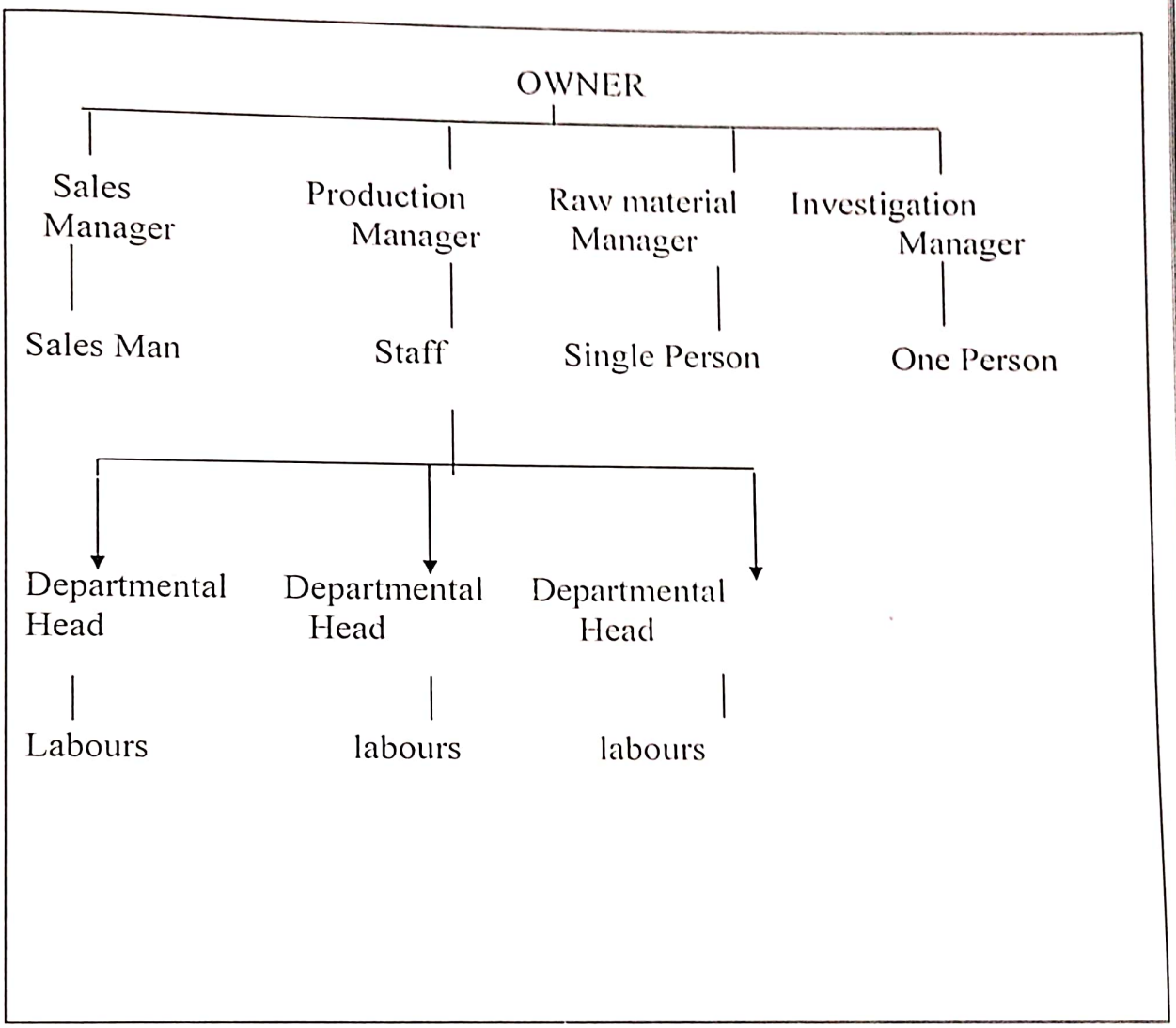
ORGANIZATION CHART

ORGANIZATION STRUCTURE.



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SIZE OF COMPANY

At first this was started as family firm (S.S.I.) Nilesh Engineers Rajkot, in 1994. Then company want on further developing next years.

Any kind of industries can be classified by its investment. It is classified as under:

S. S. I. [Small Scale Industries]
M. S. I. [Medium Scale Industries]
L. S. I. [Large Scale Industries]

Small scale industries have investment less than 3 crores.

Medium scale industries has investment more than 3 crores & less than 5 crores

Large scale industries is which is it investment is more than 5 crores.

In **Nilesh Engineers** investment is less than 3 crores so it is called as S.S.I.

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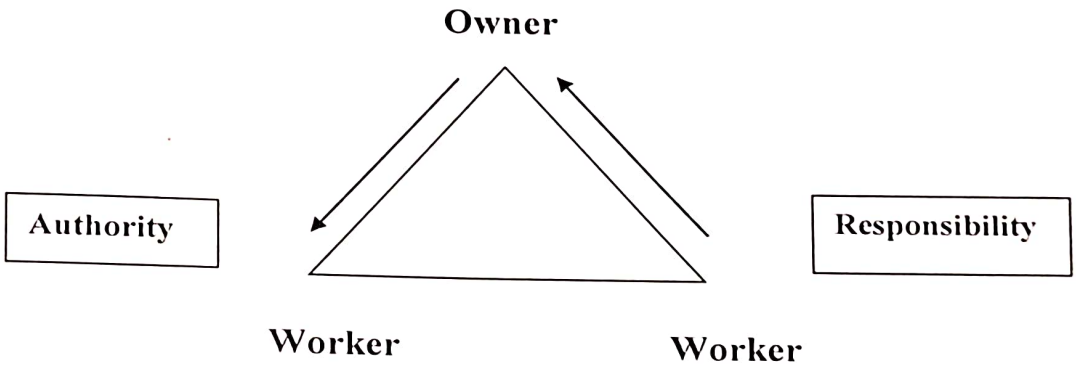
Forms of Business organization

Nilesh Engineers is small scale industry and all the business is managed by the owner.



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COMPANY PROFILE

1.Named of firm	:	Nilesh Engineers
2. Registered office	:	2- Samrat Industrial area, near kaneriya oil mill Rajkot - 360 004.
3. Registered Plant	:	2- Samrat Industrial area, near kaneriya oil mill Rajkot - 360 004.
4. Form of organization.	:	Sole proprietorship
5. Company Owner	:	Mr. Sanjay Patel
6. Size of unit	:	Small Scale Unit
7. Year of establishment	:	1994
8. Weekly rest day	:	Wednesday
9. Time keeping system	:	8:00 To 1:00 – 2:00 To 8:00
10. Auditors of the Company	:	Mr. Hitesh Parekh
11. Bankers	:	The Co-Operative Bank of Rajkot.
12. Total Employee	:	30 Employees

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HUMAN RESOURCE DEPARTMENT

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INDEX

-

Sr. No.	PARTICULAR	PAGE NO.
1.	INTRODUCTION	12
2.	ORGANIZATION CHART	13
3.	RECRUITMENT	14
4.	SELECTION	15
5.	TRAINING & DEVELOPMENT	16
6.	WAGES & SALARY	17
7.	Working of E.S.I. Scheme	18
8.	WELFARE FACILITY	19
9.	INDUSTRIAL RELATION	20
10.	GRIEVANCE HANDLING SYSTEM	21
11.	PERSONNEL RECORDS	22

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INTRODUCTION

`Personnel Management is the management of human resources in an organization and is concerned with the creation of harmonious working relationship among its participants and bringing about their utmost individual development. Such management is concerned with leadership in both groups and 'individual relationship' and 'labour relations' and 'personnel management'. It effectively describes the process of planning and directing the application, development and utilization of human resources in employment. In fact, personnel management undertakes all those activities, which are concerned with human elements or relations as well as with material element in an organization. Whatever functions are listed there in, the main objective of these functions is to bring together expertise in a scientific way and to create attitudes that motivate a group to achieve its goals economically, effectively and speedily.

Personnel management is a specialized branch of general management which is connected with establishment and maintaining the personnel relation with human beings. So, personnel management performs the crucial work for managing "MEN".

The personnel department is most powerful from other department personnel department include employees, labours, workers, and helpers.

Machine also makes the furniture but it not works it self so employees are must important for the production of products.

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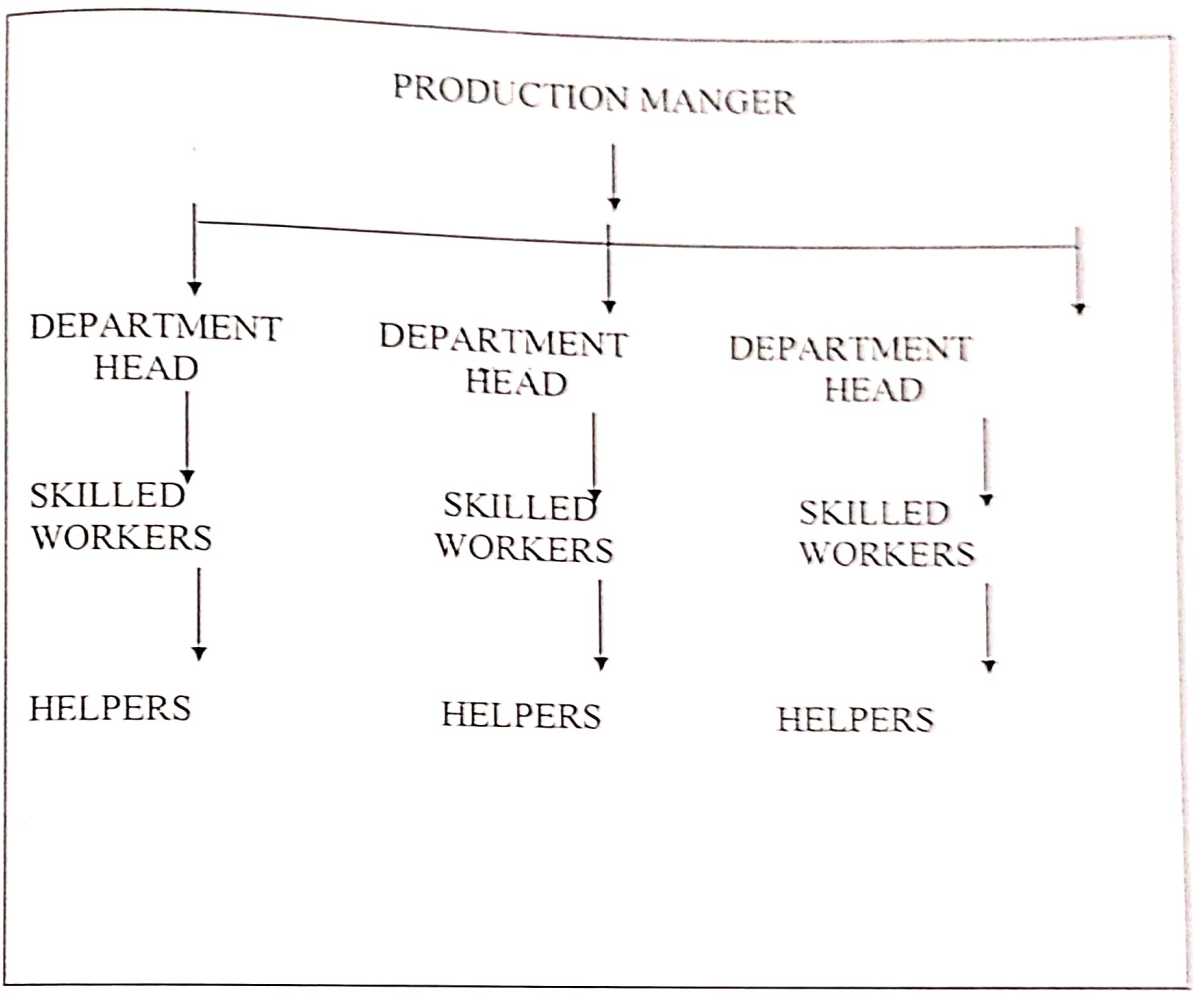
ORGANIZATION CHART



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RECRUITMENT

➢ **Recruitment: -**

Recruitment forms the first stage in the process which continuous with selection and ceases with the placement of candidates. It is the next step in the procurement function, the first being the manpower planning. Recruitment makes it possible to acquire the number and types of people necessary to ensure the continued operation of the organisation. *Recruiting is the discovering of potential applicant for actual or anticipated organizational vacancies.* In other words, it is a 'linking activity' bringing together those with jobs and those seeking jobs.

In Nilesh Engineers recruitment takes place when there arises vacancy. Recruitment process is done by simple method because it is a family base business.

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SELECTION

Selection

The selection procedure is concerned securing relevant information about an applicant. This information is secured in a number of steps or stages. The objective of selection process is to determine whether an applicant.

In Nilesh Engineers selection process uses only selecting qualified person. It is involve the following steps.

Application received
Screening of application
Interview
Merit list
Post or Placement

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TRAINING & DEVELOPMENT

Every organization needs to have well-trained and experienced people to perform the activities that have to be done. If the current or potential job occupants can meet this requirement, training is not important. But when this is not the case, it is necessary to raise the skill level and increase the versatility and adaptability of employee. Inadequate of job performance or a decline in productivity or changes resulting out of job redesigning or a technological break-through require some type of training and development efforts. As the jobs become more complex, the important of employee development also increases. In a rapidly changing society, employee training and development is not only an activity that is desirable but also an activity that an organization must commit resources to if it is to maintain a viable and knowledgeable work force.

"Training is the organized procedure by which people learn knowledge and for skill for a definite purpose."

- Dale S. Beach

In Nilesh Engineers training can be imparted on the job method there is another method, which is, not use in most of firm like classroom method, simulation method, etc. Nilesh Engineers has also given training to the students of different institution and colleges. I am also a trainee of Nilesh Engineers when I visited the unit. In Nilesh Engineers, senior employees informally train training.

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WAGES & SALARY

Salary is necessary for the workers because they work for rupees and this company gives salary as per the post of the person.
The salaries of every post are as under:

Helper	-	Rs. 80/- Per day
Unskilled Worker	-	Rs. 100/- Per day
Skilled worker	-	Rs.150/- Per day
Every Head	-	Fixed salary (Rs. 5,000 to 10,000 per month)

"Retrenchment compensation, payment in lieu of notice and gratuity payable on discharge constitute wages."

In Nilesh Engineers salary is given in monthly bases.

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WORKING OF E.S.I. SCHEME

It is the scheme organized by the state government for labour welfare. Its full form is "Employee State Insurance" under this scheme the worker when scheme the worker when meet with any type of accident within the firm campus, he is liable to get some medical aid, under this scheme every month 1.75% of basic salary is deducted from firm and employer also adds 4.75% of basic salary. Thus total contribution of E.S.I. scheme is 6.50% which is deposited in the workers account. This account is utilized by the company when the worker meets with an accident.

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WORKING OF E.S.I. SCHEME

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WELFARE FACILITY

Nilesh Engineers is small units so they not give any welfare facility to the workers but they provide other facility like, bonus commissions etc. are as follows

❖ **MEDICAL FACILITIES: -**

All the divisions are equipped with first Aid box and other medical treatments are provided of free of cost.

❖ **CANTEEN: -**

There is a canteen run by workers of Nilesh Engineers. It provides tea, coffee for staff. And R.O. system based water purification plant.

❖ **LOAN: -**

Loan facility is provided to the employees and executive by way of staff loan.

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INDUSTRIAL RELATION

Industrial relations refers to a dynamic and developing concept which is not limited to "the complex of relations between trade unions and management but also refers to the general web of relationships normally obtaining between employers and employees a web much more complex than the simple concept of labour capital conflict.

Industrial relations do not constitute a simple relationship, but are a set of functional, inter-dependent complexities involving historical, economic, social, psychological, demographic, technological, occupational, political, legal and other variables, and call for an inter- disciplinary approach to their study.

There is good industrial relation in Nilesh Engineers.

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GRIEVANCE HANDLING PROCESS

There is hardly any company or an industrial concern in which there may be n grievance. These grievances may be real or imaginary valid or unveiled broadly speaking it is complete affecting one or more workers.

In this unit only one recognized trade union. Generally its representatives solve the problem with the management on behalf of the workers. If the problem is serious and employees also can't solve it. Then the manager will help the workers to solve the problems.

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PERSONNEL RECORDS

Personnel records mean the preservation of information in files and document. They are generally prepared from reports & meant for long term use.

In this company a separate file is maintained for every individual about his personnel records. This file will have individually all the information about employees like age, education, qualification, and date of recruitment date of promotion if any warning notice is given either for irregularity or for misbehavior with colleagues and sub ordinates, then the suspension order is given to employees.

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MARKEING DEPARTMENT

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INDEX

Sr. No.	PARTICULAR	PAGE NO.
1.	INTRODUCTION	25
2	PRODUCT PLANNING	26
3	MARKET SEGMENTATION	27
4	PRICE POLICY	28
5	DISTRIBUTION CHART	29
6	ADVERTISEMENT POLICY	30
7	COMPETITORS	31

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INTRODUCTION

Marketing is a comprehensives term and it includes facilitate the flow of goods and services from producer to customer in the process of distribution. Marketing is actually a business process by which transfer of title and ownership are affected. By identifying the consumer's specific needs, desires and attitude towards new products, a systematic research data collection and planned organization is a primary need for success of market.

Business refers the marketing process, as distributions process, human efforts, finance and management constitute the primary resources in marketing.

In this unit the word marketing is the utility of the item or products produced by them.

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PRODUCT PLANNING

Each product level (product line, brand) must develop a **marketing plan** for achieving its goals. The marketing plan is one of the most important outputs of the marketing process. Marketing plans are becoming more customer- and competitor-oriented and better reasoned and more realistic than in the past. The plans draw more inputs from all the functions and are team-developed. Marketing executives increasingly see themselves as professional managers first, and specialist second. Planning is becoming a continuous process to respond to rapidly changing market conditions. The trends we have discussed so far are in full force in the world of marketing.

At the same time, marketing planning procedures and content very considerably among companies. The plan is variously called a "business plan", a "marketing plan", and sometimes a "battle plan". Some companies take their plans very seriously, where as others see them only as a rough guide to action. Eisenhower once observed: "In preparing for battle I have always found that plans are useless but planning is indispensable." The most frequently shortcoming of current marketing plans, according to marketing executives, are lack of realism, insufficient competitive analysis, and a short-run focus.

Nilesh Engineers has got wide range of product for different application.

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MARKET SEGMENTATION

Segmentation or subdivision of the market is based upon the modern marketing concept i.e. market-oriented strategy and philosophy. Segmentation gives special emphasis on the demand side of the market. It is a more rational and more precise adjustment of the product and marketing effort is tuned with consumer or user needs and requirements. Segmentation implies bending of supply to the will of demand as far as feasible and desirable.

Market segmentation is a method for achieving maximum market response from limited marketing resources by recognizing differences in the response characteristics of various parts of the market. Segmentation is an answer to the question, "To whom should we sell our products, and what should we sell them?" as opposed to tactical choice, "doing things right".

Geographic location is the usual and popular basis for market segmentation. Distinction between urban and rural markets is still of great importance in India. AMT is following the Geographical Segmentation as its market structure is divided in India's different zones. The whole market is divided in the five zones.

1. Gujarat
2. Delhi
3. Bombay
4. Calcutta
5. Chennai

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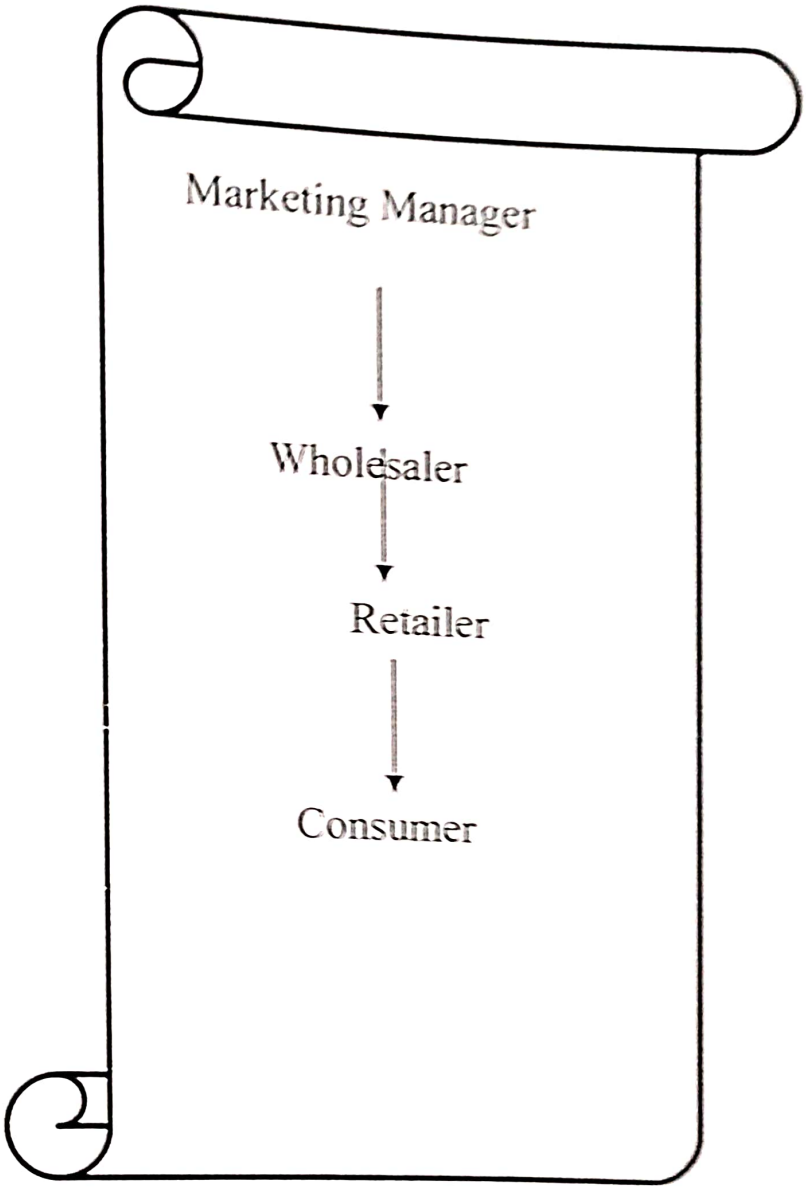
PRICE POLICY

Price is the one element of the marketing mix that produces revenue; the other element produce costs. Prices are the easiest marketing-mix element to adjust; product features, channels, and even promotion take more time. Price also communicates to the market the company's intended value positioning of its product or brand.

Pricing policy means policies related to the price of a product. An organization is having various price options for a particular product. A number of factors affect such pricing decision. A firm may choose various kinds of pricing methods, for their various products.

In Nilesh Engineers, prices are decided according to marketing policy for most of its product and for some quality products, prices are decided according to competitor's price method.

DISTRIBUTION CHART



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ADVERTISEMENT POLICY

Advertising is any paid form of non-personal presentation and promotion of ideas, goods, or services by an identified sponsor. Advertisers include not only business firms, but also museums, charitable organizations, and government agencies that direct message to target publics.

Advertising appears in the recognized media such as newspapers, magazines, radio.

In Nilesh Engineers, they give their advertisement in Telephone directory, Yellow Pages, Rajkot Engineering Association Book.

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COMPETITORS

In each and every company there are competitors. Competitors are the company who make same product of the company. In short the company which is making substitute of the company.

There are some competitors of the Nilesh Engineers, they are as follows.

1. Jyoti Industries
   3, Laxmi Nagar,
   Rajkot.

2. Gopal Engineering Works
   Aji Industrial Estate,
   Plot No. 29,
   Rajkot.

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FINANCE DEPARTMENT

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Rajkot

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Rajkot

INDEX

Sr. No.	PARTICULAR	PAGE NO.
1.	INTRODUCTION	34
2.	ORGANIZATION CHART	35
3.	FINANCIAL PLANNING	36
4.	CAPITALIZATION	37
5.	CAPITAL BUDGETING	50
6.	CAPITAL INVESTMENT	51
7.	SOURCES OF FINANCE	52

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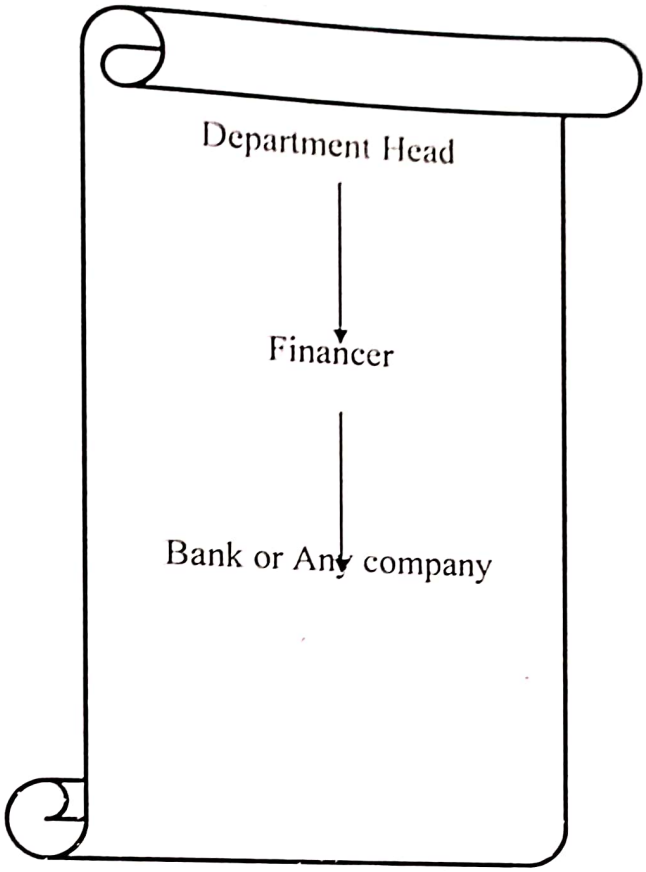
Rajkot

INTRODUCTION

Financial management is that managerial activity which is concerned with the planning and controlling of the firm's financial resources. Though it was a branch of economics till 1890. as a separate activity or discipline it is of recent origin. Still, it has no unique body of knowledge of its own, and draws heavily on economics for its theoretical concepts even today.

The subject of financial management is of immense to both academicians and practicing managers. It is of great interest to academicians because the subject is still developing, and then there are still certain areas where controversies exist for which no unanimous solutions have been reached as yet. Practicing managers are interested in this subject because among the most crucial decisions of the firm are those which relate to finance, and an understanding of the theory of financial management provides them with conceptual and analytical insights to make those decisions skillfully.

ORGANIZATION CHART



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FINANCIAL PLANNING

Growth in sales is an important objective of most firms. An increase in a firm's market share will lead to higher growth. The firm would need assets to sustain the higher growth in sales. It may have to invest in additional plant and machinery to increase its production capacity. Also, it would need additional current assets to produce and sell more goods or services. The firm would have to acquire raw material convert them in to finished goods after incurring manufacturing expenses. It may have to sell goods on credit because of the industry norms or to push up sales. This gives rise to debtors or accounts receivables. The suppliers of raw materials may extend credit to the firm. The firm may use its internally generated funds to finance current and fixed assets. When the firm grows at a high rate, internal funds may not be sufficient. Thus, the firm would have to raise external funds either by issuing by equity or debt or both. The process of estimating the funds requirements of a firm and determining the sources of funds is called financial planning.

There are three types of financial planning.

- Short term planning for 1 year.
- Medium term planning for 5 year.
- Long term planning for 10 year.

In Nilesh Engineers, the financial planning is long term & also short term. In Raj deep industry there only short term loan.

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CAPITALIZATION

Capitalization means the total accounting value of capital stock, surplus in whichever from it may appear and funded long debt. Capitalization means total amount of company's capital or total value of its capital stock.

In simple words we can say that valuation of capital as business means capitalization form accounting point of view. Capitalization means accounted funds which have been insisted for some business purpose to earn rate of return.

TYPES OF CAPITALIZATION

1) **Fair Capitalization** = Book Value = Real Value
2) **Under Capitalization** = Book Value < Real Value
3) **Over Capitalization** = Book Value > Real Value

In other profit making industries, expenses are capitalized as per their profit margin. If profit is low, expenses are capitalized.

This firm is sole proprietorship Firm so that all capital is taken by the owner.

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1st year-2016-17

Trading Account					
Particulars			Amount (Rs.)	Particulars	Amount (Rs.)
To Purchase A\c			7609500	By Sales A\c	9000000
To Electricity Phase A\c	Electricity Phase		60000		
To Freight Inward	Water Expenses		4800		
To salary A\c	Unskilled Labour	24000	24000		
To Gross Profit			1085700		
			9000000		9000000

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1st year 2016-17

Profit and Loss Account

Particular			Amount (Rs.)		Particular			Amount (Rs.)
To	Salary A\c:		174000					
	General Mgr	84000			By	Gross Profit		1085700
	Accountants	3000						
	Dyer	18000						
	Peon	24000						
	Supervisor	18000						
To	Depreciation		142500					
	Building	100000						
	Plant & Mach.	12000						
	Other fixed Asset	10500						
	Computers	2000						
To	Stationery Exp	9600						
	Telephone Exp	14600						
	Misc Exp	6000						
	Inter on Loan	162500						
	Transport Exp	3600						
	Packaging Exp	36000						
	Loan Installment	250000						
	NET PROFIT		286900					
			1085700					1085700

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1st year 2016-17

Balance Sheet

Liabilities		Amount (Rs.)	Assets		Amount (Rs.)
Capital Account:			**Fixed Assets:**		
Neel vyas		1030600			
Net Profit		286900	Land	900000	900000
Secured Loans:			Building	1000000	
H.D.F.C Bank Loan		1250000	Less: Depreciation	100000	900000
			Printing Tables	240000	
			Less: Depreciation	12000	228000
			Other Assets		
			Furniture	5000	
			Less: Depreciation	7500	42500
			Computer	50000	
			Less: Depreciation	20000	30000
			Motors	20000	
			Less: Depreciation	3000	17000
			Bank		

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			Balance:		
			IDBI Bank A\c		400000
			Cash in Hand:		
			Cash Balance		50000
		2567500			2567500

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2nd Year 2017-18

Trading Account

Particular			Amount (Rs.)		Particular	Amount (Rs.)
To Purchase A\c			7605900		By Sales A\c	9450000
To Electricity Phase A\c	Electricity Expenses		6300			
To Freight Inward A\c	Water Expenses		5040			
To Salary A\c:						
	Unskilled Labour	252000	252000			
To Gross Profit			1580760			
			9450000			9450000

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2nd Year 2017-18

Profit and Loss Account

Particular			Amount (Rs.)		Particular			Amount (Rs.)
To	Salary A\c		177900					
	General Mgr	85000			By	Gross Profit		1580760
	Accounts	30500						
	Dyer	18900						
	Peon	25000						
	Supervisor	18500						
To	Depreciation:							
	Building	100000						
	Plant & Mach.	12100						
	Other fixed Asset	110000						
	Computers	20500						
To	Stationery Exp	10000						
	Telephone Exp	15000						
	Interest on Loan	162500						
	Misc Exp	6300						
	Transport Exp	3780						
	Packing Exp	37800						
	Loan Installment	250000						
	NET PROFIT		784880					
			1580760					1580760

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2nd Year 2017-18

Balance Sheet

Liabilities		Amount (Rs.)	Assets		Amount (Rs.)
Capital Accounts :			**Fixed Assets**		
Neel vyas		1300000	Land	1058480	1058480
Net Profit		784880			
Secured Loans :			Building	1400000	
H.D.F.C Bank Loan		1250000	Less: Depreciation	100000	1300000
			Printing Tables	300000	
			Less: Depreciation	12100	287900
			Other Assets		
			Furniture		100000
			Computer	57000	
			Less: Depreciation	20500	36500
			Motors		22000
			Bank Balance:		
			IDBI Bank A\c		450000
			Cash Balance		80000

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		3334880				3334880

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3rd Year 2018-19

Trading Account

Particular		Amount (Rs.)	Particular	Amount (Rs.)
To Purchase A\c		8750925	By Sales A\c	10350000
To Electricity Phase A\c		69000		
To Freight Inward A\c		5520		
To Salary A\c				
	Unskilled Labour	276000		
To Gross Profit		1248555		
		10350000		10350000

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3rd year 2018-19

Profit and Loss Account

Particular			Amount (Rs.)	Particular		Amount (Rs.)
To	Salary A\c		200100	By	Gross Profit	1248555
	General Mgr	96600				
	Account	34500				
	Dyer	20700				
	Peon	27600				
	Supervisor	20700				
To	Depreciation		167325			
	Building	115000				
	Printing Table	13800				
	Other Fixed Asset	12075				
	Computer	23000				
	Motor	3450				
To	Stationery Exp		11040			
	Telephone Exp		16790			
	Misc Exp		6900			
	Interest on Loan		186875			
	Transport Exp		4140			
	Packaging Exp		41400			
	Loan Installment		287500			
	NET PROFIT		326485			
			1248555			1248555

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3rd Year 2018-19

Balance Sheet

Liabilities	Amount (Rs.)	Assets		Amount (Rs.)
Capital Account :		**Fixed Assets:**		
Neel vyas	1185190	Land		1035000
Net Profit	326485	Building	1150000	
		Less: Depreciation	115000	1035000
Secured Loans :				
		Printing Table	276000	
H.D.F.C Bank Loan	1437500	Less: Depreciation	13800	262200
		Other Assets		
		Furniture	57500	
		Less: Depreciation	8625	
		Computer	57500	
		Less: Depreciation	23000	34500
		Motors	23000	
		Less: Depreciation	3450	19550
		Bank Balance :		
		IDBI Bank A\c		460000

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			Cash in hand		
			Cash Balance		57500
		2903750			2903750

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CAPITAL BUDGETING

Capital budgeting is a very important process of selection of investment proposal benefit which is likely to be available in future. The process of taking decision is to which assets should be purchased and how to send the funds for these purpose is called capital budgeting.

Capital budgeting is of paramount importance as the framework of future development & major determinant of efficiency & competitive power of a firm. It relates of fixed assets that are in operations & yield return over a period of time. Capital budgeting on a long term basis is on essential part of fixed assets management. The decision with regard to long term fixed assets are widely known as Capital budgeting.

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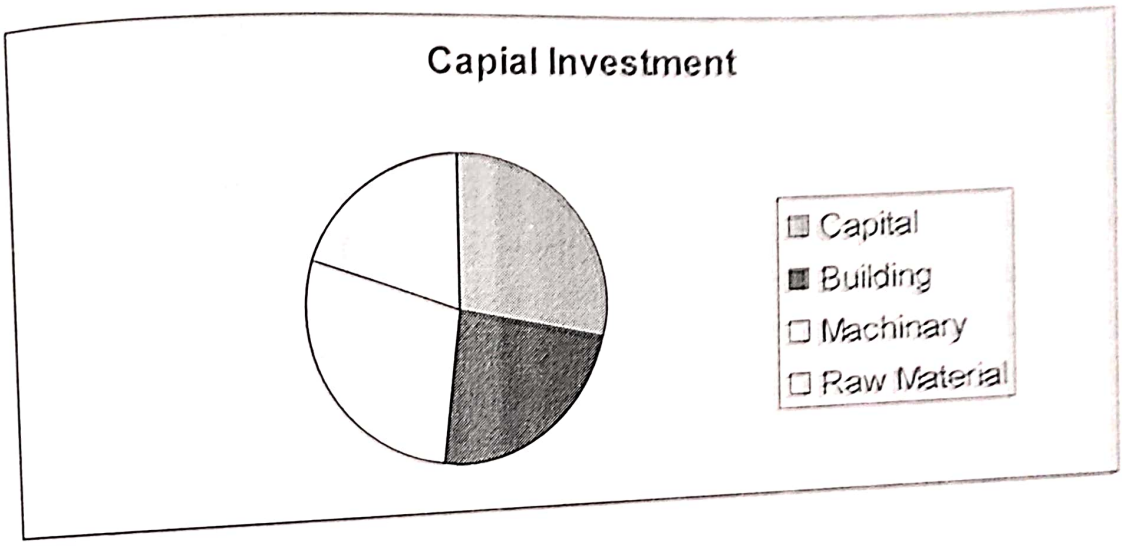
CAPITAL INVESTMENT

This company's total capital investment is 2 crores and it includes building, machinery, and raw material etc.



LOANS & BORRWING

For the needed of money it is necessary to take loan or borrow money. This company also gets loan from different places. Like,

HDFC BANK CAR LOAN	403054
	658399
Sanjay Patel	1061453
Total -	

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SOURCES OF FINANCE

Adequate sources of capital must be developed by every business concern. For small and medium-sized companies, the supply of capital is a frequently a limitation on the successful execution of many policies and programmers. A business run by a sole trader or a partnership mainly relies on personal savings and the business assets of the owners. But further growth or expansion is severely limited for want of additional capital in the case of all proprietary concerned. In the case of companies vast amount of capital can be easily raised from a number of sources, provided the management is competent and honest. The principal sources of capital available to most companies may be classified as under: (1) owners, (2) long term creditors, (3) short term creditors.

Nilesh Engineers gets finance from bank and also own capital.

Banks like,

- Co- operative bank of India–Rajkot.
- State Bank of India Rajkot.

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SWOT ANALYSIS

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SWOT ANALYSIS

- **Strength:-**

Nilesh Engineers never compromises with quality of the Ball valves quality is the strength or this unit.

- **Weakness:-**

During my training program I have never seen any weakness of Nilesh Engineers this unit believes good quality production.

- **Opportunity:-**

Whenever Nilesh Engineers has an opportunity to prove it self, they never missed any opportunity.

- **Threats:-**

There are many company which producing Ball valves in Rajkot but, Nilesh Engineers has never threats of its competitors' because this units product is a best other company's product so there is no question of threats.

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FUTURE PLAN

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FUTURE PLAN OF THE COMPANY

Global level, to fetch and to achieve standard quality the company will be establishing quality control department. The company has already got documentation system as per ISO Norms and may even go for ISO 9000-9001 in future.

To developed and expand its production and operation, the company is also going to make an R & D department with required laboratories and to its equipment in near future.

As the second line of production is being installed, the company will be able to manufacturer the economy of the scale with more wait age of product.

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CONCLUSION

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CONCLUSION

From the foregoing discussion it can be concluded that the firm owns considerable status in internal as well as in international market of its field. It is highly significant that it has grown with the help of its power and without any collaboration. It has been successful in maintaining high standard quality. Nilesh Engineers has created optimum utilization of its resources. Many giant companies have reposed their trust and expectations in the firm.

All the workers have joined hand to hand for achievement of industry. The success of their industry is the result of efficiency of management efforts of employee and his good co-ordination.

Thus in the context of the above achievement, it is certain that Nilesh Engineers future will be magnificent.

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SUGESTION

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SUGGESTION

I think if company more expanse in advertisement so company will capture the market and make good will in the market and if company pay to sales in more percentage than after company's good will increase in the stock exchange and market.

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All these information I gathered from the books and link.Which is given below:

SR. NO.	BOOK NAME	AUTHOR NAME	PUBLICATION	EDITION
1	MARKETING MANAGEMENT	S.A.Sheriekar	Himaliya publishing house	7th
2	HUMAN RESOURCES MANAGEMENT	K.Aswathapa	Tata magrow	3th
3	FINANCIAL MANAGEMENT	B.S. Shah	Tata magrow hill	3rd
4	PRINCIPAL & PRACTICE OF MANAGEMENT	L.M.Prasad	Himaliya publishing house	13th

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