3.4.1	The institution ensures implementation of its stated Code of Ethics for research

S.N.	Department	Program Name	Research Methodology, Ethics Course Detail	Page No.
1	Microbiology	B.Sc. Microbiology	18BMBDC502 Bioethics and IPR	3
2	Microbiology	B.Sc. Microbiology	18BMBDC502 Bioethics and IPR Practical	5
3	Microbiology	B.Sc. Microbiology	18BMBDC602 Fundamentals of Research Methodology	8
4	Microbiology	Ph.D. Microbiology	19PMBCC101 Core I - Research Methodology	11
5	Microbiology	B.Sc. Microbiology	21BMBCL401 Biosafety and Intellectual Property Rights	24
6	Biotechnology	Ph.D. Biotechnology	19PBTCC101 Core I - Research Methodology	32
7	Chemistry	Ph.D. Chemistry	19PCHCC101 Core I - Research Methodology	59
8	Industrial Chemistry	Ph.D. Industrial Chemistry	19PICCC101 Core I - Research Methodology	69
9	Mathematics	Ph.D. Mathematics	19DPMTCC101 Course I - Research Methodology	79
10	Commerce	Ph.D. Commerce	19DPCMCC101 Course I - Research Methodology	85
11	Electronics & Communication	Ph.D. Electronics & Communication	19PECCC101 Core I - Research Methodology	96
12	Civil Engineering	Ph.D. Civil Engineering	19PCICC101 Core I - Research Methodology	112
13	Mechanical Engineering	Ph.D. Mechanical Engineering	19DPMECC101 Core I - Research Methodology	126
14	Pharmacy	Ph.D. Pharmacy	19DPPHCC101 Course I - Research Methodology	134

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Semester – V

Course Code	Course	Hrs- of Instructions/wk			Exam Duration hrs	Marks allotted			Credits
		Th	Pr	Tu		CIA	SEE	Total	
Part –II									
18BMBCC501	**Core 11**: Medical Microbiology	4	-	-	3	30	70	100	4
18BMBCC502	**Core 12:** Biostatistics & Bioinformatics	4	-	-	3	30	70	100	4
18BMBCC503	**Core 13**: Microbiology and Health Care (Self Study)	1	-	-	3	30	70	100	4
18BMBCC504	**Core 14:**CBT (Computer Based Test for Core Courses of Sem I to V)	-	-	-	2	100	-	100	1
18BMBDC501/ 18BMBDC502	**DSE-Core 1** Quality Assurance and Quality control / Bioethics & IPR	4	-	-	3	30	70	100	4
18BMBCC505	**Core Practical- 5** Medical Microbiology & Bioinformatics Practical	-	9	-	6*	40	60	100	3
18BMBDC503/ 18BMBDC504	**DSE-Core 1 –Practical** Quality Assurance and Quality Control Practical / Bioethics and IPR Practical	--	2	-	3	20	30	50	1
	Research Project / Training / Internship	-	4	-	-	-	-	-	-
18BMBGE01	**Generic Elective-1-** From Common UG Pool	2	-	-	-	100	-	100	2
	TOTAL	**30**						**750**	**23**

***3 hrs each Day for 3 days**

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18BMBDC502	DSE-Core 1 Bioethics and IPR	4hrs/week	4Credits

Objectives

- This part of the syllabus helps the students to understand the ethical, social, legal aspects in biology and bio containment

Unit 1: Bioethics **12 hrs**

- Bioethics - legal and socioeconomic impacts
- ethical concerns of biological research and innovation,
- Bioethics committees and guidelines for biosafety
- stem cell research
- The Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA)

Unit 2: Intellectual Property Rights **12 hrs**

Intellectual property rights-Definition, Types

- Patent
- Copyright
- Trade mark
- Plant Breeders Rights (PBR)
- World Trade Organization (WTO)

Unit 3: Patents and Patent Laws **12 hrs**

- Patenting laws-Legal development
- Patentable subjects
- Trade Related Aspects in Intellectual Property(TRIPS)
- protection in biology
- The patenting of living organisms

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Unit 4: Biosafety **12 hrs**

- GLP - Containment facilities
- Biosafety levels - Genetically modified organisms and its release
- Genetically modified foods
- Biosafety guidelines in India
- International guidelines

Unit 5: Biodiversity **12 hrs**

- Elements of Biodiversity
- Ecosystem Diversity
- Genetic Diversity
- Species Abundance
- Importance of Diversity

Text Books:

1. Sasson Albert, Biotechnologies and Development, UNESCO Publications, 1988.
2. Singh K, Intellectual Property rights on Biotechnology 2010, BCIL, New Delhi,

Reference book

1. Sasson Albert. Biotechnologies in developing countries present and future, UNESCO publishers, 1993
2. Shaleesha A. Stanley, Bioethics, Wisdom educational service, 2008, Wisdom Educational Service
3. Beier, F.K., Crespi, R.S. and Straus, T. 1985 Biotechnology and Patent protection- Oxford and IBH Publishing Co. New Delhi,
4. Biotechnology by U. Sathyanarayana, 2009, Books and allied (p) Ltd
5. Biotechnology by B.D.Singh, 2009 Kalyani publishers,

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18BMBDC504	DSE-Core Practical 1 Bioethics and IPR Practical	2 Hrs/week	1 Credits

Course Objectives:

The student shall be able to:

1. Acquire knowledge about patent laws.
2. Understand the role of different government bodies
3. Identify different domains of biodiversity

List of Practical

1. Case study of Patenting (Basmati patent).
2. To study various biodiversity hot spots.
3. Patent prior art search.
4. Patent drafting / claim drafting.

Reference books:

1. K.C. Kankanala, (2012) Indian Patent Law and Practice, Oxford India Publication,
2. M. B. Rao & Manjula Guru, (2010) Patent Law in India, Wolters Kluver Publication,
3. Ademola A. Adenle, E. Jane Morris, Denis J. Murphy, (2017) Genetically Modified Organisms in Developing Countries: Risk Analysis and Governance, Cambridge University Press
4. K. D. Raju, Genetically Modified Organisms: emerging law and policy in India, Tata Energy Research Institute (TERI) Press

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Semester – VI									
Course Code	Course	Hrs- of Instructions/wk			Exam Duration hrs	Marks allotted			Credits
		Th	Pr	Tu		CIA	SEE	Total	
Part –II									
18BMBCC601	**Core 15**: Molecular Biology and Genetic Engineering	4	-	-	3	30	70	100	4
18BMBCC602	**Core 16:** Industrial Microbiology	4	-	-	3	30	70	100	4
18BMBDC601/ 18BMBDC602	**DSE Core 2** Advances in Microbiology / Fundamentals of Research Methodology	4	-	-	3	30	70	100	4
18BMBCC603	**Core Practical-6** Industrial & Molecular Techniques Practical	-	9	-	6*	40	60	100	3
18BMBDC603/ 18BMBDC604	**DSE Core 2 Practical** Advances in Microbiology Practical / Fundamentals of Research Methodology Practical	-	2	-	2	20	30	50	1
18BMBCC604	**Research Project / Training / Internship**	-	5	-	-	50	50	100	2
18BMBGE02	**Generic Elective-2** From Common UG Pool	2	-	-	3	100	-	100	2
		30						**650**	**20**

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18BMBDC602	DSE Core 2 Fundamentals of Research Methodology	4 hrs/week	4 Credits

Objectives

- After completion of this course, student will be able to:
- Understand the concept of research and importance of studying research methodology
- Gain knowledge regarding various components of research
- Distinguish between various scientific documents
- Understand the concept of thesis writing
- Gain elementary knowledge regarding application of statistics in research

Unit 1: Introduction to Research Methodology **12 hrs**

- Introduction to Research and Research Methodology
- Objective of Research
- Types of research
- Significance of research
- Process of Research

Unit 2: Components of Research **12 hrs**

- Defining research problem
- Designing research
- Sample and sampling
- Data Collection
- Data Analysis

Unit 3: Scientific documents and standards **12 hrs**

- Scientific Documents: Types
- Journals: Types and properties.
- Publication: Types
- Quality of Journal: Impact Factor, Citation
- Publication ethics: Plagiarism

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Unit 4: Dissertation/Thesis Writing and Presentation **12 hrs**

- Modes of presenting scientific data
- Basics of poster presentation
- Reports and dissertation
- Steps to write scientific report
- Steps to write dissertation thesis

Unit 5: Elementary statistics for Research **12 hrs**

- Data collection and sampling
- Hypothesis
- Hypothesis testing
- Measures of central tendency: Mean, Mode, Median
- ANOVA , Chi Square test

Text book:

1. Kothari C.R. (2004) Research Methodology. 2nd Edition, New Age International Publisher.

Reference book:

1. Panneerselvam R (2013) Research Methodology, 2nd Edition, Prentice Hall India Learning Private Limited
2. Chawla Deepak and Sondhi Neena (2016) Research Methodology: Concepts and Cases: Concepts & Cases 2nd Edition, Vikas Publishing House.

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M.Phil./Ph.D. Course Work

Scheme for Microbiology
(From A.Y. 2019 and onwards)

Preamble

The Atmiya University, offers M.Phil. & Ph.D. programmes in Microbiology being its major research discipline. Considering the magnitude of research in present scenario and to augment the quality of research the syllabus for the Course Work, named as the M.Phil./ Ph.D. Course Work, as a prerequisite to continue with the programme in Microbiology discipline, has been designed.

The course work aims to provide a full research based program to equip the students with necessary tools so that the students can grasp the area of study better as well as improve on their scientific writing skills, which is essential in any kind of quality research. The course further aims at familiarizing the perspectives, pedagogy and their implications in various areas of investigations.

As per the university ordinance and new guidelines of UGC, the research scholars who are provisionally registered under the M.Phil./Ph.D. Programme will have to undergo a Pre- Ph.D. Course Work.

The main objectives of the Course Work is to inculcate the following qualities in the Research Scholar:

- **Inquisition:** The ability to inquire about the research problem and to relate this with current socio-economic scenario.
- **Understanding:** Understand the theories that strengthen their dissertation research, with the depth needed to produce their own hypothesis and find out the research gape.
- **Analysis:** Student will be able to design the experiment and analysis the research problem.
- **Interpretation:** Interpret and compare the research outcomes.
- **Assessment:** Appraise the results and draw a conclusion.
- **Writing, editing, proof reading and designing:** Ability to write the scientific draft (*viz.* manuscript, review article, book chapter, research proposal etc)

Programme Structure

The M.Phil./Ph.D. course work shall comprise of Two Semesters (i.e. one Year) in which there shall be **four** compulsory courses:

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Semester I							
Course Code	**Course**	**Hrs of Instruction / week**	**Exam Duration (Hrs)**	**Max Marks**			**Credit**
				CIA	**SEE**	**Total**	
19PMBCC101/ 19MPMBCC101	**Course I -** Core I - Research Methodology*	4	3 Hr	30	70	100	4
19PMBCC102/ 19MPMBCC102	**Course II -** Core II - Seminar Presentation	-	-	50	-	50	1
Total		**4**		**80**	**70**	**150**	**5**
***80% of the total syllabus of Research Methodology is common to all discipline across the University while the rest 20% will be discipline specific.							
Semester II							
19PMBDC201/ 19MPMBDC201	**Course III - Discipline Specific Elective Core I -** Advanced Techniques in Biotechnology	4	3 Hr	30	70	100	4
19PMBDC202/ 19MPMBDC202	**Discipline Specific Elective Core II -** Advanced Techniques in Microbiology						
19PMBDC203/ 19MPMBDC203	**Discipline Specific Elective Core III -** Methods of Culture Identification and Preservation						
19PMBCC201/ 19MPMBCC201	**Course IV -** Core III - Seminar Presentation	-	-	50	-	50	1
Total				**80**	**70**	**150**	**5**
TOTAL OF ALL SEMESTERS				**160**	**140**	**300**	**10**

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a) The student shall be evaluated at the end of each semester. Total marks for Semester I is 150 (Course I - 100 marks, Course II- 50 marks) and Semester II is 150 (Course III-100 marks and Course IV - 50). **Minimum Pass marks are 50 % in each paper**. If a student is not able to complete a course with 50% marks, the student shall be allowed to reappear only once in the examination in the subsequent academic year (As per the ordinance).

b) The final research proposals will be presented before the DRC within the stipulated period as prescribed by the ordinance.

c) Participation in M.Phil./Ph.D. presentation seminar, M.Phil./Ph.D. submission presentation, M.Phil./Ph.D. Viva Voce Exam and Seminars conducted by the Department is mandatory.

d) The minimum attendance required during the Course work period is 80% of the total classes.

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SYLLABUS

SEMESTER I

Course code: 19PMBCC101/ 19MPMBCC101	Course I: Research Methodology	4 hrs/week	4 Credits

Unit 1: Research: Introduction, Design and Methods **12 hrs**

Meaning of research, objectives of research, motivations in research, types of research, research process, significance of research, criteria for good research; definition of research problem, selection of research problem, technique involved in defining a problem; basic principles and need of research design, important concepts relating to research design, measurement in research; methods of data collection- collection of primary data, observation method, interview method, collection of data through questionnaires, collection of data through schedules, collection of secondary data.

Unit 2: Scientific documentation in research **12 hrs**

Definition and kinds of scientific documents: research paper, review paper, book reviews, thesis & technical reports; plagiarism checking; standards of research journal: impact factor, citation index, H index, I-10 index, Eigen factor, ISBN & ISSN; components of a research paper: title, authors and addresses, abstract, acknowledgements, tables and illustrations, graph, documentation of collected literature, reference index, database generation, basics of bibliographic citations, reference management software, different bibliographic styles; dealing with publishers: submission of manuscript, ordering reprints.

Unit 3: Interpretation, Report Writing and Research ethics **11 hrs**

Data analysis, data sorting and validation of data; meaning of interpretation, technique of interpretation, precaution in interpretation; report writing: significance, different steps, layout of the research report, types of reports, mechanics of writing a research report, precautions for writing research reports, thesis writing; preparation of manuscript for publication of research paper, presenting a paper in scientific seminar, oral presentation; research ethics, intellectual property rights, conflict of interest.

Unit 4: Statistical tests **13 hrs**

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Statistics in research; descriptive statistics- measure of central tendency, measure of variance; students 't' test: hypotheses, acceptance and rejections, significance levels (one sampled test, two sampled test-paired and unpaired test); regression and correlation – biveriate analysis, analysis of Variance (ANOVA): general principles, completely randomized and random-block design, ANOVA (One-way ANOVA, two-way-ANOVA); Non parametric tests- Chi-square test; Normality tests, statistical analysis by SPSS software.

Unit 5: In Silico Tools and Techniques in Biology **12 hrs**

Demonstration of use of reference management software (Mendeley and Zotero). Analysis and interpretation of data using prism/graph pad software. Demonstration of use of INFLIBNET. Retrieval of biological sequences from major databases editing of chromatogram, Elimination of contamination and submission of sequence to Genbank Sequence. Alignments and assemblies Sequence similarity search against biological databases. Primer Designing

Text books:

- Kothari C.R., Garg G. (2019). Research Methodology: methods and techniques. 4th Edition, New age International (P) limited Publishers
- Chawla, Deepak & Sondhi, Neena (2011). Research methodology: Concepts and cases, Vikas Publishing House Pvt. Ltd. Delhi.
- Rstogi V. B. (2015) Biostatistics 3rd Edition, Medtech Publication.
- Daniel W. W., Cross, C. L. (2014) Biostatistics: Basic Concepts and Methodology for the Health Sciences, 10th Edition, Wiley Publication.

Reference books:

- Holmes, D., Moody, P., & Dine, D. (2011). Research methods for the Biosciences. Oxford University Press.
- Flick U. (2017) Introducing Research Methodology: A Beginner's Guide to Doing a Research Project, Sage Publications India Private Limited.

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Course code: 19PMBCC102/ 19MPMBCC102	Course II: Seminar	-	1 Credit

This course will be of self study type where the students shall have to write and submit a review/concept paper on the topic of their choice on recent trends in life sciences and will be asked to prepare presentation (approx of 20 minutes) on this topic. The presentation will be evaluated at the end of semester by members of DRC. Only those students, who have completed their 80% attendance, will be allowed to appear in this course. All the other staff members or students of the concern Department may also remain present in this seminar.

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SEMESTER II

Course code: 19PMBDC201/ 19MPMBDC201	Discipline Specific Elective core I : Advanced Techniques in Biotechnology	4 hrs/week	4 Credits

Unit 1: Techniques in plant tissue culture **09 hrs**

Basics of Plant Tissue culture- Explant selection, preparation and aseptic inoculation, preparation of tissue culture medium, techniques of micropropagation (*viz.* callus induction, sub-culturing, somatic embryogenesis *in vitro* rooting and hardening etc.), maintenance and troubleshooting of growth room and equipments used in plant tissue culture.

Unit 2: Techniques in animal cell culture **09 hrs**

Animal cell culture techniques- growth medium for animal cell, growth factors, serum and protein free defined medium, methodology of establishment of primary and secondary culture, Established/continuous Cell lines and their maintenance and applications.

Unit 3: Improvisation in plants and its genome **10 hrs**

Basic techniques and Instrumentation related with genetic engineering- DNA and RNA Isolation Gene Mapping and Blot Techniques (Northern, Southern etc.), PCR and DNA Fingerprinting Techniques (RAPD, AFLP etc.), Gene Cloning Techniques Protein Isolation and Purification, Agrobacterium mediated transformation, Microprojectile bombardment mediated transformation and Target tissue preparation, Marker assisted selection in plants.

Unit 4: Advanced molecular techniques **10 hrs**

Fluorescent in situ hybridization, DNA-protein cross-linking assay, Gel mobility shift assay, Dnase I foot printing and Sl nuclease mapping, Chromatin immunoprecipitation (ChIP), DNA microarray, Protein- protein interactions: Chemical cross-linking, Co-immunoprecipitation (CIP), Tandam affinity tags (TAT), Phage display, Fluorescent resonance energy transfer (FRET), Yeast-2-hybid, Yeast-3-hybid and their various version

Unit 5: Preparative techniques for biology **10 hrs**

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Calculations based on mole concept, Molarity, Normality Calculating moles of compound present in given solution, Gram molecular weight, Preparation of Molar, Molal and Normal solutions. Calculations pertaining to nucleic acids, proteins and enzyme activity: Quantification of nucleic acid and protein by UV absorption data, quantification of oligonucleotides, calculating Tm based on GC content, salt concentration and DNA length, calculation of enzyme activities in different units. Standard curve (Calculation of concentration of an Unknown sample)

Reference Books:

1. Freshney, I. (2010). Culture of Animal Cell (6th edition). John Wiley.
2. Gamborg, O. L., & Phillips, G. (Eds.). (2013). Plant cell, tissue and organ culture: fundamental methods. Springer Science & Business Media. Strauch, M. A. Protein–DNA Interactions: Techniques Used. eLS, John Wiley & Sons.
3. Brown, T. A., & Brown, T. (2016). Gene cloning and DNA analysis: an introduction. John Wiley & Sons.
4. Dale, J. W., Von Schantz, M., & Plant, N. (2012). From genes to genomes: concepts and applications of DNA technology. John Wiley & Sons.
5. Lesk, A. (2013). Introduction to bioinformatics. Oxford University Press.

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Course code: 19PMBDC202/ 19MPMBDC202	Discipline Specific Elective core II: Advanced Techniques in Microbiology	4 hrs/week	4 Credits

Unit 1: Basic methods in Microbiology **09 hrs**

Pure culture techniques- isolation, cultivation, enumeration and preservation of microbes, staining techniques- simple and differential staining. Growth curve, Auxenic culture, Diauxic cultures, Synchronous culture, Continuous culture and Batch culture Microbial growth: Batch, Fed-batch, yield constants, Methods of growth estimation, Stringent response, Death of a bacterial cell.

Unit 2: Advanced methods in microbiology **09 hrs**

Molecular analysis of Bacterial community: Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis (ARDRA) and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project

Unit 3: Improvisation in microbes and its genome **10 hrs**

Cloning in bacteria; vectors and host. Gene targeting. Gene transfer methods- Transformation, Transduction, Conjugation. Regulation of Gene expression: Bacteria and Phages. Mutation: Type, causes and effect of mutation. DNA repair system, Recombination of Bacterial Genes. Applications of recombinant microbes.

Unit 4: Advanced molecular techniques **10 hrs**

Fluorescent in situ hybridization, DNA-protein cross-linking assay, Gel mobility shift assay, Dnase I foot printing and Sl nuclease mapping, Chromatin immunoprecipitation (ChIP), DNA microarray, Protein- protein interactions: Chemical cross-linking, Co-immunoprecipitation (CIP), Tandam affinity tags (TAT), Phage display, Fluorescent resonance energy transfer (FRET), Yeast-2-hybid, Yeast-3-hybid and their various version

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Unit 5: Preparative techniques for biology **10 hrs**

Calculations based on mole concept, Molarity, Normality Calculating moles of compound present in given solution, Gram molecular weight, Preparation of Molar, Molal and Normal solutions. Calculations pertaining to nucleic acids, proteins and enzyme activity: Quantification of nucleic acid and protein by UV absorption data, quantification of oligonucleotides, calculating Tm based on GC content, salt concentration and DNA length, calculation of enzyme activities in different units. Standard curve (Calculation of concentration of an unknown sample)

Reference Books:

1. Willey J. W., Sherwood L., Woolverton C. J. (2017) Prescott's Microbiology, 10th Edition, McGraw-Hill.
2. Strauch, M. A. Protein–DNA Interactions: Techniques Used. eLS, John Wiley & Sons.
3. Brown, T. A., & Brown, T. (2016). Gene cloning and DNA analysis: an introduction. John Wiley & Sons.
4. Dale, J. W., Von Schantz, M., & Plant, N. (2012). From genes to genomes: concepts and applications of DNA technology. John Wiley & Sons.

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Course code: 19PMBDC203/ 19MPMBDC203	Discipline Specific Elective core III: Methods of Culture Identification and Preservation	4 hrs/week	4 Credits

Unit 1: Isolation and identification of Microbes **16 hrs**

Techniques for isolation of microbes: Serial Dilution, pour plate, streak plate, spread plate, slant, broth and enrichment culture, enriched culture. Identification of bacteria according to Bergey's Manual of Determinative bacteriology (Morphology, biochemistry). Identification of bacteria according to Bergey's Manual of Systematic bacteriology (Taxonomy, systematics, physiology, ecology and habitats of individual prokaryotic groups as well as a natural classification of prokaryotes that reflects their evolutionary history). Morphology, classification, occurrence, reproduction and culture growth requirements of fungi and algae. Microscopy: Application of various staining techniques, microscopes (light, phase contrast, fluorescence) in microbial identification. Use of electron microscope (TEM and SEM) in microbial identification.

Unit 2: Sterilization and biosafety in microbiology laboratory **09 hrs**

Hygiene and biosafety for microbiology laboratory: Personal hygiene, Biosafety levels, biosafety cabinets, Discarding of contaminated media and hazardous chemicals, SOP and MSDS. Sterilization: Heat, Autoclave, Filtration. Handling of DNA, RNA and proteins: Preservation and storage strategy. Culture preservation method: Glycerol stock, oil layer, water, soil. Culture preservation: Lyophilization, cryopreservation

Unit 3: Microbial genome **09 hrs**

Methods of microbial DNA extractions from various sources. Isolation of metagenomic DNA from various environmental sources. Whole genome microbial sequencing: Gene and functional annotation. Pathway based studies for synthesis and degradation of various metabolites in microbes. Cloning and expression of genes in microbes

Unit 4: Genomic techniques related to microbes **07 hrs**

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Advanced molecular techniques for culture identification: 16S sequencing, ARDRA, DGGE, SNP. Application of FAME in bacterial identification. Biology system: Use in culture identification. Real Time PCR: Application in culture identification, quantification of gene and copy numbers. DNA barcoding of fungi and higher eukaryotes

Unit 5: Microbial culture collection centers and management 07 hrs

Important International Culture collections and organizations: World Federation for Culture Collections (WFCC), American Type Culture Collection (ATCC). National Culture Collections: Indian Type Culture Collection (ITCC), ICAR-National Agriculturally Important Microorganism Culture Collection (NAIMCC), DBT-National Centre for Microbial Resources (NCMR), Microbial Type Culture Collection (MTCC), National Collection of Industrial Microorganisms (NCIM). State culture collection: GSBTM-Gujarat Biodiversity Gene Bank (BioGene-BAB). Provision of biological patent and Patent culture collections. Provisions of biodiversity act for access of biodiversity

Reference Books:

1. Holt J. G. (1993) Bergey's Manual of Determinative Bacteriology, 9th Edition, Williams & Wilkins Publications, Baltimore, USA.
2. Garrity G. M., Boone, D. R., Castenholz R. W. (2002) Bergey's Manual of Systematic Bacteriology (5 volumes set), 2nd Edition, Springer Publications, New York, USA.
3. Whitman W. B. (2012), Bergey's Manual of Systematic of Archaea and Bacteria, 1st Edition, John Wiley & Sons, Inc.
4. Alexopoulos, C. J., Mims C., Blackwell M. (2007) Introductory Mycology, 4th Edition, John Wiley & Sons.
5. Kidd S., Halliday C., Alexiou H., Ellis D. (2016). Descriptions of Medial Fungi, 3rd Edition, www.mycology.adelaide.edu.au, Australia.
6. Ausubel F. M., Kingston B. R., Moore D.D., Seidman J. G, Smith J. A., Struhl K. (2001) Current Protocols in Molecular Biology, Wiley Publications, USA.
7. Green M. R., Sambrook J. (2012) Molecular cloning. A Laboratory Manual 4th Editions, Cold-Spring Harbor Press.

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8. Kress W. J., Erickson D. L. (2012) DNA Barcodes: Methods and Protocols, Springer Publications.
9. de Bruijn F. J., (2011) Handbook of Molecular Microbial Ecology I: Metagenomics and Complementary Approach, Wiley-Blackwell.
10. Sharma S. K., Varma A. (2018) Microbial Resource Conservation: Conventional to Modern Approaches, Soil Biology Vol 54, Springer Publications.
11. Reddy C. A. (2007) Methods for General and Molecular Microbiology, ASM Press.
12. Dunn D. M., Speicher D. W., Wingfield P. T., Coligan J. E. (2003) Short protocols in protein science: a compendium of methods from Current protocols in protein science, Wiley Blackwell.
13. Sandle T. (2016) Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control, Elsevier Ltd.

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Course code: 19PMBCC201/ 19MPMBCC201	Course IV: Seminar Presentation	-	1 Credit

This course will be of self study type where the students shall have to write and submit a review/concept paper on the topic of their choice on recent trends in life sciences and will be asked to prepare presentation (approx of 20 minutes) on this topic. The presentation will be evaluated at the end of semester by members of DRC. Only those students, who have completed their 80% attendance, will be allowed to appear in this course. All the other staff members or students of the concern Department may also remain present in this seminar.

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Semester IV									
Course Code	Course	Contact Hrs/wk			SEE Duration hrs	Maximum Marks			Credits
		T	Tu	P		CIA	SEE	Total	
Part –I									
21ULCEN401	Effective Communicative Skills	2	1		3	40	60	100	3
	Part-I Total	**2**	**1**	**0**		**40**	**60**	**100**	**3**
Part – II									
21BMBCC401	**Core 10:** Microbial Genetics (Ap)	4	-	-	2.5	50	50	100	4
21BMBCC402	**Core 11**: Medical Microbiology & Immunology (Ad)	4	-	-	3	40	60	100	4
21BMBCL401/ 21BMBCl402	**Core Elective 1:** <1> Biosafety and ntellectual Property Rights Aquatic Microbiology (Ad)	4	-	-	3	40	60	100	4
21UFSDE402	**DSE-C- 2:** Quality Assurance and Quality Control	4	-	-	3	40	60	100	4
21UTDE020	**TDE 1:** Science of Life	2	-	-	3	100	-	100	2
21BMBCC403	**Core Practical 4** Applied Microbiology Practical-II	-	-	6	3	40	60	100	2
21BMBCR401	**Core Enrichment 1:** Concept to Practice	-	1	-	-	100	-	100	1
	Part-II Total	**18**	**1**	**6**		**410**	**290**	**700**	**21**
Part-III: Ability Enhancement Courses									
	FS 3: Career Acceleration Program	-	2	-					Audit course
	Part-III Total	**0**	**2**	**0**					
	Total (Part-I to Part-III)	**20**	**4**	**6**		**450**	**350**	**800**	**24**
		30				**800**			

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OBJECTIVES OF THE PROGRAMME

The Curriculum is designed to attain the following learning goals which students shall accomplish by the time of their graduation:

- This programme will enable students to acquire knowledge on the Microbiology, Cell Biology, Microbiology, Immunology, Bioprocess Technology and Molecular Biology to enable them to understand emerging and advanced concept in modern biology and help them to take their career in this field.
- After completion of the programme, the students will be able to acquire the necessary theoretical and practical competencies in Microbiology to enable them to undertake higher studies in recognized Institutions of advance learning and engage gainful self-employment.
- The Programme is intended to help the students to be the innovative and versatile personalities in the field of Life Science with quality education and provide the skilled manpower required by Research and Development, Institutions of Higher Learning and Industry.

GRADUATE ATTRIBUTES FOR UNDER GRADUATE PROGRAMS

1. **Academic excellence**: Ability to identify key questions, research and pursue rigorous evidence-based arguments
2. **Critical Thinking and Effective communications:** Analysis and evaluation of information to form a judgement about a subject or idea and ability to effectively communicate the same in a structured form.
3. **Global Citizenship:** Mutual understanding with others from diverse cultures, perspectives and backgrounds
4. **Life Long Learning:** Open, curious, willing to investigate, and consider new knowledge and ways of thinking

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PROGRAMME EDUCATIONAL OBJECTIVES OF B.Sc. MICROBIOLOGY PROGRAMME

Our programme will produce Graduates who:		
PEO 1	**:**	**Core competency:** enhance the competency to pursue higher education or a successful professional career by combining knowledge and skills in microbiology and allied areas
PEO 2	**:**	**Breadth of knowledge:** will show capabilities of independently observe,analyse and interpret domain specific and alliedproblemsby integrating the interdisciplinary knowledge
PEO 3	**:**	**Preparedness:** will demonstrate professional behaviour and skills as an effective contributor in their chosen occupations, careers, and communities.
PEO 4	**:**	**Professionalism:**values and responsibilities will be reflected to enhance their suitability for multidisciplinary teams and to foster socio-ethically responsible citizenship.
PEO 5	**:**	**Learning environment:**exhibit a self-learning attitude and stay updated with the latest developments in all aspects of life.

PROGRAM OUTCOMESOF B.Sc. MICROBIOLOGY PROGRAMME

After completion of the programme the Graduate will be able to:		
PO 1	**:**	**Domain knowledge:** Ability to observe and explore beneficial and harmful aspects of microorganism.
PO 2	**:**	**Problem analysis:** Identifyscientific and societal issues across the spectrum of relateddisciplines
PO 3	**:**	**Design/development of solutions:** Acquire skills to identify possiblesolutionsby data analytics and learn to verify and recorddata
PO 4	**:**	**Conduct investigations of complex problems:** Able to understand ~~c~~ause and problems related to biotic and abiotic factors
PO 5	**:**	**Modern tool usage:** Capable for samples collection ,isolation of microbes, preliminary identification andanalysis
PO 6	**:**	**Professional and society:** Capacitate to expand the essence of awareness of microbiology tosociety
PO 7	**:**	**Environment and sustainability:** emphasizes the importance of understanding the environmental issues for sustainable development
PO 8	**:**	**Ethics:** Develop behavioural up-liftment through inculcation of moral values, logical clarity of sense of aesthetics and ethicalconsiderations.

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PO 9	**:**	**Individual and team work:** Acquire skills of team leading, working with peers in coordination, and adopt the nature of commitment for fulfillingtask
PO 10	**:**	**Communication:** Able to develop communicative skills and reasoning ofdefence
PO 11	**:**	**Project management and finance:** Understand the principles of management of finance and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**:**	**Life-long learning:** Able to pursue lifelong learning by In depth understanding of fundamental and few applied aspects

PROGRAMME SPECIFIC OUTCOME (PSOs) FOR B.Sc. MICROBIOLOGY PROGRAMME

After completion of the programme the Graduate will:		
PSO 1	:	Be able to apply the knowledge of microbiology in Various aspects of day to day life
PSO 2	:	Develop basic skills for microbial culture handling, staining, microscopy, biochemical tests, and molecular biology approaches.
PSO 3	:	Successfully assistto specialists from other disciplines, acknowledging the interdisciplinary character
PSO 4	:	Possesses communication skills, capable to understand and present different concepts with findings.
PSO 5	:	Exhibit a commitment to lifelong learning and professional development staying updated with emerging trends, technologies.

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Course Code	Course Title	Credit
21BMBCL401	**Core Elective 1:** Biosafety and Intellectual Property Rights	**4 Credits**

Course Description:

The course is dened to provide comprehensive knowledge to the students regarding the general principles of Biosafety, and IPR. Students will have knowledge of working in a microbiology laboratory taking all safety measures, handing of live bacteria, disposal of infectious waste, care of the equipment requiring safety audit. Developed knowledge of patent filing, and some well-known/well-publicized case studies related to IPR.

Course Objective:

This course is designed in such a way that students can acquainted with terminology like IPR. Intellectual Property Rights (IPR) awareness is critical to shaping an environment that is conducive to fostering creativity & innovation in the country. Information about Critical aspects of bio safety play crucial role in handling microorganisms in laboratory. Syllabus designing also focus on knowledge about patent filing and various patent agreements which are crucial for the process of filing the patent.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Bloom's taxonomy Level(K_1 to K_6)
CO1	Know about Biosafety, Guidelines and related issues while working with microorganisms. Risk assessment and analysis	K1, K2,
CO2	Evaluate Biosafety concerns in microbiology laboratory for all safety measures, handing of live bacteria, disposal of infectious waste, care of the equipment requiring safety audit	K4, K5

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CO3	Developed knowledge of basic concepts related to different IPR.	K1,K2
CO4	Understand analyze patent filing, and some well-known/well-publicized case studies related to IPR	K3,K4
CO5	Justify and explain role of different agreement and treaties related to IPR	K4,K5

Course Content	**Hours**
Module-I: Bio safety	**12 hrs**
• Introduction; bio safety issues in handling biological organizations • Primary Containment for Biohazards • Bio safety Levels of Specific microorganisms • Biological Safety Cabinets & their types • Radiation Bio safety : AERB/RSD/RES guidelines	
Module-II: Bio safety Guidelines	**12 hrs**
• Role of Institutional Bio safety Committees (IBSC), RCGM, GEAC for GMO applications in food and agriculture • An overview of WHO Laboratory Manuals of Bio safety • GRAS status • Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; • Overview of International Agreements - Cartagena Protocol	
Module-III: Introduction to Intellectual Property	**12 hrs**
• History of IPR • Types of IPR: Patents Trademarks, Copyright& Related Rights, • Types of IPR: Industrial Design and Rights, Traditional Knowledge, Geographical Indications • Introduction to PVPFR, 2001 : Scope, Criteria and application • Provisions for IPR Protection of biotechnological inventions	
Module-IV: Overview of Patent document and application	**12hrs**

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• Grant of Patent and Patenting Authorities • Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition • Overview of the patent document and an Patent Filing Procedures in India • Importance of IPR –patentable and non patentable inventions in India • Patent Grant Procedure (Key forms and application fees)	
Module-V: Key acts, agreements and treaties	**12hrs**
• Introduction to WIPO • WTO (TRIPS Agreements) for IPR protection • Paris convention • Budapest Treaty on international recognition of the deposit of microorganisms • Patent Co-operation Treaty (PCT)	

Pedagogic tools:

- Power point
- Chalk and Talk
- Audio-video

Text books:

1. Deepa Goel, Shomini Parashar (2013) IPR, Biosafety and Bioethics, Pearson India,
2. Anil Dusane, (2013) A Text Book of Biosafety, Bioethics and Intellectual Property Rights, Vision Publications

Reference books:

1. M K Sateesh .Bioethics and Biosafety . Kindle Edition
2. Sasson Albert (1993) Biotechnologies in developing countries present and future, UNESCO publishers,
3. Shaleesha A. Stanley, (2008) Bioethics, Wisdom educational service, Wisdom Educational Service
4. Beier, F.K., Crespi, R.S. and Straus, T. (1985) Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi,

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Suggested readings / e-resources:

- Intellectual Property Rights – Role in Biotechnology K. Jeyaprakash* Head, Dept. of Biochemistry, Rajah Serfoji Govt. College, Thanjavur – 05, India, Int.J.Curr.Microbiol.App.Sci (2016) Special Issue-3: 39-43

Suggested MOOCs:

- https://www.ipr.res.in/
- https://www.wipo.int/about-ip/en/
- https://www.iipta**.com**/role-of-ipr-in-biotechnology-industry/

Methods of assessing the course outcomes

Components of CIA: 40 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1st Two Module	$1^{1/2}$ hours	5 (Set for 30)	20
	Test 2	All 5 Module	3 hours	15 (Set for 50)	
B	Assignment	-	-	10	20
C	Class activity	-	-	10	
Grand Total					**40**
Assignment	• MCQ Test /Visit and Visit Report/Review Writing: 10				
Class activity	• Question Bank Preparation / Comprehension :10				

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Ph.D. Course Work - Biotechnology
(From A.Y. 2023 and onwards)

Preamble

The Department of Biotechnology, Atmiya University, offers Ph. D. Programmes in broad research areas of Biotechnology and Microbiology being its major research discipline. Considering the magnitude of research in present scenario and to augment the quality of research the syllabus for the Course Work, named as the Pre-Ph.D. Course Work, as a prerequisite to continue with the programme in Biotechnology and Microbiology discipline, has been designed.

The course work aims to provide a full research based program to equip the students with necessary tools so that the students can grasp the area of study better as well as improve on their scientific writing skills, which is essential in any kind of quality research. The course further aims at familiarizing the perspectives, pedagogy and their implications in various areas of investigations.

As per the university ordinance and new guidelines of UGC, the research scholars who are provisionally registered under the Ph.D. Programme will have to undergo a Pre- Ph.D. Course Work.

The main objectives of the Course Work is to inculcate the following qualities in the Research Scholar:

- **Inquisition:** The ability to inquire about the research problem and to relate this with current socio-economic scenario.
- **Understanding:** Understand the theories that strengthen their dissertation research, with the depth needed to produce their own hypothesis and find out the research gape.
- **Analysis:** Student will be able to design the experiment and analysis the research problem.
- **Interpretation:** Interpret and compare the research outcomes.
- **Assessment:** Appraise the results and draw a conclusion.
- **Writing, editing, proof reading and designing:** Ability to write the scientific draft (*viz.* manuscript, review article, book chapter, research proposal etc)

Programme Structure

The Pre-Ph.D. course work shall comprise of Two Semesters (i.e. one Year) in which there shall be **four** compulsory courses:

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Semester I							
Course Code	Course	Hrs of Instruction / week	Exam Duration (Hrs)	Max Marks			Credit
				CIE	SEE	Total	
23PBTCC101	**Course I -** **Core I -** Research Methodology*	4	3 Hr	30	70	100	4
23PBTCC102	**Course II -** **Core II - Seminar Presentation** (Recent Trends in broad research areas of Biotechnology)	-	-	50	-	50	1
Total		**4**		**80**	**70**	**150**	**5**

***70% of the total syllabus of Research Methodology is common to all discipline across the University while the rest 30% will be discipline specific.*

.Semester II							
Course Code	Course	Hrs of Instruction / week	Exam Duration (Hrs)	Max Marks			Credit
				CIE	SEE	Total	
23PBTDC201 / 23PBTDC202 / 23PBTDC203	**Course III -** **Discipline Specific Elective core I - Advanced** Techniques in Biotechnology / **Discipline Specific Elective core II -** Advanced Techniques in Microbiology / **Discipline Specific Elective core III** - Methods of Culture Identification and Preservation	4	3 Hrs	30	70	100	4
23PBTCC201	**Course IV -** **Core III -** Writing a concept paper/ review articles on recent trends or existing problem of biotechnology or allied areas	-	-	50	-	50	1
23PBTCC202	**Course V -** **Core IV –** Seminar Presentation (Review of Literature)	-	-	50	-	50	1

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23PBTCC203	**Course VI - Core V** – Research and Professional Ethics	-	-	50	-	50	1
Total				**180**	**70**	**250**	**7**
TOTAL OF ALL SEMESTERS				**260**	**140**	**400**	**12**

a) The student shall be evaluated at the end of each semester. Total marks for Semester I is 150 and Semester II is 250. **Minimum Pass marks is 50% in each paper**. If a student is not able to complete a course with 50% marks, the student shall be allowed to reappear only once in the examination in the subsequent academic year (As per the ordinance).
b) The final research proposals will be presented before the DPC within the stipulated period as prescribed by the ordinance.
c) Participation in Pre-Ph.D. presentation seminar, Pre-Ph.D. submission presentation, Ph.D. Viva Voce Exam and Seminars conducted by the Department is mandatory.
d) **The minimum attendance required during the Course work period is 80% of the total classes.**

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SEMESTER I

Course code: 23PBTCC101	Course I: Research Methodology	4 hrs/week	4 Credits

Course Description:

This course is designed to provide PhD students with a comprehensive understanding of research methodologies and techniques essential for conducting rigorous and impactful research. Through a blend of theoretical concepts, practical exercises, and real-world examples, students will develop the skills needed to formulate research questions, design robust studies, gather and analyze data, and communicate their findings effectively. Additionally, ethical considerations and the integration of interdisciplinary approaches will be emphasized to enhance the quality and integrity of students' research endeavors.

Course Objectives:

- **Research Paradigms and Approaches:** Familiarize students with different research paradigms, both qualitative and quantitative, and enable them to understand how these paradigms influence research design.
- **Problem Formulation and Justification:** Develop students' ability to formulate well-defined research questions and objectives and justify their significance within the broader academic context.
- **Method Selection and Design:** Equip students with the skills to select appropriate research methods and design frameworks that align with their research questions and objectives.
- **Data Collection and Analysis:** Teach students to gather data using diverse techniques, conduct valid and reliable data analysis, and interpret findings accurately.
- **Ethical Considerations:** Raise awareness about ethical principles in research, encouraging students to conduct their research with integrity and respect for participants' rights.

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Course Outcomes:

1. **Research Competence:** Graduates will exhibit a strong grasp of research methodologies, enabling them to confidently design and execute research projects.
2. **Focused Research Questions:** Students will be adept at formulating precise research questions that guide their investigations and contribute meaningfully to their field.
3. **Methodological Expertise:** Graduates will possess the ability to choose appropriate research methods and designs, enhancing the rigor and validity of their research.
4. **Data Proficiency:** Participants will demonstrate proficiency in collecting and analyzing data, effectively deriving insights and drawing valid conclusions.
5. **Ethical Research Conduct:** Graduates will uphold ethical standards, demonstrating respect for participants and contributing to research integrity in their academic pursuits.

These objectives and outcomes collectively ensure that participants emerge from the course with the knowledge, skills, and ethical foundation required to conduct meaningful and impactful research in their respective disciplines.

Unit I	**Introduction to Research Methodology& Research Design**	**12**
	• Meaning of Research, Objectives of Research, Motivations in Research, Types of Research, Research Process • Significance of Research, Criteria for good research • Definition of research problem, Selection of research problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem. • Basic Principles and Need of research design, features of good design, Important concepts relating to research design • Measurement in Research; Methods of Data Collection- Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires • Collection of Data through Schedules, Collection of Secondary Data.	
Unit 2	**Scientific documentation**	**16**
	• Definition and kinds of Scientific documents: Research paper, Review paper, Book reviews	

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	• Thesis & Technical reports; Standards of research journal: Impact factor, • Citation index, H index, I10 index, Eigen factor; Components of a research paper: Title, Authors and addresses • Abstract, Acknowledgements, Tables and illustrations, Documentation of collected literature, Reference Index, Database generation • Basics of Bibliographic Citations, ISBN & ISSN, Different Bibliographic styles; Dealing with publishers: Submission of Manuscript, Ordering reprints.	
Unit 3	**Statistical tests**	**10**
	• Statistics in Research; Descriptive Statistics- measure of central tendency, measure of variance • Student's 't' test: Hypotheses, acceptance and rejections, significance levels (One sampled test, two sampled test-paired and unpaired test) • Regression and correlation – biveriate analysis, Analysis of Variance (ANOVA): General principles • completely randomized and random-block design ANOVA (One-way ANOVA, two-way-ANOVA) • Non parametric tests- Chi-square test; Normality tests.	
Unit 4	**Interpretation and Report Writing**	**10**
	• Data Analysis, Data sorting and validation of data • Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation • Significance of Report Writing, Different Steps in Writing Report • Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, • Precautions for Writing Research Reports • Preparation of manuscript for Publication of Research paper • Presenting a paper in scientific seminar, Thesis writing.	
Unit V	**Use of software's in life science research**	**13 Hrs**

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	• Demonstration of use of reference management software (Mendeley and Zotero). • Analysis and interpretation of data using prism/graph pad software. Demonstration of use of INFLIBNET. • Retrieval of biological sequences from major databases Editing of chromatogram, Elimination of contamination and submission of sequence to Genbank Sequence. • Alignments and assemblies Sequence similarity search against biological databases. Primer Designing	

Text books

1. Kothari C.R. (2004). Research Methodology: methods and techniques. New age International (P) limited Publishers

2. Chawla, Deepak & Sondhi, Neena (2011). Research methodology: Concepts and cases, Vikas Publishing House Pvt. Ltd. Delhi.

3. Khan, I. A., & Khanum, A. (2004). Fundamentals of Biostatistics. Ukaaz Publications.

4. Gurumani, N. (2004). An introduction to Biostatistics. MJP publisher.

Reference books:

1. Holmes, D., Moody, P., & Dine, D. (2011). Research methods for the Biosciences. Oxford University Press.

2. Dutta, N. K. (2002). Fundamentals of Biostatistics: Practical Approach. Kanishka Publishers.

3. Field A., Discovering Statistics Using SPSS, Fourth Edition, SAGE, 2013

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Course code: 23PBTCC102	Course II: Seminar	-	1 Credits

Course Description:

This course aims to equip PhD course work students in the field of biotechnology with the skills to deliver effective and engaging seminar presentations on cutting-edge trends within various subfields of biotechnology. Through in-depth exploration of recent research, hands-on practice, and constructive feedback, students will learn to critically analyze, synthesize, and communicate complex scientific concepts to diverse audiences, fostering their abilities as both researchers and communicators.

Course Objectives:

- **Exploring Recent Trends:** Introduce students to the latest developments in biotechnology research across various subfields, such as genetic engineering, bioinformatics, biopharmaceuticals, and environmental biotechnology.
- **Critical Analysis and Synthesis:** Develop students' skills in critically evaluating scientific literature, identifying key findings, and synthesizing information into coherent narratives.
- **Effective Presentation Design:** Teach students to design engaging presentation structures, select compelling visuals, and create informative slides that enhance the clarity and impact of their content.
- **Public Speaking and Communication:** Enhance students' public speaking skills, including clear articulation, confident body language, and effective use of voice modulation, to engage and captivate their audience.
- **Question Handling and Discussion**: Prepare students to respond to audience questions and facilitate discussions after their presentations, demonstrating their depth of understanding and ability to defend their ideas.

Course Outcomes:

1. **Research Awareness:** Graduates will be well-informed about recent trends in various biotechnology subfields, contributing to their knowledge base as emerging researchers.

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2. **Effective Communication**: Students will possess strong presentation and public speaking skills, enabling them to convey complex scientific ideas with clarity and confidence.
3. **Critical Analysis**: Graduates will have honed their ability to critically analyze research articles and synthesize information from diverse sources.
4. **Audience Engagement:** Participants will engage their audience effectively, fostering discussions and showcasing their expertise in the chosen research trend.
5. **Peer Collaboration:** Graduates will have learned to provide and receive constructive feedback, enhancing their ability to learn from peers and improve their presentations.

Course Outline:

Module 1: Introduction to Seminar Presentations

- Importance of seminar presentations in academic and professional contexts.
- Key components of an effective seminar presentation.

Module 2: Research Trends in Biotechnology

- Exploration of recent trends and breakthroughs in diverse biotechnology subfields.
- Identification of research gaps and potential avenues for future studies.

Module 3: Literature Review and Content Preparation

- Conducting thorough literature reviews to gather relevant research articles.
- Summarizing and synthesizing research findings for presentation content.

Module 4: Presentation Structure and Visual Design

- Creating engaging presentation structures with clear introductions, main points, and conclusions.
- Incorporating visually appealing slides to complement spoken content.

Module 5: Public Speaking and Delivery Techniques

- Developing confident and persuasive public speaking skills.

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- Practicing effective body language, eye contact, and voice modulation.

Module 6: Handling Questions and Facilitating Discussion

- Strategies for handling audience questions and encouraging meaningful discussions.
- Defending ideas and responding thoughtfully to inquiries.

Module 7: Peer Review and Rehearsals

- Peer review sessions to provide and receive constructive feedback on presentation content and delivery.
- Rehearsals to refine presentation skills based on feedback.

Module 8: Final Seminar Presentations

- Each student delivers a seminar presentation on a chosen recent trend in biotechnology.
- Q&A session and audience feedback following each presentation.

Assessment:

- **Literature Review and Topic Selection:** Students submit a brief literature review on their chosen trend, demonstrating their ability to identify key research articles.
- **Presentation Outline and Structure:** Students create a detailed outline of their presentation, showcasing a logical flow of content.
- **Presentation Slides:** Students design visually engaging slides that complement their spoken content effectively.
- **Practice Presentations:** Students practice their seminar presentations in front of peers, refining their delivery based on feedback.
- **Final Seminar Presentation:** Each student delivers a final seminar presentation, incorporating feedback received during practice sessions.

By completing this course, students will have developed the skills and confidence to deliver impactful seminar presentations on recent trends in biotechnology research, positioning themselves as proficient researchers and communicators in their field.

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SEMESTER II

Course code: 23PBTDC201	Discipline Specific Elective core I: Advanced Techniques in Biotechnology	4 hrs/week	4 Credits

Course Description:

This advanced course is tailored for PhD students in the field of biotechnology, aiming to provide in-depth knowledge and hands-on experience in cutting-edge techniques that drive biotechnological research forward. Covering a range of advanced methodologies, students will gain practical skills and theoretical understanding required for innovative research in areas such as genetic engineering, bioprocessing, omics technologies, and bioinformatics.

Course Objectives:

- **Explore Advanced Techniques:** Introduce students to state-of-the-art techniques in biotechnology, focusing on their principles, applications, and relevance in current research.
- **Critical Analysis:** Teach students to critically evaluate experimental designs, troubleshoot issues, and assess the reliability of obtained results.
- **Interdisciplinary Integration:** Highlight the interdisciplinary nature of advanced biotechnology techniques and their integration with other scientific domains.
- **Ethical and Safety Considerations:** Emphasize the importance of ethical research conduct and safety protocols when working with advanced biotechnological tools.

Course Outcomes:

1. **Advanced Techniques Proficiency:** Graduates will have gained proficiency in a range of advanced biotechnological techniques, enhancing their research capabilities.
2. **Analytical Skills:** Students will be adept at critically analyzing research papers, experimental designs, and data interpretation.
3. **Interdisciplinary Understanding:** Graduates will appreciate the interdisciplinary nature of advanced biotechnology, fostering integration with related fields.
4. **Ethical Awareness:** Graduates will demonstrate ethical research conduct and prioritize safety when working with advanced techniques.

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By completing this course, students will have acquired the expertise and confidence to employ advanced biotechnological techniques in their research, contributing to the advancement of knowledge and innovation in the field of biotechnology.

Unit I	**Techniques in plant tissue culture**	**09 Hrs**
	• Basics of Plant Tissue culture- Explant selection, preparation and aseptic inoculation • Preparation of tissue culture medium • Techniques of micropropagation (*viz.* callus induction, sub-culturing, somatic embryogenesis *in vitro* rooting and hardening etc.), maintenance and troubleshooting of growth room and equipments used in plant tissue culture. • Applications of plant tissue culture	
Unit II	**Techniques in animal cell culture**	**09 Hrs**
	• Animal cell culture techniques- growth medium for animal cell, • Growth factors, serum and protein free defined medium, • Methodology of establishment of primary and secondary culture • Established/continuous Cell lines and their maintenance and applications. • Applications of animal cell cultures	
Unit III	**Improvisation in plants and its genome**	**10 Hrs**
	• Basic techniques and Instrumentation related with genetic engineering- • DNA and RNA Isolation Gene Mapping and Blot Techniques (Northern, Southern etc.), • PCR and DNA Fingerprinting Techniques (RAPD, AFLP etc.), • Gene Cloning Techniques Protein Isolation and Purification, • Agrobacterium mediated transformation, • Microprojectile bombardment mediated transformation and Target tissue preparation • Marker assisted selection in plants.	
Unit IV	**Advanced molecular techniques**	**10 Hrs**

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	• Fluorescent in situ hybridization, DNA-protein cross-linking assay, • Gel mobility shift assay, Dnase I foot printing and Sl nuclease mapping, Chromatin immunoprecipitation (ChIP), • DNA microarray, Protein- protein interactions: Chemical cross-linking, Co-immunoprecipitation (CIP), • Tandam affinity tags (TAT), Phage display, • Fluorescent resonance energy transfer (FRET), • Yeast-2-hybid, Yeast-3-hybid and their various version	
Unit V	**Calculations in Biology**	**10 Hrs**
	• Calculations based on mole concept, Molarity, Normality Calculating moles of compound present in given solution, Gram molecular weight, • Preparation of Molar, Molal and Normal solutions. • Calculations pertaining to nucleic acids, proteins and enzyme activity: Quantification of nucleic acid and protein by UV absorption data, quantification of oligonucleotides, • calculating Tm based on GC content, salt concentration and DNA length, calculation of enzyme activities in different units. • Standard curve (Calculation of concentration of an Unknown sample)	

Reference Books:

6. Freshney, I. (2010). *Culture of Animal Cell (6th edition)*. John Wiley.
7. Gamborg, O. L., & Phillips, G. (Eds.). (2013). *Plant cell, tissue and organ culture: fundamental methods.* Springer Science & Business Media. Strauch, M. A. Protein–DNA Interactions: Techniques Used. eLS, John Wiley & Sons.
8. Brown, T. A., & Brown, T. (2016). Gene cloning and DNA analysis: an introduction. John Wiley & Sons.
9. Dale, J. W., Von Schantz, M., & Plant, N. (2012). From genes to genomes: concepts and applications of DNA technology. John Wiley & Sons.
10. Lesk, A. (2013). Introduction to bioinformatics. Oxford University Press.Mount, D. W., & Mount, D. W. (2001). Bioinformatics: sequence and genome analysis (Vol. 2). New York: Cold spring harbor laboratory press.

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Course code: 23PBTDC202	Discipline Specific Elective core II: Advanced Techniques in Microbiology	4 hrs/week	4 Credits

Course Description:

This course is tailored for PhD students in biotechnology / microbiology seeking to deepen their practical skills and theoretical understanding of advanced techniques used in microbial research. Through a combination of hands-on laboratory work, theoretical instruction, and critical analysis of experimental results, students will gain proficiency in cutting-edge methods, enabling them to address complex research questions and contribute to advancements in microbiology.

Course Objectives:

- **Comprehensive Technique Familiarization:** Introduce students to a range of advanced techniques in microbiology, including molecular, cellular, and microbial community analyses.
- **Data Analysis and Interpretation:** Teach students to critically analyze experimental data, interpret results, and draw meaningful conclusions from complex datasets.
- **Troubleshooting and Optimization:** Equip students with problem-solving skills to identify and troubleshoot issues that may arise during experimental design and execution.
- **Integration of Techniques:** Demonstrate how to combine multiple techniques to address multifaceted research questions, promoting interdisciplinary thinking.
- **Ethical Considerations:** Discuss ethical considerations in microbiological research, including biosafety and responsible experimentation.

Course Outcomes:

1. **Advanced Skill Proficiency:** Graduates will possess expertise in a range of advanced microbiological techniques.
2. **Interdisciplinary Thinking:** Students will be able to apply integrated approaches to tackle complex research questions.
3. **Effective Data Analysis:** Participants will demonstrate the ability to analyze and interpret complex experimental data.

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4. **Problem-Solving Aptitude:** Graduates will be equipped to identify and address challenges in experimental design and execution.
5. **Ethical Awareness:** Students will understand and apply ethical considerations in microbiological research.

By completing this course, students will be well-prepared to engage in cutting-edge microbiological research, employ advanced techniques, and contribute to the advancement of knowledge in the field.

Unit I	**Methods in microbiology**	**12 Hrs**
	• Pure culture techniques- isolation, cultivation, enumeration and preservation of microbes, • staining techniques- simple and differential staining. • Growth curve, Axenic culture, Diauxic cultures, Synchronous culture, Continuous culture and Batch culture • Microbial growth: Batch, Fed-batch, yield constants, • Methods of growth estimation, Stringent response, Death of a bacterial cell.	
Unit II	**Methods in microbiology**	**12 Hrs**
	• Molecular analysis of Bacterial community: Denaturing Gradient Gel Electrophoresis (DGGE), • Temperature Gradient Gel Electrophoresis (TGGE), • Amplified rDNA Restriction Analysis (ARDRA) • Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; • 16S rDNA sequencing and Ribosomal Database Project	
Unit III	**Improvisation in microbes and its genome**	**10 Hrs**
	• Cloning in bacteria; vectors and host. Gene targeting. • Gene transfer methods- Transformation, Transduction, Conjugation. • Regulation of Gene expression: Bacteria and Phages. • Mutation: Type, causes and effect of mutation. • DNA repair system, • Recombination of Bacterial Genes. Applications of recombinant microbes.	

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Unit IV	**Advanced molecular techniques**	**10 Hrs**
	• Fluorescent in situ hybridization, DNA-protein cross-linking assay, • Gel mobility shift assay, Dnase I foot printing and Sl nuclease mapping, Chromatin immunoprecipitation (ChIP), • DNA microarray, Protein- protein interactions: Chemical cross-linking, Co-immunoprecipitation (CIP), • Tandam affinity tags (TAT), Phage display, • Fluorescent resonance energy transfer (FRET), • Yeast-2-hybid, Yeast-3-hybid and their various version	
Unit V	**Calculations in Biology**	**10 Hrs**
	• Calculations based on mole concept, Molarity, Normality Calculating moles of compound present in given solution, Gram molecular weight, • Preparation of Molar, Molal and Normal solutions. • Calculations pertaining to nucleic acids, proteins and enzyme activity: Quantification of nucleic acid and protein by UV absorption data, quantification of oligonucleotides, • calculating Tm based on GC content, salt concentration and DNA length, calculation of enzyme activities in different units. • Standard curve (Calculation of concentration of an Unknown sample)	

Reference Books:

1. Prescott, L. M. H., Klein, J. P., Prescott, D. A. L. M., Harley, J. P., & Klein, D. A. (2004). Microbiology. McGraw-Hill.
2. Strauch, M. A. Protein–DNA Interactions: Techniques Used. eLS, John Wiley & Sons.
3. Brown, T. A., & Brown, T. (2016). Gene cloning and DNA analysis: an introduction. John Wiley & Sons.
4. Dale, J. W., Von Schantz, M., & Plant, N. (2012). From genes to genomes: concepts and applications of DNA technology. John Wiley & Sons.
5. Lesk, A. (2013). Introduction to bioinformatics. Oxford University Press.
6. Mount, D. W., & Mount, D. W. (2001). Bioinformatics: sequence and genome analysis (Vol. 2). New York: Cold spring harbor laboratory press.

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Course code: 23PBTDC203	Discipline Specific Elective core III: Methods of Culture Identification and Preservation	4 hrs/week	4 Credits

Course Description:

This advanced course is tailored for PhD students pursuing studies in microbiology, biotechnology, and related fields. It focuses on imparting in-depth knowledge and practical skills related to the identification, classification, and preservation of microbial cultures. Students will explore a variety of traditional and modern techniques, enhancing their expertise in maintaining and characterizing microorganisms for research, industrial, and medical applications.

Course Objectives:

- **Microbial Identification Techniques:** Introduce students to diverse methods for accurate microbial identification, including morphological, biochemical, molecular, and genotypic approaches.
- **Taxonomy and Classification:** Familiarize students with microbial taxonomy and classification systems, enabling them to understand the evolutionary relationships among microorganisms.
- **Culture Preservation Methods:** Teach students various methods for preserving microbial cultures, such as cryopreservation, lyophilization, and sub-culturing, ensuring long-term viability.
- **Quality Control and Authentication:** Develop students' skills in quality control procedures to ensure the purity and authenticity of microbial cultures, essential for reliable research outcomes.
- **Emerging Technologies:** Explore cutting-edge technologies in microbial identification and preservation, including next-generation sequencing and novel preservation techniques.

Course Outcomes:

1. **Microbial Expertise:** Graduates will demonstrate a deep understanding of microbial identification techniques and preservation methods.

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2. **Accurate Classification:** Students will be skilled in accurately classifying microorganisms and understanding their evolutionary relationships.
3. **Effective Preservation Skills:** Participants will be proficient in various culture preservation methods, ensuring the long-term viability of microbial cultures.
4. **Quality Control Proficiency:** Graduates will possess the skills needed to maintain pure and authentic microbial cultures for reliable research outcomes.
5. **Innovative Awareness:** Students will be informed about emerging technologies, fostering their ability to adapt to future advancements in the field.
6. **Ethical Awareness:** Graduates will be aware of ethical considerations in microbial research, contributing to responsible research practices.

By successfully completing this course, students will have acquired specialized knowledge and practical skills necessary for accurate microbial identification, classification, and preservation, empowering them to contribute effectively to research and applications in their chosen field.

Unit I	**Isolation and identification of Microbes**	**16 Hrs**
	• Techniques for isolation of microbes: Serial Dilution, pour plate, streak plate, spread plate, slant, broth and enrichment culture, enriched culture. • Identification of bacteria according to Bergey's Manual of Determinative bacteriology (Morphology, biochemistry). • Identification of bacteria according to Bergey's Manual of Systematic bacteriology (Taxonomy, systematics, physiology, ecology and habitats of individual prokaryotic groups as well as a natural classification of prokaryotes that reflects their evolutionary history). • Morphology, classification, occurrence, reproduction and culture growth requirements of fungi and algae. • Microscopy: Application of various staining techniques, microscopes (light, phase contrast, fluorescence) in microbial identification. • Use of electron microscope (TEM and SEM) in microbial identification	
Unit II	**Sterilization and biosafety in microbiology laboratory**	**09 Hrs**
	• Hygiene and biosafety for microbiology laboratory: Personal hygiene, Biosafety levels, biosafety cabinets,	

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	• Discarding of contaminated media and hazardous chemicals, SOP and MSDS. Sterilization: Heat, Autoclave, Filtration. Handling of DNA, RNA and proteins • Preservation and storage strategy. Culture preservation method: Glycerol stock, oil layer, water, soil. Culture preservation: • Lyophilization, cryopreservation	
Unit III	**Microbial genome**	**09 Hrs**
	• Methods of microbial DNA extractions from various sources. • Isolation of metagenomic DNA from various environmental sources. • Whole genome microbial sequencing: Gene and functional annotation. Pathway based studies for synthesis and degradation of various metabolites in microbes. • Cloning and expression of genes in microbes	
Unit IV	**Genomic techniques related to microbes**	**07 Hrs**
	• Advanced molecular techniques for culture identification: 16S sequencing, ARDRA, DGGE, SNP. • Application of FAME in bacterial identification. Biology system: Use in culture identification. • Real Time PCR: Application in culture identification, quantification of gene and copy numbers. • DNA barcoding of fungi and higher eukaryotes	
Unit V	**Microbial culture collection centers and management**	**07 Hrs**
	• Important International Culture collections and organizations: World Federation for Culture Collections (WFCC), American Type Culture Collection (ATCC). • National Culture Collections: Indian Type Culture Collection (ITCC), ICAR-National Agriculturally Important Microorganism Culture Collection (NAIMCC), DBT-National Centre for Microbial Resources (NCMR), Microbial Type Culture Collection (MTCC), • National Collection of Industrial Microorganisms (NCIM). State culture collection: GSBTM-Gujarat Biodiversity Gene Bank (BioGene-BAB).	

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	• Provision of biological patent and Patent culture collections. Provisions of biodiversity act for access of biodiversity	

Reference Books:

1. John G. Holt, Bergey's Manual of Determinative Bacteriology, 9th Edition, Williams & Wilkins Publications, Baltimore, USA.
2. George M. Garrity, David R. Boone, Richard W. Castenholz, Bergey's Manual of Systematic Bacteriology (5 volumes set), 2nd Edition, Springer Publications, New York, USA.
3. William B. Whitman, Bergey's Manual of Systematic of Archaea and Bacteria, 1st Edition, John Wiley & Sons, Inc.
4. C. J. Alexopoulos, C. W. Mims, M. Blackwell, Introductory Mycology, 4th Edition, John Wiley & Sons, 2007.
5. Sarah Kidd, Catriona Halliday, Helaen Alexiou, David Ellis. Descriptions of Medial Fungi, 3rd Edition, Australia, 2016.
6. Frederick M. Ausubel, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA, Struhl K. Current Protocols in Molecular Biology, Wiley Publications, USA, 2001.
7. Green MR, Sambrook J. Molecular cloning. A Laboratory Manual 4th Edition, Cold-Spring Harbor Press, 2012.
8. W. John Kress, David L. Erickson, DNA Barcodes: Methods and Protocols, Springer Publications, 2012.
9. Frans J. de Bruijn, Handbook of Molecular Microbial Ecology I: Metagenomics and Complementary Approach, Wiley-Blackwell, 2011.
10. Sushil K. Sharma, Ajit Varma, Microbial Resource Conservation: Conventional to Modern Approaches, Soil Biology Vol 54, Springer Publications, 2018
11. C. A. Reddy, Methods for General and Molecular Microbiology, ASM Press, 2007.
12. Ben M. Dunn (Auth.), David W. Speicher (Auth.), Paul T. Wingfield (Auth.), John E. Coligan (Ed.), Short protocols in protein science: a compendium of methods from Current protocols in protein science, Wiley-Blackwell, 2003
13. Wayne P. Olson, Automated Microbial Identification and Quantitation: Technologies for the 2000s, 1st Edition, CRC Press, 1996

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Course Code: 23PBTCC201	Core III - Writing a concept paper/ review articles on recent trends or existing problem of biotechnology or allied areas	1 hr/week	1 Credits

This course is designed to equip PhD course work students in the field of biotechnology and allied areas with the necessary skills to craft comprehensive and insightful review articles or concept paper on recent trends and existing problems in the field. Review articles play a crucial role in summarizing and critically analyzing the current state of knowledge in a specific area of biotechnology, enabling researchers to stay updated with the latest advancements and challenges. Through a combination of theoretical instruction, practical exercises, and peer feedback, students will develop the expertise to effectively communicate complex scientific concepts and contribute to the scientific discourse in their respective domains.

Course Objectives:

- Understand the structure and components of a review article.
- Identify recent trends and existing problems in biotechnology and related fields.
- Conduct thorough literature searches to gather relevant information.
- Analyze and synthesize information from diverse sources.
- Develop critical thinking and analytical skills for evaluating scientific literature.
- Effectively communicate complex scientific concepts in a clear and organized manner.
- Receive constructive peer feedback and incorporate revisions.

Course Outcomes:

By the end of the course, students will be able to:

1. **Analyze Research Trends:** Identify and critically analyze recent trends and existing problems in biotechnology and related fields through a comprehensive review of the literature.
2. **Synthesize Information:** Synthesize complex scientific information from diverse sources into a coherent and structured review article.
3. **Evaluate Literature:** Critically evaluate the quality, relevance, and significance of research articles, highlighting gaps and areas of controversy in the field.

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4. **Effective Communication:** Communicate scientific concepts effectively through well-structured, clear, and engaging writing, tailored for a target audience.
5. **Peer Collaboration:** Engage in constructive peer review processes, provide meaningful feedback, and incorporate suggestions for enhancing the quality of written work.

Through a combination of hands-on writing experience, critical thinking exercises, peer interaction, and expert guidance, students will develop the skills needed to contribute valuable review articles to the academic discourse in biotechnology and its allied areas.

Course Outline:

Module 1: Introduction to Review Articles

- Definition and purpose of review articles.
- Different types of review articles: systematic, narrative, meta-analysis, etc.
- Role of review articles in advancing scientific understanding.

Module 2: Selecting a Topic

- Identifying recent trends and challenges in biotechnology and allied areas.
- Niche selection vs. broad overview: pros and cons.
- Formulating a research question or thesis statement.

Module 3: Literature Review

- Conducting comprehensive literature searches using databases and other resources.
- Evaluating the credibility and relevance of sources.
- Organizing and categorizing retrieved literature.

Module 4: Synthesizing Information

- Developing frameworks for structuring the review article.
- Synthesizing findings from different studies.
- Identifying gaps and controversies in the literature.

Module 5: Critical Analysis

- Developing critical thinking skills to assess the strengths and limitations of studies.

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- Analyzing conflicting findings and interpretations.
- Presenting a balanced view of the literature.

Module 6: Writing and Structuring

- Crafting an engaging introduction and clear thesis statement.
- Structuring the review article: sections and sub-sections.
- Incorporating effective transitions and signposts.

Module 7: Language and Style

- Using clear and concise language for scientific communication.
- Avoiding jargon and explaining technical terms.
- Maintaining a coherent narrative throughout the article.

Module 8: Incorporating Visuals and References

- Integrating tables, figures, and diagrams to enhance understanding.
- Properly citing and referencing sources using appropriate citation styles.

Module 9: Peer Review and Revision

- Peer-review process: giving and receiving constructive feedback.
- Revising and improving the article based on peer suggestions.
- Finalizing the review article for submission or publication.

Evaluation Method:

- **Literature Analysis Assignments:** Students will be assigned research papers and articles to critically analyze and summarize. This assesses their ability to synthesize information and identify key points.
- **Topic Proposal and Literature Review:** Students will submit a topic proposal along with a brief literature review, demonstrating their understanding of the chosen topic's background and significance.
- **Outline and Structure:** Students will create a detailed outline and structure for their review article, highlighting the main sections and their content.

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- **Draft Submission:** Students will submit a draft of their review article. Peers and the instructor will provide feedback on clarity, organization, and content.
- **Peer Review Workshop:** In-class peer review sessions will allow students to receive constructive feedback on their drafts and practice providing insightful critiques.
- **Final Review Article:** The submission of the final review article, incorporating feedback from peers and the instructor, will demonstrate the student's ability to apply the concepts learned throughout the course.
- **Participation and Engagement:** Active participation in class discussions, workshops, and group activities will be assessed to gauge the student's involvement and understanding.

By the end of this course, students will not only possess the skills to write well-structured and informative review articles but also have an enhanced ability to critically evaluate scientific literature and contribute meaningfully to their field of study.

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Course code: 23PBTCC202	Course IV: Seminar Presentation (Review of Literature presentation)	-	1 Credits

Course Description:

This course is designed to provide PhD students with the skills and knowledge to create and deliver compelling literature review presentations for their proposed research topics. Effective literature review presentations are essential for communicating the background, context, and significance of a research project to peers, advisors, and potential collaborators. Through a combination of theoretical instruction, practical exercises, and peer feedback, students will develop the ability to synthesize complex information, structure presentations logically, and engage their audience with clear and engaging delivery.

Course Objectives:

- Understand the purpose and importance of literature review presentations in the research process.
- Develop skills to critically analyze and synthesize relevant literature.
- Structure presentations to effectively convey the context and significance of their research.
- Create visually engaging presentation slides.
- Develop public speaking skills to confidently deliver presentations.
- Receive and provide constructive peer feedback for continuous improvement.

Course outcomes

1. **Contextual Clarity:** Students will be proficient in articulating the context and significance of their research topic, providing a clear understanding of its relevance within the broader academic landscape.
2. **Structured Communication:** Participants will possess the ability to structure presentation content logically, ensuring a coherent flow of ideas that effectively conveys the background and importance of their research.

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3. **Engaging Visual Communication**: Graduates of the course will have the skills to create visually engaging presentation slides that complement their spoken content, enhancing clarity and engagement for their audience.
4. **Confident Public Speaking**: Students will develop confidence in public speaking, showcasing effective body language, voice modulation, and eye contact, resulting in compelling and confident presentations.
5. **Peer Collaboration and Improvement:** Through peer review workshops, participants will have learned how to give and receive constructive feedback, enabling continuous improvement and refinement of their presentation skills.

These outcomes collectively equip students with the ability to deliver compelling literature review presentations that effectively communicate the context, significance, and importance of their proposed research topics to various audiences.

Evaluation Method:

- **Literature Review Analysis:** Students will submit a brief analysis of key literature related to their research topic, demonstrating their ability to critically evaluate and synthesize information.
- **Presentation Outline:** Students will submit an outline of their presentation, showcasing the logical flow of their content.
- **Presentation Slides:** Students will create visually appealing presentation slides that effectively complement their spoken content.
- **Practice Presentations:** Students will conduct practice presentations in front of peers, allowing them to refine their delivery and receive constructive feedback.
- **Peer Review Participation:** Active participation in peer review workshops, providing feedback to peers, and incorporating received feedback into their own presentations.
- **Final Presentation:** Each student will deliver a final literature review presentation to the class, demonstrating their ability to convey the context and significance of their research topic effectively.
- **Self-Reflection:** Students will submit a self-reflection on their growth and improvement in public speaking and presentation skills over the course duration.

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Upon completing this course, students will have honed their ability to present complex research concepts clearly, engage their audience effectively, and create persuasive and visually appealing presentations that effectively convey the importance and context of their proposed research topics.

Course Code: 23PBTCC203	**Course IV: Core V –** Research and Professional Ethics	**-**	**1 Credits**

Course content, objective outcomes evaluation methods of this course will be as per description provided in UGC guideline. This course will be same for all Ph.D. students of all stream of Atmiya University.

(Students are requested to visit the website of AU or contact office of Director RIT, AU for details of this course)

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Department of Chemistry
Ph.D. – Chemistry

Preamble

Atmiya University offers Ph.D. Programmes in Chemistry being its major research discipline. Considering the magnitude of research in present scenario and to augment the quality of research the syllabus for the Course Work, as a prerequisite to continue with the programme in Chemistry discipline, has been designed.

The course work aims to provide a full research based program to equip the Scholars with necessary tools so that they can grasp the area of study better as well as improve on their scientific writing skills, which is essential in any kind of quality research. The course further aims at familiarizing the perspectives, pedagogy and their implications in various areas of investigations.

As per the university ordinance and new guidelines of UGC, the research scholars who are provisionally registered under the Ph.D. Programme will have to undergo a Course Work.

The main objectives of the Course Work are to inculcate the following qualities in the Research Scholar:

- **Inquisition:** The ability to inquire about the research problem and to relate this with current socio-economic scenario.
- **Understanding:** Understand the theories that strengthen their dissertation research, with the depth needed to produce their own hypothesis and find out the research gape.
- **Analysis:** Student will be able to design the experiment and analysis the research problem.
- **Interpretation:** Interpret and compare the research outcomes.
- **Assessment:** Appraise the results and draw a conclusion.
- **Writing, editing, proof reading and designing:** Ability to write the scientific draft (*viz.* manuscript, review article, book chapter, research proposal etc)

Programme Structure

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The Pre-Ph.D. course work shall comprise of Two Semesters (i.e. one Year) in which there shall be **four** compulsory papers:

Semester – I							
Course Code	**Course**	**Hrs. of Instruction/ week**	**Exam Duration (Hrs.)**	**Maximum Marks**			**Credits**
				CIA	**SEE**	**Total**	
19PCHCC101	**Course I -** Research Methodology	4	3 Hr	30	70	100	4
19PCHCC102	**Course II -** Seminar Presentation (Recent Trends in Chemistry)	-	-	50	-	50	1
	Total	**4**		**80**	**70**	**150**	**5**

* 80% of the total syllabus of Research Methodology is common to all discipline across the University while the rest 20% will be discipline specific.

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Semester – II							
Course Code	Course	Hrs. of Instruction/ week	Exam Duration (Hrs.)	Maximum Marks			Credits
				CIA	SEE	Total	
19PCHDC201 19PCHDC202 19PCHDC203	**Course III -** DSE-Core I – Spectroscopy II – Separation Techniques III–Synthetic Organic Chemistry	4	3 Hr	30	70	100	4
19PCHCC201	**Course IV -** Seminar Presentation (Review of Literature)	-	-	50	-	50	1
	Total	**4**		**80**	**70**	**150**	**5**
TOTAL OF ALL SEMESTER				**160**	**140**	**300**	**10**

a) The student shall be evaluated at the end of each semester. Total marks for semester 1 is 150 and semester II is 150. Minimum Pass marks are 50% in each paper. If a student is not able to complete a course with 50 % marks, the student shall be allowed to reappear only once in the examination in the subsequent academic year (As per the ordinance).

b) The candidate already holding M.Phil degree and completed the course work in M.Phil and have been permitted to proceed to the Ph.D. in integrated course, may be exempted by the Department from the Ph.D. course work. All other candidates admitted to the Ph.D. programme shall be required to complete the Ph.D. course work prescribed by the Department.

c) The final research proposal will be presented before the DRC within the stipulated period and prescribed by the ordinance.

d) Participation in Pre-Ph.D. presentation seminar, Pre-Ph.D. submission presentation, Ph.D. Viva Voce Exam and Seminars conducted by the Department is mandatory.

e) The minimum attendance required during the Course work period is 80% of the total classes.

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Ph.D. – Chemistry

SEMESTER – I

19PCHCC101	Course I - Research Methodology	4 Hrs /week	4 Credits

Unit 1	**Introduction to Research Methodology& Research Design**	**10**
	Meaning of Research, Objectives of Research, Motivations in Research, Types of Research, Research Process, Significance of Research, Criteria for good research; Definition of research problem, Selection of research problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem. Basic Principles and Need of research design, features of good design, Important concepts relating to research design, Measurement in Research; Methods of Data Collection- Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Collection of Secondary Data.	
Unit 2	**Scientific documentation**	**10**
	Definition and kinds of Scientific documents: Research paper, Review paper, Book reviews, Thesis & Technical reports; Standards of research journal: Impact factor, Citation index, H index, I10 index, Eigen factor; Components of a research paper: Title, Authors and addresses, Abstract, Acknowledgements, Tables and illustrations, Documentation of collected literature, Reference Index, Database generation, Basics of Bibliographic Citations, ISBN & ISSN, Different Bibliographic styles; Dealing with publishers: Submission of Manuscript, Ordering reprints.	
Unit 3	**Statistical tests**	**10**
	Statistics in Research; Descriptive Statistics- measure of central tendency, measure of variance; Student's 't' test: Hypotheses, acceptance and rejections, significance levels (One sampled test, two sampled test-paired and unpaired test);Regression and correlation – biveriate analysis, Analysis of Variance (ANOVA): General principles, completely randomized and	

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	random-block design ANOVA (One-way ANOVA, two-way-ANOVA); Non parametric tests- Chi-square test; Normality tests.	
Unit 4	**Interpretation and Report Writing**	**10**
	Data Analysis, Data sorting and validation of data, Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation; Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing.	
Unit 5	**Application of Computer and Chemistry software in Research**	**8**
	Literature survey using web and search engines, Use of technology and other equipments in Research, Seminar presentations – Power point for oral and poster presentations. Use of Internet for Research Purpose, Introduction to UGC infonet, Shodhganga: INFLIBNET and ERNET etc, Introduction and practice of Chemistry software tools for reaction scheme, reaction structure and assembly drawings.	

Reference Books :

Mastering Internets - Coleman P and Dyson P

How the Internet Works - Gralla P

Inside Microsoft Office Professional - Cassel P et al

Statistical Methods - Snedecor GW & Cochran WG

Plagiarism: Why it happens, How to prevent it? - Gilmore B

Research Methodology - R Panneerselvam

Research Methodology: Methods & techniques, 2008 - CR Kothari

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Ph.D. – Chemistry

SEMESTER – II

19PCHDC101	Course III - Discipline Specific Core Elective I Spectroscopy	4 Hrs /week	4 Credits

Unit 1	**UV Spectroscopy**	**8**
	Theory and principles of electronic transition and UV absorption, chromophores and auxochromes, characteristic absorptions in organic compound. Effects of conjugation. Characteristic absorptions in aromatic compounds.	
Unit 2	**Infrared Spectroscopy**	**10**
	Theory and principles, Instrumentations, molecular vibrations and calculations of vibrational frequencies, characteristic group absorptions in hydrocarbons, aromatic compounds, alcohol and phenols, ethers, carbonyl compounds, amines, nitriles, nitro compounds, carboxylic acids and halide.	
Unit 3	**MASS Spectroscopy**	**8**
	Theory and principles of mass spectroscopy, Instrumentation, low and high resolution mass spectra, Ionization techniques – Electron Impact (EI) ionization, Chemical Ionization (CI), Field Desorption (FD), Fast Ion Bombardment (FAB), Electron spray Ionization (ESI) and Matrix Assisted Laser Desorption/Ionization (MALDI). Determination of molecular weight and molecular formula, nitrogen rule, detection of molecular ion peak, metastable ion peak. Fragmentations –rules governing the fragmentations, Interpretation of mass spectra of different class of compounds.	
Unit 4	**^{1}H NMR Spectroscopy**	**12**
	Proton resonance condition, aspects of PMR spectra – number of signals, chemical shifts, shielding and deshielding, diamagnetic	

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	anisotropy, factors affecting chemical shifts, peak area and integration, splitting of the signals – spin spin coupling, coupling constants – vicinal, germinal, long range and virtual couplings, chemical shift equivalence and magnetic equivalence, first order and second order spectra, complex PMR spectra. 2D NMR spectroscopy and their examples	
Unit 5	**^{13}C NMR Spectroscopy**	**10**
	Theory, principles and instrumentations. Interpretation of NMR spectra.	

Reference Books:

Spectrometric Identification of organic Compounds, R.M. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley

Spectroscopy of Organic Compounds, P.S.Kalsi, 5th edition, New age international publishers

Organic Spectroscopy, William Kemp, 3rd edition ,Palgrave

Spectroscopy Methods in Organic Chemistry, D. H. Williams, I. Fleming, Tata McGraw-Hill.

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SEMESTER – II

19PCHDC202	**Course III - Discipline Specific Core Elective II Separation Technique**	**4 Hrs /week**	**4 Credits**

Unit 1	**Gas Chromatography**	**10**
	Principle, Theory and Instrumentation, Solid/Liquid Stationary phases, Column types ,Detectors, Applications	
Unit 2	**High Performance Liquid Chromatography (HPLC)**	**10**
	Principle, Theory and Instrumentation, Column types, Detectors, Applications	
Unit 3	**TLC and HPTLC**	**10**
	Principle, Instrumentation, Applications	
Unit 4	**Column Chromatography**	**10**
	Principle, Theory, Column types, Applications	
Unit 5	**Ion exchange Chromatography**	**8**
	Principle, Theory and Instrumentation, Applications	

Reference Books:

Instrumental method of chemical analysis, B. K. Sharma, 4th edition, GOEL Publishing house Meerut

Vogel's Textbook of Quantitative Chemical Analysis, G. H. Jeffery, J. Bassett, J. Mendham and C. Denney, Longman Singapore Publisher Pvt. Ltd. (Singapore).

Principles of Instrumental Analysis, Skoog, Holler and Neiman, Sunders College Publishers (USA)

Introduction to Instrumental Analysis, Robert D. Braun, Pharma Med Press Hyderabad- India.

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SEMESTER – II

19PCHDC203	**Course III - Discipline Specific Core Elective III Synthetic Organic Chemistry**	**4 Hrs /week**	**4 Credits**

Unit 1	**Purification and Crystallization**	**10**
	Isolation and purification of organic compounds (solids and liquids) with special emphasis on chromatographic techniques: TLC, column chromatography and HPLC. Crystallization: Single crystal development, Drying and dehydrating agents.	
Unit 2	**Modern Concepts of Organic Chemistry**	**12**
	New Techniques and concepts in organic synthesis. i) Combinatorial synthesis ii) Phase transfer catalysis iii) Tandem synthesis iv) Cascade reaction.	
Unit 3	**Advance Heterocyclic Chemistry**	**10**
	Systematic nomenclature (Hantzsch – Widman system) for monocycle and fused heterocycles. General approach to heterocyclic synthesis – cyclization and cycloaddition routes. Heterocycles in organic synthesis – masked functionalities, functional group interconversion, umpolung, rearrangement and ring transformation involving 5- and 6- membered heterocycles with one heteroatom.	
Unit 4	**Asymmetric synthesis and catalysis**	**8**

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	Terminology, concepts of Prochirality, enantioselectivity and diastereo selectivity. Methods for determination of Enantiomer purity: Polarimeter, Asymmetric catalysis:- Metal mediated catalysis – asymmetric hydrogenation; early advances DIPAMP, DIOP and Noyori's BINAP – Sharpless epoxidation, dihydroxylation, aminohydroxylation of alkenes – metal biocatalysts – organocatalysis – Proline mediated aldol reaction and further expansion in the field of organocatalysis.	
Unit 5	**Green Chemistry**	**8**
	Green Chemistry: Introduction, principles of green chemistry, Different approaches to green synthesis: Ultrasound assisted organic synthesis, Ionic liquids. Solid phase and aqueous phase organic synthesis, Microwave assisted organic reactions and their advantages and limitations.	

Reference Books:

Vogel's textbook of practical Organic Chemistry, B.S. Furhen ey. al. Longman Group.

Some modern methods of organic synthesis by W Carruthers

Organic Synthesis - The disconnection approach by S Warren

Organic chemistry by Claydon and others 2005

Reagents in Organic synthesis by B.P.Mundy and others.

Tandem Organic Reactions by Tse-Lok Ho

Organic synthesis in water. By Paul A. Grieco Blackie.

Green chemistry, Theory and Practical, Paul T.Anastas and John C.Warner.

New trends in green chemistry By V.K.Ahulwalia and M.Kidwai.

Organic Synthesis: Special techniques. V.K.Ahulwalia and Renu Aggarwal

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Ph.D. – Industrial Chemistry

Scheme of Instruction & Examinations

Preamble

Atmiya University offers Ph.D. Programs in Industrial Chemistry being its major research discipline. Considering the magnitude of research in present scenario and to augment the quality of research the syllabus for the Course Work, as a prerequisite to continue with the program in Industrial Chemistry discipline, has been designed.

The course work aims to provide a full research based program to equip the Scholars with necessary tools so that they can grasp the area of study better as well as improve on their scientific writing skills, which is essential in any kind of quality research. The course further aims at familiarizing the perspectives, pedagogy and their implications in various areas of investigations.

As per the university ordinance and new guidelines of UGC, the research scholars who are provisionally registered under the Ph.D. Program will have to undergo a Course Work.

The main objectives of the Course Work are to inculcate the following qualities in the Research Scholar:

Inquisition: The ability to inquire about the research problem and to relate this with current socio-economic scenario.
Understanding: Understand the theories that strengthen their dissertation research, with the depth needed to produce their own hypothesis and find out the research gape.
Analysis: Student will be able to design the experiment and analysis the research problem.
Interpretation: Interpret and compare the research outcomes.
Assessment: Appraise the results and draw a conclusion.
Writing, editing, proof reading and designing: Ability to write the scientific draft (*viz.* manuscript, review article, book chapter, research proposal etc)

Program Structure

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The Pre-Ph.D. course work shall comprise of Two Semesters (i.e. one Year) in which there shall be **four** compulsory papers:

Semester – I							
Course Code	**Course**	**Hrs. of Instruction/ week**	**Exam Duration (Hrs.)**	**Maximum Marks**			**Credits**
				CIA	**SEE**	**Total**	
19PICCC101	**Course I -** Research Methodology	4	3 Hr				4
19PICCC102	**Course II -** Seminar Presentation (Recent Trends in Chemistry)	-	-				1
		4					**5**

* 80% of the total syllabus of Research Methodology is common to all discipline across the University while the rest 20% will be discipline specific.

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Semester – II							
Course Code	Course	Hrs. of Instruction/ week	Exam Duration (Hrs.)	Maximum Marks			Credits
				CIA	SEE	Total	
19PICDC201 19PICDC202 19PICDC203	**Course III -** DSE-Core I – Spectroscopy II – Chromatography III– Synthetic Organic Chemistry	4	3 Hr	30	70	100	4
19PICCC201	**Course II -** Seminar Presentation (Review of Literature)	-	-	50	-	50	1
		4					**5**

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Ph.D. – Industrial Chemistry

SEMESTER – I

19PICCC101	Course I -Research Methodology	4 Hrs /week	4 Credits

Unit 1	**Introduction to Research Methodology& Research Design**	**12**
	Meaning of Research, Objectives of Research, Motivations in Research, Types of Research, Research Process, Significance of Research, Criteria for good research; Definition of research problem, Selection of research problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem. Basic Principles and Need of research design, features of good design, Important concepts relating to research design, Measurement in Research; Methods of Data Collection- Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Collection of Secondary Data.	
Unit 2	**Scientific documentation**	**16**
	Definition and kinds of Scientific documents: Research paper, Review paper, Book reviews, Thesis & Technical reports; Standards of research journal: Impact factor, Citation index, H index, I10 index, Eigen factor; Components of a research paper: Title, Authors and addresses, Abstract, Acknowledgements, Tables and illustrations, Documentation of collected literature, Reference Index, Database generation, Basics of Bibliographic Citations, ISBN & ISSN, Different Bibliographic styles; Dealing with publishers: Submission of Manuscript, Ordering reprints.	
Unit 3	**Statistical tests**	**10**
	Statistics in Research; Descriptive Statistics- measure of central tendency, measure of variance; Student's 't' test: Hypotheses,	

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	acceptance and rejections, significance levels (One sampled test, two sampled test-paired and unpaired test);Regression and correlation – biveriate analysis, Analysis of Variance (ANOVA): General principles, completely randomized and random-block design ANOVA (One-way ANOVA, two-way-ANOVA); Non parametric tests- Chi-square test; Normality tests.	
Unit 4	**Interpretation and Report Writing**	**10**
	Data Analysis, Data sorting and validation of data, Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation; Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing.	
Unit 5	**Application of Computer and Chemistry software in Research**	
	Literature survey using web and search engines, Use of technology and other equipments in Research, Seminar presentations – Power point for oral and poster presentations. Use of Internet for Research Purpose, Introduction to UGC infonet, Shodhganga: INFLIBNET and ERNET etc, Introduction and practice of Chemistry software tools for reaction scheme, reaction structure and assembly drawings.	

Reference Books :

Mastering Internets - Coleman P and Dyson P

How the Internet Works - Gralla P

Inside Microsoft Office Professional - Cassel P et al

Statistical Methods - Snedecor GW & Cochran WG

Plagiarism: Why it happens, How to prevent it? - Gilmore B

Research Methodology - R Panneerselvam

Research Methodology: Methods & techniques, 2008 - CR Kothari

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Ph.D. – Industrial Chemistry

SEMESTER – II

Course Code 19PICDC101	Course III - Discipline Specific Core Elective I Spectroscopy	4 Hrs /week	4 Credits

Syllabus:

Unit 1	**UV Spectroscopy**	**8**
	Theory and principles of electronic transition and UV absorption, chromophores and auxochromes, Woodward-Fieser rules for dienes and enones, characteristic absorptions in organic compound. Effects of conjugation. Characteristic absorptions in aromatic compounds.	
Unit 2	**Infrared Spectroscopy**	**10**
	Theory and principles, Instrumentations, molecular vibrations and calculations of vibrational frequencies, characteristic group absorptions in hydrocarbons, aromatic compounds, alcohol and phenols, ethers, carbonyl compounds, amines, nitriles, nitro compounds, carboxylic acids and halide.	
Unit 3	**MASS Spectroscopy**	**8**
	Theory and principles of mass spectroscopy, Instrumentation, low and high resolution mass spectra, Ionization techniques – Electron Impact (EI) ionization, Chemical Ionization (CI), Field Desorption (FD), Fast Ion Bombardment (FAB), Electron spray Ionization (ESI) and Matrix Assisted Laser Desorption/Ionization (MALDI). Determination of molecular weight and molecular formula, nitrogen rule, detection of molecular ion peak, metastable ion peak. Fragmentations –rules governing the fragmentations, Interpretation of mass spectra of different class of compounds.	
Unit 4	**^{1}H NMR Spectroscopy**	**12**
	Proton resonance condition, aspects of PMR spectra – number of signals, chemical shifts, shielding and deshielding, diamagnetic	

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	anisotropy, factors affecting chemical shifts, peak area and integration, splitting of the signals – spin spin coupling, coupling constants – vicinal, germinal, long range and virtual couplings, chemical shift equivalence and magnetic equivalence, first order and second order spectra, complex PMR spectra. 2D NMR spectroscopy and their examples	
Unit 5	**^{13}C NMR Spectroscopy**	**10**
	Theory and principles of mass spectroscopy, Instrumentation, low and high resolution mass spectra, Ionization techniques – Electron Impact (EI) ionization, Chemical Ionization (CI), Field Desorption (FD), Fast Ion Bombardment (FAB), Electron spray Ionization (ESI) and Matrix Assisted Laser Desorption/Ionization (MALDI), and their examples	

Reference Books :

- Spectrometric Identification of organic Compounds, R.M. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley.
- Spectroscopy of Organic Compounds, P.S.Kalsi, 5th edition, New age international publishers
- Organic Spectroscopy, William Kemp, 3rd edition ,Palgrave
- Spectroscopy Methods in Organic Chemistry, D. H. Williams, I. Fleming, Tata McGraw-Hill.

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Course Code 19PICDC202	Course III - Discipline Specific Core Elective II Chromatography	4 Hrs /week	4 Credits

Syllabus:

Unit 1	**Gas Chromatography**	**10**
	Principle, Theory and Instrumentation, Solid/Liquid Stationary phases, Column types ,Detectors, Applications	
Unit 2	**High Performance Liquid Chromatography (HPLC)**	**10**
	Principle, Theory and Instrumentation, Column types, Detectors, Applications	
Unit 3	**TLC and HPTLC**	**10**
	Principle, Instrumentation, Applications	
Unit 4	**Column Chromatography**	**10**
	Principle, Theory, Column types, Applications	
Unit 5	**Ion exchange Chromatography**	**8**
	Principle, Theory and Instrumentation, Applications	

Reference Books:

- Instrumental method of chemical analysis, B. K. Sharma, 4th edition, GOEL Publishing house Meerut
- Vogel's Textbook of Quantitative Chemical Analysis, G. H. Jeffery, J. Bassett, J.
- Mendham and C. Denney, Longman Singapore Publisher Pvt. Ltd. (Singapore).
- Principles of Instrumental Analysis, Skoog, Holler and Neiman, Sunders College Publishers (USA)
- Introduction to Instrumental Analysis, Robert D. Braun, Pharma Med Press Hyderabad- India.

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Course Code 19PICDC203	Course III - Discipline Specific Core Elective III Synthetic Organic Chemistry	4 Hrs /week	4 Credits

Unit 1	**Purification and Crystallization**	**10**
	Isolation and purification of organic compounds (solids and liquids) with special emphasis on chromatographic techniques: TLC, column chromatography and HPLC. Drying and dehydrating agents.	
Unit 2	**Modern Concepts of Organic Chemistry**	**12**
	New Techniques and concepts in organic synthesis. i) Combinatorial synthesis ii) Phase transfer catalysis iii) Tandem synthesis iv) Cascade reaction.	
Unit 3	**Advanced Heterocyclic Chemistry**	**10**
	Systematic nomenclature (Hantzsch – Widman system) for monocycle and fused heterocycles. General approach to heterocyclic synthesis – cyclization and cycloaddition routes. Heterocycles in organic synthesis – masked functionalities, umpolung, Rearrangement and ring transformation involving 5- and 6- membered heterocycles with one heteroatom.	
Unit 4	**Asymmetric synthesis and catalysis**	**8**
	Terminology, concepts of Prochirality, enantioselectivity and diastereo selectivity. Methods for determination of Enantiomer purity: Polarimeter, Asymmetric catalysis:- Metal mediated catalysis – asymmetric hydrogenation; early advances DIPAMP, DIOP and Noyori's BINAP – Sharpless epoxidation, dihydroxylation, aminohydroxylation of alkenes – metal biocatalysts – organocatalysis – Proline mediated aldol reaction and further expansion in the field of organocatalysis.	
Unit 5	**Green Chemistry**	**8**
	Green Chemistry: Introduction, principles of green chemistry, Different approaches to green synthesis: Ultrasound assisted organic synthesis, Ionic liquids. Solid phase and aqueous phase organic synthesis, Microwave assisted organic reactions and their advantages and limitations.	

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Reference Books:

- Vogel's textbook of practical Organic Chemistry, B.S. Furhen ey. al. Longman Group.
- Some modern methods of organic synthesis by W Carruthers
- Organic Synthesis - The disconnection approach by S Warren
- Organic chemistry by Claydon and others 2005
- Reagents in Organic synthesis by B.P.Mundy and others.
- Tandem Organic Reactions by Tse-Lok Ho
- Organic synthesis in water. By Paul A. Grieco Blackie.
- Green chemistry, Theory and Practical, Paul T.Anastas and John C.Warner.
- New trends in green chemistry By V.K.Ahulwalia and M.Kidwai.
- Organic Synthesis: Special techniques. V.K.Ahulwalia and Renu Aggarwal

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Ph.D. – Mathematics

Scheme of Instruction and Examination

FOR STUDENTS ADMITTED FROM A.Y. 2019-2020 & ONWARDS

Preamble

Atmiya University offers Ph. D. Programmes in Mathematics being its major research discipline. Considering the magnitude of research in present scenario and to augment the quality of research the syllabus for the Course Work, as a prerequisite to continue with the programme in mathematics and communication discipline, has been designed.

The course work aims to provide a full research based program to equip the Scholars with necessary tools so that they can grasp the area of study better as well as improve on their scientific writing skills, which is essential in any kind of quality research. The course further aims at familiarizing the perspectives, pedagogy and their implications in various areas of investigations.

As per the university ordinance and new guidelines of UGC, the research scholars who are provisionally registered under the Ph.D. Programme will have to undergo a Course Work.

The main objectives of the Course Work are to inculcate the following qualities in the Research Scholar:

- **Inquisition:** The ability to inquire about the research problem and to relate this with current socio-economic scenario.
- **Understanding:** Understand the theories that strengthen their dissertation research, with the depth needed to produce their own hypothesis and find out the research gape.
- **Analysis:** Student will be able to design the experiment and analysis the research problem.
- **Interpretation:** Interpret and compare the research outcomes.
- **Assessment:** Appraise the results and draw a conclusion.
- **Writing, editing, proof reading and designing:** Ability to write the scientific draft (*viz.* manuscript, review article, book chapter, research proposal etc)

Programme Structure

The Pre-Ph.D course work shall comprise of Two Semesters (i.e. one Year) in which there shall be **four** compulsory papers:

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Semester – I							
Course Code	Course	Hrs. of Instruction/ week	Exam Duration (Hrs.)	Maximum Marks			Credits
				CIA	SEE	Total	
19DPMTCC101	**Course I -** Research Methodology	4	3 Hr	30	70	100	4
19DPMTCC102	**Course II -** Seminar Presentation (Recent Trends in Mathematics)	-	-	50	-	50	1
		4		**80**	**70**	**150**	**5**

** 80% of the total syllabus of Research Methodology is common to all discipline across the University while the rest 20% will be discipline specific.*

Semester – II							
Course Code	Course	Hrs. of Instruction / week	Exam Duration (Hrs.)	Maximum Marks			Credits
				CIA	SEE	Total	
19DPMTDC102	**Course III -** DSE-Core I – Research Tool: Introduction to LaTeX	4	3 Hr	30	70	100	4
19DPMTCC201	**Course II -** Seminar Presentation (Review of Literature)	-	-	50	-	50	1
		4		**80**	**70**	**150**	**5**
TOTAL OF ALL SEMESTERS				**160**	**140**	**300**	**10**

a) The student shall be evaluated at the end of each semester. Total marks for Semester I is 150 (Course I - 100 marks, Course II- 50 marks) and Semester II is 150 (Course III-100 marks and Course IV - 50). **Minimum Pass marks is 50% in each paper**. If a student is not able to complete a course with 50% marks, the student shall be allowed to reappear only once in the examination in the subsequent academic year (As per the ordinance).

b) The final research proposals will be presented before the DRC within the stipulated period as prescribed by the ordinance.

c) Participation in Pre-Ph.D. presentation seminar, Pre-Ph.D. submission presentation, Ph.D. Viva Voce Exam and Seminars conducted by the Department is mandatory.

d) **The minimum attendance required during the Course work period is 80 % of the total classes**

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Department of Mathematics
Ph.D. – Mathematics
Syllabi for Course Work
FOR STUDENTS ADMITTED FROM A.Y. 2019-2020 & ONWARDS
SEMESTER – I

19DPMTCC101	**Course I - Research Methodology**	**4 Hrs /week**	**4 Credits**

Syllabus:

Unit 1 **Introduction to Research Methodology& Research Design** **12**

Meaning of Research, Objectives of Research, Motivations in Research, Types of Research, Research Process, Significance of Research, Criteria for good research; Definition of research problem, Selection of research problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem. Basic Principles and Need of research design, features of good design, Important concepts relating to research design, Measurement in Research; Methods of Data Collection- Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Collection of Secondary Data.

Unit 2 **Scientific documentation** **16**

Definition and kinds of Scientific documents: Research paper, Review paper, Book reviews, Thesis & Technical reports; Standards of research journal: Impact factor, Citation index, H index, I10 index, Eigen factor; Components of a research paper: Title, Authors and addresses, Abstract, Acknowledgements, Tables and illustrations, Documentation of collected literature, Reference Index, Database generation, Basics of Bibliographic Citations, ISBN & ISSN, Different Bibliographic styles; Dealing with publishers: Submission of Manuscript, Ordering reprints.

Unit 3 **Statistical tests** **10**

Statistics in Research; Descriptive Statistics- measure of central tendency, measure of variance; Student's 't' test: Hypotheses, acceptance and rejections, significance levels (One sampled test, two sampled test-paired and unpaired test);Regression and correlation – biveriate analysis, Analysis of Variance (ANOVA): General principles, completely randomized and random-block design ANOVA (One-way ANOVA, two-way-ANOVA); Non parametric tests- Chi-square test; Normality tests.

Unit 4 **Interpretation and Report Writing** **10**

Data Analysis, Data sorting and validation of data, Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation; Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Preparation of manuscript for

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Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing.

Unit 5 **Graph Theory** **10**

A quick review of Graph, Degree of a vertex, Path, Circuit, Connected and disconnected graphs, Components.

Euler trail, Euler tour, Euler Graph, Characterizations of Eulerian graph, Hamiltonian Paths and Cycles, Trees and their properties, Bridges, Spanning trees, Planar Graphs.

Matching, Augmenting path, Kuratowski's two graphs.

Different representation of planarity, Detection of Planarity.

Coloring of graphs, Chromatic number, Chromatic polynomial,

The four color problem.

Text Book :

- Kothari C. R. and Gaurav Garg (2014 – Third Edition), Research Methodology – Methods and Techniques, New Age International Publishers.
- J. Clark and D. A. Hotton (1995), A first Look at Graph Theory, World Scientific Publishing Co. Pte. Ltd.

Reference Books :

- Mangal S.K. and Shubhra Mangal (2013), Research Methodology in Behavioural Sciences, PHI Learning Private Limited.
- F. Harary (1969), Graph theory,Addision – Wesley.

19DPMTCC102	**Course II: Seminar**	-	**1 Credits**

This course will be of self-study type where the students shall have to write and submit a review/concept paper on the topic of their choice on recent trends in mathematics and will be asked to prepare presentation (approximately of 20 minutes) on this topic. The presentation will be evaluated at the end of semester by members of DRC. Only those students who have completed their 80% attendance, will be allowed to appear in this course. All the other staff members or students of the concern Department may also remain present in this seminar.

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Ph.D – Mathematics
SEMESTER – II

19DPMTDC201	**Course III -** **Discipline Specific Core Elective I** Research Tool: Introduction to LaTeX	**4 Hrs /week**	**4 Credits**

Syllabus:

Unit 1 History and Basics of LaTeX

- History of LaTeX, How to install LaTeX,
- Basic Structure of LaTeX Document, Layout Design,
- Advantages and Disadvantages,
- Input file structures, Document class, Page Style, Packages.

Unit 2 Simple documents and type setting

- Typesetting of Text, Structure of Document,
- Line Break and Page Break,
- Fonts and Size,
- Different Environments,
- Cross references,
- Footnotes, Fancy header.

Unit 3 Mathematical Type Setting

- Typesetting Mathematics, single equation,
- Mathematical Formulas, multiline single equation, multiple equations,
- array and matrix, command for mathematical symbols,
- theorem and lemmas.

Unit 4 Use of Graphicx and Tables.

- Graphicx package,
- tabular environment,
- bibliography.

Unit 5 Presentation using LaTeX.

- Preparing presentation using LaTeX.

Text Book : Tobias Oetiker, Hubert Partl, Irene Hyna and Elisabeth Schlegl, The Not So Short Introduction to LaTeX 2ε, www.ctan.org.

Reference Books: George Grätzer (2007), *More Math into LaTeX*, 4th edition, Springer.

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19DPMTCC201	**Course IV: Seminar Presentation**	-	**1 Credits**

This course will be of self study type where the students shall have to write and submit a review/concept paper on the topic of their choice on recent trends in mathematics and will be asked to prepare presentation (approximately of 20 minutes) on this topic. The presentation will be evaluated at the end of semester by members of DRC. Only those students who have completed their 80% attendance, will be allowed to appear in this course. All the other staff members or students of the concern Department may also remain present in this seminar.

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Atmiya University

Department of Commerce

Ph.D – Commerce

Preamble

Atmiya University offers Ph. D. Programmes in Commerce and Management being its major research discipline. Considering the magnitude of research in present scenario and to augment the quality of research the syllabus for the Course Work, as a prerequisite to continue with the programme in Commerce and Management discipline, has been designed.

The course work aims to provide a full research based program to equip the Scholars with necessary tools so that they can grasp the area of study better as well as improve on their scientific writing skills, which is essential in any kind of quality research. The course further aims at familiarizing the perspectives, pedagogy and their implications in various areas of investigations.

As per the university ordinance and new guidelines of UGC, the research scholars who are provisionally registered under the Ph.D. Programme will have to undergo a Course Work.

The main objectives of the Course Work are to inculcate the following qualities in the Research Scholar:

- **Inquisition:** The ability to inquire about the research problem and to relate this with current socio-economic scenario.
- **Understanding:** Understand the theories that strengthen their dissertation research, with the depth needed to produce their own hypothesis and find out the research gape.
- **Analysis:** Student will be able to design the experiment and analysis the research problem.
- **Interpretation:** Interpret and compare the research outcomes.
- **Assessment:** Appraise the results and draw a conclusion.
- **Writing, editing, proof reading and designing:** Ability to write the scientific draft (*viz.* manuscript, review article, book chapter, research proposal etc)

Programme Structure

The Pre-Ph.D course work shall comprise of Two Semesters (i.e. one Year) in which there shall be **four** compulsory papers:

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Semester – I							
Course Code	Course	Hrs. of Instruction/ week	Exam Duration (Hrs.)	Maximum Marks			Credits
				CIA	SEE	Total	
19DPCMCC101	**Course I -** Research Methodology	4	3 Hr	30	70	100	4
19DPCMCC102	**Course II -** Seminar Presentation (Recent Trends in Commerce and Management)	-	-	50	-	50	1
		4					**5**

* 70% of the total syllabus of Research Methodology is common to all discipline across the University while the rest 30% will be discipline specific.

Semester – II							
Course Code	Course	Hrs. of Instruction/ week	Exam Duration (Hrs.)	Maximum Marks			Credits
				CIA	SEE	Total	
19PHDCC201	Research and publication Ethics	2	-	50	-	50	2
19DPCMDC201 19DPCMDC202 19DPCMDC203	**Course III -** DSE-Core I – **Statutory and Financial Aspects** II – Name of the Course III – Name of the Course	4	3 Hr	30	70	100	4
19DPCMCC201	**Course II -** Seminar Presentation (Review of Literature)	-	-	50	-	50	1
		6					**7**

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Ph.D – Commerce

SEMESTER – I

19DPCMCC101	**Course I -** **Research Methodology**	**4 Hrs /week**	**4 Credits**

Syllabus:

Unit 1 Introduction to Research Methodology& Research Design 12 hrs

- Meaning of Research
- Objectives of Research
- Motivations in Research
- Types of Research
- Research Process
- Significance of Research
- Criteria for good research
  - Definition of research problem
  - Selection of research problem
  - Necessity of Defining the Problem
  - Technique Involved in Defining a Problem.
- Basic Principles and Need of research design
- Features of good design
- Important concepts relating to research design
- Measurement in Research
- Methods of Data Collection
  - Collection of Primary Data
  - Observation Method & Interview Method
  - Collection of Data through Questionnaires
  - Collection of Data through Schedules
  - Collection of Secondary Data.

Unit 2 Scientific documentation 16 hrs

- Definition and kinds of Scientific documents:
  - Research paper

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- Review paper
- Book reviews
- Thesis & Technical reports
- Standards of research journal

- Impact factor
- Citation index
- H index
- I10 index
- Eigen factor Components of a research paper:
  - Title
  - Authors and addresses
  - Abstract
  - Acknowledgements
  - Tables and illustrations
  - Documentation of collected literature
  - Reference Index
  - Database generation
- Basics of Bibliographic Citations
- ISBN & ISSN
- Different Bibliographic styles;
  - Dealing with publishers
  - Submission of Manuscript
  - Ordering reprints.

Unit 3 Statistical tests 10 hrs

- Statistics in Research; Descriptive Statistics
  - Measure of central tendency
  - Measure of variance
- Student's 't' test:
  - Hypotheses, acceptance and rejections,
  - Significance levels (One sampled test

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- Two sampled test-paired and unpaired test)
- Regression and correlation
- Bi-veriate analysis
- Analysis of Variance (ANOVA)
  - General principles
  - Completely randomized and random-block design ANOVA (One-way ANOVA, two-way-ANOVA)
  - Non parametric tests- Chi-square test; Normality tests.

Unit 4 Interpretation and Report Writing 10 hrs

- Data Analysis
- Data sorting and validation of data
- Meaning of Interpretation
- Technique of Interpretation
- Precaution in Interpretation
- Significance of Report Writing
- Different Steps in Writing Report
- Layout of the Research Report
- Types of Reports
- Oral Presentation
- Mechanics of Writing a Research Report
- Precautions for Writing Research Reports
- Preparation of manuscript for Publication of Research paper
- Presenting a paper in scientific seminar, Thesis writing.

Unit 5 Latest trends in Commerce 12 hrs

- Role of Modern finance manager
- International Financial Management
- Global marketing- Rationale, India and world trade, foreign trade policy in Indian context

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- HRM in global context- Retention strategies, Stress management- Measurement and coping strategies, Total quality management in organization
- Privatization: change in the top management of public sector, disinvestment of public enterprises and entry into MOUs & Navaratnas,

Reference Books :

1. Kothari, C. R., & Garg, G. (2019). Research methodology: Methods and techniques. New Delhi: New Age International (P) Limited.
2. Gupta, S. L., & Gupta, H. (2012). Business research methods. New Delhi: Tata McGraw Hill Education
3. LAL, J. (2016). ACCOUNTING: Theory and practice. Place of publication not identified: HIMALAYA Publishing House.
4. Chidambaram, K. (2000). Business environment. New Delhi: Vikas Pub. House
5. Wilson, C. (2018). Financial management. South Melbourne, Victoria: Cengage Learning Australia.
6. Sanghi, S. (2014). Human resource management. New Delhi: Vikas Publishing House.
7. Neelamegham, S. (2010). Marketing in India. New Delhi: Vikas Pub. House Pvt.

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Ph.D – Commerce

SEMESTER – II

19DPCMDC201	**Course -** Research and publication Ethics	**2 Hrs /week**	**2 Credits**

Objectives:

1. To aware the scholars about Publication Ethics and Publication Misconduct
2. To impart them knowledge regarding basics of philosophy of science and ethics, research integrity and publication ethics.
3. To provide students hands-on-sessions to identify research misconduct and predatory publications and to make them aware about indexing and citation databases, open access publications, research metrics and plagiarism tools.

Syllabus:

Unit 1 Philosophy & Ethics and Scientific Misconduct 8 hrs

(A) Philosophy & Ethics

- Introduction to philosophy
- Definition, Nature & Scope
- Concepts and Branches
- Ethics: Definition, Moral Philosophy
- Nature of Moral judgments and reactions

(B) Scientific Misconduct

- Ethics with respect to science and research
- Intellectual honesty and research integrity
- Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
- Redundant publications: Duplicate and overlapping publications, salami slicing

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- Selective reporting and misrepresentation of data

Unit 2 Publication Ethics **7 hrs**

- Definition, Introduction and Importance
- Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
- Conflicts of interest
- Publication misconduct
  - Definition
  - Concepts
  - Problems that lead to unethical behavior and vice versa
  - Types
- Violation of publication ethics, authorship and contributorship
- Identification of publication misconduct, complaints and appeals
- Predatory publishers and journals

Unit 3 Open Access Publishing **4 hrs**

- Open Access Publications and initiatives
- SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
- Software tool to identify predatory publications developed by SPPU
- Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer, Journal Suggester, etc.

Unit 4 Publication Misconduct **4 hrs**

(A) Group Discussions

- Subject Specific ethical issues, FFP, authorship
- Conflicts of interest

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- Complaints and appeals: examples and fraud from India and abroad

(B) Software tools

- Use of plagiarism software like Turnitin, Urkund and other open source software tools

Unit 5 Databases and Research Metrics **7 hrs**

(A) Databases

- Indexing databases
- Citation databases: Web of Science, Scopus, etc.

(B) Research Metrics

- Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
- Metrics: h-index, g-index, i10 index, altmetrics

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19DPCMDC201	**Course III - Discipline Specific Core Elective I Statutory and Financial Aspects**	**4 Hrs /week**	**4 Credits**

Objectives:

1. To provide higher understanding of financial reporting requirements
2. To provide advanced understandings of research related statutory and legal requirements
3. To provide intellect/experience in research relevant area

Syllabus:

Unit 1 **Accounting Standards and Ind AS and Applicability (Relevant to Research area)** **12 hrs**

- Standard setting process
- In depth study of research related accounting standards including inter related accounting standards and guidance notes
- Brief study of IND AS and its applicability
- In depth study of research related Ind AS including inter related Ind AS

Unit 2 **International Financial Reporting and Disclosure (Relevant to Research area)** **8 hrs**

- Overview of International Financial Reporting Standards
- In depth study of research relevant IFRS
- Comparative Study of IFRS – Ind AS – AS

Unit 3 **Analysis of Financial Statement (Relevant to Research area)** **9 hrs**

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- Framework for the Preparation and Presentation of Financial Statements; Ratio Analysis

Unit 4 Statutory and legal Requirement (Relevant to Research area) 12 hrs

- Brief study of research relevant applicable sections of The Companies Act,2013 along with The companies rules
- Brief study of research relevant applicable sections of The Income tax Act,1961 along with relevant provision of International Taxation
- Brief study of relevant Auditing and Assurance Standards and its disclosure requirement

Unit 5 Analysis of Cases / Research exchange program / work with industry 9 hrs

- Study of Various cases on relevant research;
- Scholar can go on research exchange program with other university
- Work with research relevant industry/Expert/Experienced personnel for suitable time period;

Reference Books :

1. Dr.Girish Ahuja (38th Edition) : Systematic Approach to Taxation :Wolters Kluwer CA Munish Bhanderi : 28th :Corporate and allied laws :Bestword
2. ACCA DiplFR : 2016 Edition or latest : BPP learning media
3. D.S.Ravat : Latest :Accounting Standard : Taxmann
4. Corporate and Other Laws – ICAI or Ministry of Corporate Affairs (Act and Rules)

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Atmiya University

Department of Electronics and Communication Engineering

Ph.D. – Electronics and Communication Engineering

Preamble

Atmiya University offers Ph. D. Programmes in Electronics and Communication Engineering being its major research discipline. Considering the magnitude of research in present scenario and to augment the quality of research the syllabus for the Course Work, as a prerequisite to continue with the programme in Electronics and Communication discipline, has been designed.

The course work aims to provide a full research based program to equip the Scholars with necessary tools so that they can grasp the area of study better as well as improve on their scientific writing skills, which is essential in any kind of quality research. The course further aims at familiarizing the perspectives, pedagogy and their implications in various areas of investigations.

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The main objectives of the Course Work are to inculcate the following qualities in the Research Scholar:

- **Inquisition:** The ability to inquire about the research problem and to relate this with current socio-economic scenario.
- **Understanding:** Understand the theories that strengthen their dissertation research, with the depth needed to produce their own hypothesis and find out the research gape.
- **Analysis:** Student will be able to design the experiment and analysis the research problem.
- **Interpretation:** Interpret and compare the research outcomes.
- **Assessment:** Appraise the results and draw a conclusion.
- **Writing, editing, proof reading and designing:** Ability to write the scientific draft (*viz.* manuscript, review article, book chapter, research proposal etc)

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Programme Structure

The Pre-Ph.D course work shall comprise of Two Semesters (i.e. one Year) in which there shall be **four** compulsory papers:

Semester – I							
Course Code	**Course**	**Hrs. of Instruction/ week**	**Exam Duration (Hrs.)**	**Maximum Marks**			**Credits**
				CIA	**SEE**	**Total**	
19PECCC101	**Course I -** Research Methodology	4	3 Hr	30	70	100	4
19PECCC102	**Course II -** Seminar Presentation (Recent Trends in Electronics and Communication Engineering)	-	-	50	-	50	1
		4					**5**

* 70% of the total syllabus of Research Methodology is common to all discipline across the University while the rest 30% will be discipline specific.

Semester – II							
Course Code	**Course**	**Hrs. of Instruction / week**	**Exam Duration (Hrs.)**	**Maximum Marks**			**Credits**
				CIA	**SEE**	**Total**	
19PECDC201 / 19PECDC202 / 19PECDC203	**Course III -** DSE-Core Theory I – Wireless Communication / II – Digital Image Processing/ III – Embedded Systems and IoT	4	3 Hr	30	70	100	4
19PECDC204 / 19PECDC205 / 19PECDC206	**Course III -** DSE-Core Practical I – Wireless Communication	2	3 Hr	20	30	50	1

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	II – Digital Image Processing/ III – Embedded Systems 20and IoT						
19PECCC201	**Course IV -** Seminar Presentation (Review of Literature)	-	-	50	-	50	1
19PECCC207	**Course V –** Research and Professional Ethics	-	-	50	-	50	1
		4					**7**

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Ph.D – Electronics & Communication Engineering
SEMESTER – I

19PECCC101	Course I - Research Methodology	4 Hrs /week	4 Credits

Syllabus:

Unit 1	**Introduction to Research Methodology& Research Design**	**12**
	• Meaning of Research, Objectives of Research, Motivations in Research, Types of Research, Research Process • Significance of Research, Criteria for good research • Definition of research problem, Selection of research problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem. • Basic Principles and Need of research design, features of good design, Important concepts relating to research design • Measurement in Research; Methods of Data Collection- Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires • Collection of Data through Schedules, Collection of Secondary Data.	
Unit 2	**Scientific documentation**	**16**
	• Definition and kinds of Scientific documents: Research paper, Review paper, Book reviews • Thesis & Technical reports; Standards of research journal: Impact factor, • Citation index, H index, I10 index, Eigen factor; Components of a research paper: Title, Authors and addresses • Abstract, Acknowledgements, Tables and illustrations, Documentation of collected literature, Reference Index, Database generation • Basics of Bibliographic Citations, ISBN & ISSN, Different Bibliographic styles; Dealing with publishers: Submission of Manuscript, Ordering reprints.	
Unit 3	**Statistical tests**	**10**
	• Statistics in Research; Descriptive Statistics- measure of central tendency, measure of variance • Student's 't' test: Hypotheses, acceptance and rejections, significance levels (One sampled test, two sampled test-paired and unpaired test) • Regression and correlation – biveriate analysis, Analysis of Variance (ANOVA): General principles • completely randomized and random-block design ANOVA (One-way ANOVA, two-way-ANOVA) • Non parametric tests- Chi-square test; Normality tests.	

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Unit 4	**Interpretation and Report Writing** • Data Analysis, Data sorting and validation of data • Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation • Significance of Report Writing, Different Steps in Writing Report • Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, • Precautions for Writing Research Reports • Preparation of manuscript for Publication of Research paper • Presenting a paper in scientific seminar, Thesis writing.	**10**
Unit 5	**Latex** • Installation of the software LaTeX • Understanding Latex compilation Basic Syntax, Writing equations, Matrix, Tables • Page Layout – Titles, Abstract Chapters, Sections, References, Equation references, citation. List making environments Table of contents, Generating new commands, Figure handling numbering, List of figures, List of tables, Generating index • Packages: Geometry, Hyperref, amsmath, amssymb, algorithms, algorithmic graphic, color, tilez listing.	**12**

Reference Books:

1. Research Methodology Methods and Techniques by C. R. Kothari, New Age International Publishers
2. Research Methodology by D. K. Bhattacharyya, Excel Books Publications.
3. Research Methodology: A Guide for Researchers in Management and Social Sciences by Taylor, Sinha & Ghoshal, PHI Publications

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Department of Electronics and Communication Engineering

Ph.D – Electronics and Communication Engineering

SEMESTER – I

19PECCC101	Course I - Research Methodology	4 Hrs /week	4 Credits

Syllabus:

Unit 1	**Introduction to Research Methodology& Research Design**	**12**
	• Meaning of Research, Objectives of Research, Motivations in Research, Types of Research, Research Process • Significance of Research, Criteria for good research • Definition of research problem, Selection of research problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem. • Basic Principles and Need of research design, features of good design, Important concepts relating to research design • Measurement in Research; Methods of Data Collection- Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires • Collection of Data through Schedules, Collection of Secondary Data.	
Unit 2	**Scientific documentation**	**16**
	• Definition and kinds of Scientific documents: Research paper, Review paper, Book reviews • Thesis & Technical reports; Standards of research journal: Impact factor, • Citation index, H index, I10 index, Eigen factor; Components of a research paper: Title, Authors and addresses • Abstract, Acknowledgements, Tables and illustrations, Documentation of collected literature, Reference Index, Database generation • Basics of Bibliographic Citations, ISBN & ISSN, Different Bibliographic styles; Dealing with publishers: Submission of Manuscript, Ordering reprints.	
Unit 3	**Statistical tests**	**10**
	• Statistics in Research; Descriptive Statistics- measure of central tendency, measure of variance	

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	• Student's 't' test: Hypotheses, acceptance and rejections, significance levels (One sampled test, two sampled test-paired and unpaired test) • Regression and correlation – biveriate analysis, Analysis of Variance (ANOVA): General principles • completely randomized and random-block design ANOVA (One-way ANOVA, two-way-ANOVA) • Non parametric tests- Chi-square test; Normality tests.	
Unit 4	**Interpretation and Report Writing**	**10**
	• Data Analysis, Data sorting and validation of data • Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation • Significance of Report Writing, Different Steps in Writing Report • Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, • Precautions for Writing Research Reports • Preparation of manuscript for Publication of Research paper • Presenting a paper in scientific seminar, Thesis writing.	
Unit 5	**Latex** • Installation of the software LaTeX • Understanding Latex compilation Basic Syntax, Writing equations, Matrix, Tables • Page Layout – Titles, Abstract Chapters, Sections, References, Equation references, citation. List making environments Table of contents, Generating new commands, Figure handling numbering, List of figures, List of tables, Generating index • Packages: Geometry, Hyperref, amsmath, amssymb, algorithms, algorithmic graphic, color, tilez listing.	**12**

Reference Books:

1. Research Methodology Methods and Techniques by C. R. Kothari, New Age International Publishers
2. Research Methodology by D. K. Bhattacharyya, Excel Books Publications.
3. Research Methodology: A Guide for Researchers in Management and Social Sciences by Taylor, Sinha & Ghoshal, PHI Publications

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Atmiya University, Rajkot, Gujarat-India

Ph.D – Electronics & Communication Engineering

SEMESTER – II

Course Code	Discipline Specific Core Elective I	Hrs./Week	Credits
19PECDC201	Wireless Communication and Networking	4	4

Objectives:

1. Developments in the current and next generation mobile technologies.
2. Details of advanced mobile communication standards and their evolution.
3. Knowledge on mobility support in network layers

Unit-1	**Evolution of Modern Mobile Communication**	**9 Hrs.**
	• Personal communication systems • Wireless local area networks • Wireless broadband access systems • Wireless wide area networks and Cellular systems and design fundamentals.	
Unit-2	**2G and 3G Cellular Systems**	**12 Hrs.**
	• GSM Architecture and Air interface • Protocols and Signaling • GPRS Architecture • Mobility and location management • Interfaces and Protocols • Overview of IS95 – UMTS • Architecture – Interfaces and Protocols - Mobility Management - Handover and security procedure.	
Unit-3	**Advanced Mobile Communication Standards**	**12 Hrs.**
	• IEEE 802.11 WLAN standard and its variants : PHY layer technologies and MAC mechanism. • Security, QoS and handover Issues – IEEE 802.15 WPAN standard : Bluetooth Architecture and • Protocol stack and IEEE 802.16 Wireless broadband access standard – PHY and MAC layer overviews.	
Unit-4	**Adhoc Networking**	**8 Hrs.**
	• Introduction and DOD perspective • Commercial applications • Characteristics and issues of adhoc networks • Proactive and reactive routing protocols.	

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Unit-5	Recent Trends	7 Hrs.
	• Introduction to WiMAX and OFDM • Software Defined Radio, UWB Radio Security issues and challenges in a Wireless network.	

Course Outcomes

1. Understand the basics of modern mobile communication.
2. Understand the basic concepts of basic Cellular System and the design requirements along with 3G and 4G.
3. Analysis of modern mobile communication standard.
4. Analyze adhoc networking.

Text Books

1. Wireless Communications and Networking, Vijya Garg, Elsevier
2. Wireless Communication, Theodore S. Rappaport, Prentice hall

Reference Books

4. Wireless digital communication, Kamilo Feher, PHI
5. Mobile Communications Engineering, William C. Y. Lee, Mc Graw Hill Publications
6. Mobile and personal Communication system and services by Rajpandya, IEEE press (PHI).
7. Adhoc Mobile Wireless network, C.K.Toh Pearson
8. Wireless Communications-T.L.Singh-TMH

Online Learning Resources

1. Students may use SCILAB, MATLAB, NETSIM, NS2 and NPTL Videos.
2. MIT open course website,Virtual Labs (Source:http://vlab .co.in).

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Course Code	Discipline Specific Core Elective II	Hrs./Week	Credits
19PECDC202	DSE Core: Embedded Systems and IoT	4	4

Objectives:

1. Learn IoT architecture and IoT establishment
2. Learn python programming and Raspberry Pi Architecture
3. Design a system using IoT and Raspberry Pi
4. Understand working different applications and protocols used for IoT

Syllabus:

Unit-1	IoT Architecture and Workflow	6 Hrs.
	• What is the Internet of Things(IoT)? • Brief History and evolution of IoT • IoT Architecture • Trends in the Adoption of IoT • Setup IoT Platform using Open source	
Unit-2	**Embedded C Programming**	**10 Hrs.**
	• Introduction to Embedded C • Data types in embedded C • I/O Port programming • Bitwise Operations • Logical Operations • Shift Operations • Conditional statements	
Unit-3	**Building IoT Applications using Raspberry Pi**	**12 Hrs.**
	• Overview of Raspberry Pi (RPi) hardware platform • Setup and Install Raspbian OS on Rpi • Setting up Raspbian as an IoT gateway • Write Python program to interface with Arduino using serial libraries • IoT Communication Models and Protocols	

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	• Building python based programs to communicate to cloud server using various application protocols	
Unit-4	**IoT Cloud Infrastructure**	**4 Hrs.**
	• IoT cloud building blocks • Using the platform specific dashboards • Device configuration and addressing • IoT Platforms in detail • MQTT Server • Data monitoring, visualization and IoT Analytics	
Unit-5	**Performance and Security in IoT**	**4 Hrs.**
	• Benchmarking IoT applications and Platforms • MQTT vs HTTP performance • Security considerations • Firmware updates • Cryptography basics • Cryptography in IoT	

Course Outcomes:

1. Cryptography in IoT
2. Define what an embedded system is in terms of its interface
3. Enumerate and describe the components of an embedded system
4. Describe the interaction between software and hardware in an IoT device
5. Describe the structure of the Internet
6. Describe the role of an operating system to support software in an IoT device

Text Books:

1. Embedded Software for the IoT, by by Klaus Elk, O'Reilly

Reference Books:

1. Getting started with Internet of Things: Connecting Sensors and Microcontrollers by Cuno Pfister, O'Reilly

Online Learning Resources

1. NPTEL web series: http://nptel.ac.in/courses
2. NPTEL video series: http://nptel.ac.in/downloads

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Course Code	Discipline Specific Core Elective III	Hrs./Week	Credits
19PECDC203	Core: Digital Image Processing	3	3

Objectives:

1. This course will strengthen fundamental knowledge about digital image processing techniques.
2. Enhance image quality using image enhancement techniques
3. Understand image representation

Syllabus:

Unit-1	**Introduction**	**7 Hrs.**
	• Light • Brightness adaption and discrimination • Human visual system • Image as a 2D data • Image representation Gray scale and Color image • Image sampling and quantization	
Unit-2	**Image Filtering**	**7 Hrs.**
	• Intensity level slicing and Bit-plane slicing • Image histogram • Histogram equalization process • Fundamentals of spatial filtering • Correlation and convolution • Image Smoothing • Image Sharpening • Homomorphic filtering, 2D- DFT, 2DFFT, 2D- DCT • Fundamentals of 2D-wavelet transform	
Unit-3	**Image Restoration**	**10 Hrs.**
	• Reasons for image degradation, • Model of image degradation/restoration process • Noise probability density functions • Image restoration using spatial filtering (Mean filters, Order statistic	

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	filters and adaptive filters) • Inverse Filtering • MMSE (Wiener) Filtering	
Unit-4	**Image Compression**	**6 Hrs.**
	• Fundamentals of redundancies • Basic Compression Methods: Huffman coding, Arithmetic coding, LZW coding • JPEG Compression standard • Wavelet based image compression	
Unit-5	**Image Segmentation**	**6 Hrs.**
	• Basic morphological operations • Erosion, dilation, opening, closing • Structuring elements • Hit-or-Miss transform • Basic Morphological Algorithms: hole filling, connected components, thinning, skeletons, Reconstruction by erosion and dilation	

Course Outcomes

[1] Understand image representation

[2] Enhance image quality using image enhancement techniques

[3] Filter given image using frequency domain filtering technique

[4] Select the right image restoration technique to remove degradation from given image

[5] Represent image using minimum number of bits using image compression.

[6] Understand image segmentation technique

[7] Do morphological operations on given image.

Text Books

1.Introduction to Radar System M.I. Skolnik ,McGraw Hill.

2.Global Navigation Satellite Systems Rao,TMH.

Reference Books

1. Digital Image Processing, S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill Publication
2. Digital Image Processing, S Sridhar, Oxford University Press.

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List of Open Source Software/learning website:

- SCILAB
- Open CV
- Python

Website:

- http://fossee.in/ • www.scilab.in • http://opencv.org

Course Code	Course Name	Hrs./Week	Credits
19PECDC204	Practical Core Wireless Communication and Networking	2	1

- Core course – Electronics and Communication Engineering

Objectives:

1. Implement application with WML language.
2. Analyze MIMO system.
3. Understand AT commands.
4. Analyze GSM and CDMA modulation process.

Syllabus:

Sr.	Experiments	Hrs.
1	To study about different AT commands	2
2	WML : Text operation and navigation between cards	2
3	WML : Use of input and select command	2
4	To study about direct sequence spread spectrum modulation and demodulation processes	2
5	To study about DSSS modulation/demodulation	2
6	To study about GMSK modulation-demodulation and constellation diagram in cellular system.	2
7	Simulate MIMO system with OFDM.	2
8	Comparison of AODV and DRS protocols for Adhoc network.	2
9	Designing of cellular wireless network	2
10	To study about comparison of various wireless standard	2
11	To verify GSM uplike and downlink.	2
12	To study about GMSK in GSM.	2

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Course Code	Course Name	Hrs./Week	Credits
19PECDC205	Practical Core : Embedded Systems and IoT	2	1

- Core course – Electronics and Communication Engineering

Objectives:

1. Learn IoT architecture and IoT establishment
2. Learn python programming and Raspberry Pi Architecture
3. Design a system using IoT and Raspberry Pi
4. Understand working different applications and protocols used for IoT

Syllabus:

Sr.	Experiments	Hrs.
1	Study and Install Python	**2**
2	Write a Program for arithmetic operation in Python.	**2**
3	Write a Program for looping statement in Python.	**2**
4	Write program using Arduino IDE for Blink LED in python	**2**
5	Write Program for RGB LED using Arduino	**2**
6	Study the Temperature sensor and Write Program foe monitor temperature using Arduino.	**2**
7	Study and Implement RFID, NFC using Arduino.	**2**
8	Study and implement MQTT protocol using Arduino.	**2**
9	Study and Configure Raspberry Pi.	**2**
10	WAP for LED blink using Raspberry Pi.	**2**
11	Study and Implement Zigbee Protocol using Arduino / Raspberry Pi.	**2**
12	Making of IoT Application	**2**

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Course Code	Course Name	Hrs./Week	Credits
19PECDC206	Practical Core: Digital Image Processing	2	1

- Core course - EC Engineering

Objectives:

5. Apply their knowledge and conduct programmatically approach to solve a problem using VHDL language.
6. Understand how to draw the flowchart and write an algorithm for any problem.
7. Distinguish difference between VHDL and Verilog

Syllabus:

Sr.	Experiments	Hrs.
1	Write program to read and display digital image using SCILAB	**2**
2	Become familiar with SCILAB Basic commands Read and display image in SCIAB	**2**
3	To write and execute image processing programs using point processing method	**2**
4	To write and execute programs for image arithmetic operations	**2**
5	To write and execute programs for image logical	**2**
6	To write a program for histogram calculation and equalization	**2**
7	To write and execute program for geometric transformation of image Translation	**2**
8	To understand various image noise models and to write programs for image restoration	**2**
9	Write and execute programs to remove noise using spatial filters	**2**
10	Write program to read and display digital image using SCILAB	**2**

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Engineering & Technology

Department of Civil Engineering

Ph.D. – Civil Engineering

Preamble

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- **Assessment:** Appraise the results and draw a conclusion.
- **Writing, editing, proof reading and designing:** Ability to write the scientific draft (*viz.* manuscript, review article, book chapter, research proposal etc)

Programme Structure

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Semester – I							
Course Code	Course	Hrs. of Instruction/ week	Exam Duration (Hrs.)	Maximum Marks			Credits
				CIA	SEE	Total	
19PCICC101	**Course I -** Research Methodology	4	3 Hr	30	70	100	4
19PCICC102	**Course II -** Seminar Presentation (Recent Trends in Civil Engineering)	-	-	50	-	50	1
		4					**5**

* 80% of the total syllabus of Research Methodology is common to all discipline across the University while the rest 20% will be discipline specific.

Semester – II							
Course Code	Course	Hrs. of Instruction/ week	Exam Duration (Hrs.)	Maximum Marks			Credits
				CIA	SEE	Total	
19PCIDC201 19PCIDC202 19PCIDC203 19PCIDC204	**Course III -** DSE-Core I –Design of RC Structure II –Pavement Design & Maintenance III –Water Supply & Sanitary System IV –Disaster Planning & Mitigation	4	3 Hr	30	70	100	4
19PCICC201	**Course II -** Seminar Presentation (Review of Literature)	-	-	50	-	50	1
		4					**5**

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Ph.D – Civil Engineering

SEMESTER – I

19PCICC101	**Course I -** **Research Methodology**	**4 Hrs /week**	**4 Credits**

Syllabus:

Unit 1	**Introduction to Research Methodology& Research Design**	**12**
	Meaning of Research, Objectives of Research, Motivations in Research, Types of Research, Research Process, Significance of Research, Criteria for good research; Definition of research problem, Selection of research problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem. Basic Principles and Need of research design, features of good design, Important concepts relating to research design, Measurement in Research; Methods of Data Collection- Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Collection of Secondary Data.	
Unit 2	**Scientific documentation & Statistical tests**	**16**
	Definition and kinds of Scientific documents: Research paper, Review paper, Book reviews, Thesis & Technical reports; Standards of research journal: Impact factor, Citation index, H index, I10 index, Eigen factor; Components of a research paper: Title, Authors and addresses, Abstract, Acknowledgements, Tables and illustrations, Documentation of collected literature, Reference Index, Database generation, Basics of Bibliographic Citations, ISBN & ISSN, Different Bibliographic styles; Dealing with publishers: Submission of Manuscript, Ordering reprints.	
Unit 3	**Statistical tests**	**10**
	Statistics in Research; Descriptive Statistics- measure of central tendency, measure of variance; Student's 't' test: Hypotheses,	

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	acceptance and rejections, significance levels (One sampled test, two sampled test-paired and unpaired test);Regression and correlation – biveriate analysis, Analysis of Variance (ANOVA): General principles, completely randomized and random-block design ANOVA (One-way ANOVA, two-way-ANOVA); Non parametric tests- Chi-square test; Normality tests.	
Unit 4	**Interpretation and Report Writing**	**10**
	Data Analysis, Data sorting and validation of data, Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation; Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing.	
Unit 5	Aims & objective of research. Area of Research- Formulation of research objectives based on Literature survey, critical review, Gaps exist in present knowledge domains in the field of civil engineering research. Introduction of available software in civil engineering domains	**10**

Reference Books:

1. C. R. Kothari , Research Methodology Methods & Techniques, New Age International Publishers
2. Gupta and Singh, Research Methodology, Vayu Education of India, New Delhi.
3. D. K. Bhattacharya, Research Methodology, New Delhi, Excel Books.
4. R. Pannerselvam, Research Methodology, Prentice Hall of India Pvt. Ltd., New Delhi.
5. Cooper and Schindler, Business Research Methods, Tata McGraw Hill.
6. Srivastava and Shailaja, Business Research Methodology, Tata McGral Hill, New Delhi.
7. R.S. Dwivedi,Research Methodology in Behavioural Science, McMillan India Ltd. New Delhi.

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Ph.D – Civil Engineering

SEMESTER – II

Course Code 19PCIDC201	Course III - Discipline Specific Core Elective I Design of RC Structure	4 Hrs /week	4 Credits

Objectives:

1. To introduces various structural systems and Indian Standard Codes.
2. To know different types of load and load combinations.
3. To impart knowledge about design methods for structural element.
4. Develop basic concepts of RC Design.

Syllabus:

Unit-1	**Introduction to Indian Standard codes:**	**10 Hrs.**
	• Objectives, Properties of Reinforced Concrete and Structural Steel, Loads & load combinations, Methods of Analysis, Codes & specifications, Design Philosophies - Working stress Method, Ultimate Load Method, Limit State Method, Plastic Method.	
Unit-2	**Design of Structural Elements:**	**20 Hrs.**
	• Design of Beam • Design of Column • Design of Slab	
Unit-3	**Design of Foundation:**	**10 Hrs.**
	• Design of isolated column footing.	
Unit-4	**Design of RC building – Real life Problem.**	**10 Hrs.**
	• Select any simple RC frame and design from footing to terrace.	
Unit-5	**Design of Retaining wall:**	**10 Hrs.**
	• Types, behavior and application of retaining wall, stability criteria, design & detailing of cantilever type retaining wall for various ground conditions.	

Course Outcomes:

1. Understand various design philosophy to be used in the design of structural elements and understanding of Indian Standards.

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2. Design various structural elements.
3. Design of Foundation of RC structures.
4. To get exposed to the design of structures and structural elements using various codes of practice.
5. Design & detail RC structures like Retaining Walls.

Indian Standards code of Practice:

1. IS: 456 - Code of practice for plain and reinforced concrete (Latest revision).
2. IS: 1893 - Criteria for earthquake resistant design of structures (Latest revision).
3. IS: 13920 -Code of Practice for ductile detailing of RC structure (Latest revision).

Text Books:

1. Dr. H.J. Shah; Reinforced concrete Vol-I; Charotar Pub. Anand

Reference Books:

1. Purushothaman.P. "Reinforced Concrete Structural Elements", Behavior, Analysis and Design. Tata Mc Graw Hill 1986.
2. A.K.Jain; Design of Concrete Structures, Nemchand Publication

Online Learning Resources

1. NPTEL web series: https://nptel.ac.in/courses/105105105/
2. NPTEL video series: https://nptel.ac.in/courses/105105105/19

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19PCIDC202	**Course III - Discipline Specific Core Elective II Pavement Design & Maintenance**	**4 Hrs /week**	**4 Credits**

Objectives:

1. Impart knowledge of highway pavement
2. To know properties of materials used in pavement design and construction
3. To design the pavement as per standard parameters.
4. Methods of construction, quality control, maintenance and Rehabilitation of road pavement.

Syllabus:

Unit-1	**Introduction**	**10 Hrs.**
	• Definition, Objectives, Factors, Types and Structure of Pavement	
Unit-2	**Pavement Materials**	**12 Hrs.**
	• Sub grade soil, aggregates, binder materials, bituminous, bituminous paving mixes, cement concrete - their engineering and physical properties • Recent material used in pavement strata.	
Unit-3	**Design Of Flexible Pavement**	**14 Hrs.**
	• Concept, ESWL, Tyre Pressure, other factors, Stress, Methods, design of Flexible pavement.	
Unit-4	**Design of Rigid Pavement**	**12 Hrs.**
	• Concept, Factors, Stress, Methods, design of Rigid Pavement • Joint and its design of rigid pavement	
Unit-5	**Pavement Construction & Maintenance**	**12 Hrs.**
	• Construction- Construction of various layers, earthwork, WBM, GSB, WMM, various types of bituminous layers, road drainage • Maintenance- Various types of failures, evaluation and remedial measures	

Course Outcomes:

1. Understand basic knowledge of pavement.

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2. Identify and check various highway materials and its properties.
3. Design the flexible pavement and its structure.
4. Analysis and design the rigid pavement and its joint.
5. Know pavement distresses, failures, and mitigation measures.

Text Books:

1. Khanna, S.K. and Justo, C.E.G., "Highway Engineering", Nem Chand & Bros
2. Kadiyali L. R., "Principles and Practice of Highway Engineering", Khanna Technical Publications, Delhi

Reference Books:

1. Sharma, S.K., "Principles and Design of Highway Engineering", S. Chand & Co.
2. Yoder C.J., Witizak M.W., "Principles of pavement design", John Willey & Sons.

IRC CODES:

1. IRC –37, "Guidelines for Design of flexible Pavements", IRC, New Delhi 2001.
2. IRC: 58, 2002: "Guidelines for the Design of Plain Jointed Rigid Pavements for Highways", IRC, N. Delhi 2002.

Online Learning Resources

https://www.youtube.com/results?search_query=pavement+design

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19PCIDC203	**Course III - Discipline Specific Core Elective III** Water Supply & Sanitary System	**4 Hrs /week**	**4 Credits**

- Core course –Civil Engineering

Objectives:

1. To know about different types of treatments of water and wastewater.
2. To learn designs of various components of water supply scheme.
3. To know about the collection system of sewage.
4. To understand house drainage plans and sewer plans for cities.

Syllabus:

Unit-1	**Water Supply Scheme: Source, Collection and Distribution of Water**	**12 Hrs.**
	• Components of Water Supply Scheme, Layout of Water Treatment Plant, Estimation of raw water discharge for treatment plant, Location & Selection of treatment train, Intakes, types of intakes, conveyance of water, design of pumps, Distribution System, elevated service reservoirs, valves, design of water distribution system.	
Unit-2	**Water Treatment Processes & Design of WTP units**	**12 Hrs.**
	• Water Treatment Processes, Screening, Plain Sedimentation, Aeration, Sedimentation aided with coagulation, Filtration: Slow Sand Filter, Rapid Sand Filter, Disinfection, Water Softening & Design of treatment units : Screening, Sedimentation Tank, Rapid Sand Filter	
Unit-3	**Collection of Sewage**	**12 Hrs.**
	• House Drainage: • Principle of House Drainage, Pipes and traps, Classification of traps, sanitary fittings, system of plumbing, house drainage plan, Low Cost Sanitation System: septic tank, soak pit & its design. • Sewerage & Sewerage System:	

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	• General considerations, terminology, separate versus combined system of sewerage, Sewer materials, sewer appurtenances, design of sewer systems, construction & maintenance	
Unit-4	**Wastewater Treatment Processes & Design of STP units**	**12 Hrs.**
	• Objectives, preliminary treatment, Physical Unit Processes: screening, grit removal, sedimentation Physico – treatment process: Flocculation-Coagulation Biological Unit Processes: Theory, Principles & Design of Activated sludge process, ASP & its modifications, operational difficulties in ASP, SVI, SDI, Attached growth processes- trickling filters, operational Difficulties, waste stabilization ponds, Rotating Biological Contactors, Sludge Treatment & its disposal.	
Unit-5	**Design of STP units**	**12 Hrs.**
	• Design of Screens, grit chamber, PST, ASP, TF.	

Course Outcomes:

1. Get acquainted with different components of Water Supply Scheme.
2. Determine various water and Wastewater quality and different parameters.
3. Design drainage network for buildings and towns.
4. Design different units of Water and Wastewater Treatment Plant.

Text Books:

1. Garg, S. (1977), Water supply Engineering, Delhi, D: Khanna Publication.
2. Garg, S. (1979), Sewage Disposal and Air Pollution Engineering, Delhi, D: Khanna Publication.

Reference Books:

1. E Balagurusamy. (2016). *Programming in ANSI C.* Chennai, TATA McGraw Hill. Seventh Edition.
2. Brian W. Kernighen, Dennis Ritchie. (2015). *The C Programming Language.* New Delhi, Pearson Education. Second Edition.
3. YashavantKanetkar. (2017). *Let Us C.* Delhi, BPB Publications. Fifteenth Edition.
4. Peavy, H. (1985), Environmental Engineering, New York, NY: McGraw Hill International Edition.
5. Birdie, G. (2010), Water Supply and Sanitary Engineering, New Delhi, ND: DhanpatRai Publishing Co.

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6. Weber, W. (1972) Physicochemical Processes for Water Quality Control, New York, NY: Wiley-Interscience.
7. Syed R. Qasim, Wastewater Treatment Plants: Planning, Design, and Operation, 2nd edition, New York, NY: CRC Press.
8. Metcalf and Eddy (2007), Wastewater Engineering: Treatment, and Reuse, 4th edition, New Delhi, ND: Tata McGraw Hill.
9. Benefield, L. D., & Randall, C. W. (1980). Biological process design for wastewater treatment. Englewood Cliffs, NJ: Prentice-Hall

Online Learning Resources:

1. https://nptel.ac.in

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19PCIDC204	**Course III - Discipline Specific Core Elective IV** Disaster Planning & Mitigation	**4 Hrs /week**	**4 Credits**

Objectives:

1. To Understand various disasters, disaster preparedness and mitigation measures
2. To Understand role of IT, remote sensing, GIS and GPS in risk reduction
3. To Understand disaster management acts and guidelines along with role of various stack-holders during disasters

Syllabus:

Unit-1	**Introduction**	**10 Hr.**
	• Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management	
Unit-2	**Types, Causes And Control Measures of Disaster:**	**12 Hr.**
	• Geological Disasters (earthquakes, landslides, tsunami, mining); • Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves); • Biological Disasters (epidemics, pest attacks, forest fire); • Technological Disasters (chemical, industrial, radiological, nuclear) and Man-made Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters);	
Unit-3	**Disaster Management Cycle And Framework**	**12 Hr.**
	• Disaster Management Cycle – Paradigm Shift in Disaster Management • Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Micro zonation, Prevention and Mitigation of Disasters, Early Warning System; • Preparedness, Capacity Development; Awareness During Disaster – Evacuation – Disaster Communication – Search and Rescue	

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	Emergency Operation Centre – Incident Command System – Relief and Rehabilitation – Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment; IDNDR, Yokohama Strategy, Hyogo Framework of Action	
Unit-4	**Disaster Management In India:**	**10 Hr.**
	• Disaster Profile of India – Mega Disasters of India and Lessons Learnt Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national),Non-Government and Inter-Governmental Agencies	
Unit-5	**Application Of Science And Technology For Disaster Management And Mitigation:**	**12 Hr.**
	• Geo-informatics in Disaster Management (RS, GIS, GPS and RS) • Disaster Communication System (Early Warning and Its Dissemination) • Land Use Planning and Development Regulations • Disaster Safe Designs and Constructions • Structural and Non Structural Mitigation of Disasters	

Course Outcomes:

1. Understand disasters, disaster preparedness and mitigation measures
2. Understand role of IT, remote sensing, GIS and GPS in risk reduction
3. Understand disaster management acts and guidelines along with role of various stack-holders during disasters

Text Books:

1. Disaster Management Act 2005, Publisher by Govt. of India
2. R K Bhandani, An overview on natural & man-made disasters and their reduction, CSIR, New Delhi
3. Angus M. Gunn , Vol. 1 & 2, Encyclopaedia of Disasters – Environmental Catastrophes and Human Tragedies, Greenwood Press, 2008

Reference Books:

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1. Coppola D P, 2007. Introduction to International Disaster Management, Elsevier Science (B/H), London.
2. Manual on natural disaster management in India, M C Gupta, NIDM, New Delhi
3. World Disasters Report, 2009. International Federation of Red Cross and Red Crescent, Switzerland
4. Encyclopedia of disaster management, Vol I, II and IIIL Disaster management policy and administration, S L Goyal, Deep & Deep, New Delhi, 2006
5. 7 Disasters in India Studies of grim reality, AnuKapur& others, 2005, 283 pages, Rawat Publishers, Jaipur
6. Management of Natural Disasters in developing countries, H.N. Srivastava & G.D. Gupta, Daya Publishers, Delhi, 2006, 201 pages
7. Natural Disasters, David Alexander, Kluwer Academic London, 1999, 632 pages
8. Sahni, Pardeep et.al. (eds.) 2002, Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi.
9. Roy, P.S. (2000): Space Technology for Disaster management: A Remote Sensing & GIS Perspective, Indian Institute of Remote Sensing (NRSA) Dehradun.
10. Sharma, R.K. & Sharma, G. (2005) (ed) Natural Disaster, APH Publishing Corporation, New Delhi.

Online Learning Resources:

1. www.GIS. Development.net
2. www.iirs.nrsa.org
3. http://quake.usgs.gov

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Department of Mechanical Engineering

Ph.D. – Mechanical Engineering

Preamble

Atmiya University offers Ph. D. Programmes in Mechanical Engineering being its major research discipline. Considering the magnitude of research in present scenario and to augment the quality of research the syllabus for the Course Work, as a prerequisite to continue with the programme in Mechanical discipline, has been designed.

The course work aims to provide a full research based program to equip the Scholars with necessary tools so that they can grasp the area of study better as well as improve on their scientific writing skills, which is essential in any kind of quality research. The course further aims at familiarizing the perspectives, pedagogy and their implications in various areas of investigations.

As per the university ordinance and new guidelines of UGC, the research scholars who are provisionally registered under the Ph.D. Programme will have to undergo a Course Work.

The main objectives of the Course Work are to inculcate the following qualities in the Research Scholar:

- **Inquisition:** The ability to inquire about the research problem and to relate this with current socio-economic scenario.
- **Understanding:** Understand the theories that strengthen their dissertation research, with the depth needed to produce their own hypothesis and find out the research gape.
- **Analysis:** Student will be able to design the experiment and analysis the research problem.
- **Interpretation:** Interpret and compare the research outcomes.
- **Assessment:** Appraise the results and draw a conclusion.
- **Writing, editing, proof reading and designing:** Ability to write the scientific draft (*viz.* manuscript, review article, book chapter, research proposal etc)

Programme Structure

The Pre-Ph.D course work shall comprise of Two Semesters (i.e. one Year) in which there shall be **four** compulsory papers:

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Semester – I							
Course Code	Course	Hrs. of Instruction/ week	Exam Duration (Hrs.)	Maximum Marks			Credits
				CIA	SEE	Total	
19DPMECC101	**Course I -** Research Methodology	4	3 Hr	30	70	100	4
19DPMECC102	**Course II -** Seminar Presentation (Recent Trends in Mechanical Engineering)	-	-	50	-	50	1
		4					**5**

* 80% of the total syllabus of Research Methodology is common to all discipline across the University while the rest 20% will be discipline specific.

Semester – II							
Course Code	Course	Hrs. of Instruction / week	Exam Duration (Hrs.)	Maximum Marks			Credits
				CIA	SEE	Total	
19DPMEDC201 19DPMEDC202 19DPMEDC203	**Course III -** DSE-Core I – Advancement in Manufacturing Engineering II – Advancement in Thermal Engineering III – Advance Theories of Design	4	3 Hr	30	70	100	4
19DPMECC201	**Course II -** Seminar Presentation (Review of Literature)	-	-	50	-	50	1
		4					**5**

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Department of Mechanical Engineering

Ph.D. – Mechanical Engineering

SEMESTER – I

19DPMECC101	Course I - Research Methodology	4 Hrs /week	4 Credits

Unit 1	**Introduction to Research Methodology& Research Design**	**12**
	Meaning of Research, Objectives of Research, Motivations in Research, Types of Research, Research Process, Significance of Research, Criteria for good research; Definition of research problem, Selection of research problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem. Basic Principles and Need of research design, features of good design, Important concepts relating to research design, Measurement in Research; Methods of Data Collection- Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Collection of Secondary Data.	
Unit 2	**Scientific documentation & Statistical tests**	**16**
	Definition and kinds of Scientific documents: Research paper, Review paper, Book reviews, Thesis & Technical reports; Standards of research journal: Impact factor, Citation index, H index, I10 index, Eigen factor; Components of a research paper: Title, Authors and addresses, Abstract, Acknowledgements, Tables and illustrations, Documentation of collected literature, Reference Index, Database generation, Basics of Bibliographic Citations, ISBN & ISSN, Different Bibliographic styles; Dealing with publishers: Submission of Manuscript, Ordering reprints.	
Unit 3	**Statistical tests**	**10**
	Statistics in Research; Descriptive Statistics- measure of central tendency, measure of variance;Student's 't' test: Hypotheses, acceptance and rejections, significance levels (One sampled test, two sampled test-paired and unpaired test);Regression and correlation – biveriate analysis,	

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	Analysis of Variance (ANOVA): General principles, completely randomized and random-block design ANOVA (One-way ANOVA, two-way-ANOVA); Non parametric tests- Chi-square test; Normality tests.	
Unit 4	**Interpretation and Report Writing**	**10**
	Data Analysis, Data sorting and validation of data, Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation; Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing.	
Unit 5	**DoE Introduction and Methods**	**8**
	Introduction to experimental design principles, simple comparative experiments, introduction to R language and its applications in DOE problems. Introduction to factorial designs, two levels, 2k factorial designs, confounding and blocking in factorial designs, applications to manufacturing problems. Fractional factorial designs, two-level, three-level and mixed-level factorials and fractional factorials, applications to quality control problems. Regression models, Response surface methodology, parameter optimization, robust parameter design and its application.	

Text Book :

1. 'Research Methodology: Methods and Trends', by Dr. C. R. Kothari
2. 'Research Methodology: A Step by Step Guide for Beginners', by Ranjit Kumar, 2nd Edition

Reference Books :

1. Montgomery, Douglas C. Design and Analysis of Experiments. New York: John Wiley, 2001. Print.

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Ph.D. – Mechanical Engineering

SEMESTER – II

19DPMEDC201	Course III - Discipline Specific Core Elective I Advancement in Manufacturing Engineering	4 Hrs /week	4 Credits

Unit 1	**Advance Metal Cutting:**	**10**
	Metal Machining - Modelling and control of Chip Formation, Machining of hard materials and metal matrix reinforced composites, Characterization and surface integrity in hard machining, Modern concepts of machining.	
Unit 2	**Advanced Machining Processes:**	**10**
	Hybrid electro-chemical processes, Hybrid thermal processes, Solid, liquid and powder based material addition processes (Analytical Study).Lean Manufacturing: concept, goals, components, tools and techniques, JIT, KANBAN system, waste reduction.	
Unit 3	**Advanced Welding Processes:**	**10**
	Advances in welding processes, Welding Inspection and Testing	
Unit 4	**High Integrity Die Casting**	**8**
	Vacuum die casting, Squeeze casting, Semi solid metal working, Design considerations for high integrity die Castings	
Unit 5	**Metal Forming:**	**10**
	Yield criteria, Slip line field theory, Temperature Field in Material.- Plastic and Visco-elastic behavior of material, Surfaces of Discontinuity, Numerical Models of Plasticity.	

Text Book :

1. Machining Processes", Mc-Graw Hill, London, 2005
2. Milton C Shaw, "Metal Cutting Principles" 2nd Edition, Oxford series in Advanced Manufacturing.
3. Hassan El-Hofy, "Advanced Machining Processes – Non Traditional and Hybrid.

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4. Edward J Vinarcik, “High Integrity Die Casting Processes”, John Wiley & Sons Inc., New York, 2003.
5. Sluzalec and Andrzej, “Theory of Metal Forming Plasticity - Classical and Advanced Topics” Springer Publications

Reference Books :

1. Paulo Davim (Ed.), “Machining – Fundamentals and Advances” Springer-Verlag, London, 2008.
2. Childs Thomas, Maekawa K., Obikawa T., and Yamane Y., “Metal machining – Theory and Applications” John Wiley & Sons, New York, 2000
3. Brown J., “Advanced Machining Technology Handbook”, Mc-Graw Hill, New York, 1998
4. “Welding Handbook”, Volumes 1, 2 and 3, 9th edition, American Welding Society
5. Campbell John, “Castings”, Butterworth – Heinemann, 2000.
6. Avitzur B., “Metal Forming - Process and analysis” Tata Mc-Graw Hill

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19DPMEDC202	Course III - Discipline Specific Core Elective II Advancement in Thermal Engineering	4 Hrs /week	4 Credits

Unit 1	**Convective Heat Transfer**	**10**
	Fully developed flows, exact and similarity solutions, boiling and condensation, special topics in Heat Transfer.	
Unit 2	**Advanced Topics in Refrigeration and Cryogenics**	**8**
	Refrigeration applications in preservation of Food, transport by trucks and containers, Railway cars, Marine Refrigeration; Fans and Blowers, Sound Control. Construction of psychrometric charts, enthalpy deviation curves	
Unit 3	**Advanced Gas Dynamics**	**10**
	Liberalized flow, Method of characteristics, Shock boundary layer interaction, Numerical methods	
Unit 4	**Advanced Topics in IC Engines**	**10**
	Engine Emissions & Control, Engine Electronics, Modelling Real Engine Flow and Combustion Process, Fuel/Air Mixture Requirements.	
Unit 5	**Solar Thermal Applications**	**10**
	Selection criteria of storage materials for heating and cooling applications, selection of heat transfer fluid for heating and cooling applications, active and passive solar water heating system, solar space heating, solar cooling with absorption and adsorption refrigeration, solar desalination systems, solar powered absorption air conditioning system, solar irrigation system, solar chimney, drier, dehumidifier, solar still	

Text Book :

1. W.M Kays and M.E. Crawford, “Convective Heat and Mass Transfer”, McGraw HillIntl.
2. V. Ganesan, Internal combustion engines, Tata McGraw-Hill Education
3. S P Sukhatme, Solar Energy – Principles of Thermal Collection & Storage, McGraw Hill
4. Heat Transfer by J P Holman , McGraw Hill

Reference Books:

1. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration.
2. Handbook of air-conditioning system design, Carrier Incorporation, McGraw Hill.

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19DPMEDC203	Course III - Discipline Specific Core Elective III Advance Theories of Design	4 Hrs /week	4 Credits

Unit 1	**Advanced Theory of Elasticity**	**10**
	Theories of Stress and strain, Transformation of stress and strain, Linear stress-strain –temperature relations, Applications of energy methods, Torsion, Bending, Plates	
Unit 2	**Finite Element Methods**	**12**
	Thermal analysis (temperature effects), 2D, 3D elements, Contact analysis, Non-linear static analysis	
Unit 3	**Reverse Engineering**	**10**
	Reverse engineering – Methodologies and Techniques, Hardware and software, Rapid prototyping –Relationship with reverse engineering	
Unit 4	**Computer Aided Modeling and Analysis**	**10**
	Use of popular Modeling and analysis software packages for engineering modeling and analysis related to mechanical engineering., required to undertake a couple of minor projects in modeling, analysis and design using computers.	
Unit 5	**Advancement in CAD**	**8**
	Recent developments in design techniques, optimum design, diagnosis and prognosis of component failures, fatigue design, reliability, design for production and assembly, developments in existing design performance and testing.	

Text Book :

1. Boresi A.D., Schmidt R.J, and Sidebottom O.M, "Advanced Mechanics of Materials", Wiley
2. Reddy J.N., "An Introduction to Finite Element Method", McGraw Hill
3. Timoshenko, "Theory of Elasticity" McGraw-Hil

Reference Books :

1. Vinesh Raja and Kiran J Fernandes, "Reverse Engineering – An Industrial Perspective", Springer, London, 2008

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Atmiya University, Rajkot, Gujarat-India

Atmiya University Rajkot

Faculty of Health Sciences

School of Pharmacy

Ph.D – Pharmaceutical Sciences

Preamble

Atmiya University offers Ph. D. Programmes in Pharmacy being its major research discipline. Considering the magnitude of research in present scenario and to augment the quality of research the syllabus for the Course Work, as a prerequisite to continue with the programme in Pharmacy, has been designed.

The course work aims to provide a full research based program to equip the Scholars with necessary tools so that they can grasp the area of study better as well as improve on their scientific writing skills, which is essential in any kind of quality research. The course further aims at familiarizing the perspectives, pedagogy and their implications in various areas of investigations.

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- **Understanding:** Understand the theories that strengthen their dissertation research, with the depth needed to produce their own hypothesis and find out the research gape.
- **Analysis:** Student will be able to design the experiment and analysis the research problem.
- **Interpretation:** Interpret and compare the research outcomes.
- **Assessment:** Appraise the results and draw a conclusion.
- **Writing, editing, proof reading and designing:** Ability to write the scientific draft (*viz.* manuscript, review article, book chapter, research proposal etc.).

Programme Structure

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The Pre-Ph.D course work shall comprise of Two Semesters (i.e. one Year) in which there shall be **four** compulsory papers:

Semester – I							
Course Code	**Course**	**Hrs. of Instruction/ week**	**Exam Duration (Hrs.)**	**Maximum Marks**			**Credits**
				CIA	**SEE**	**Total**	
19DPPHCC101	**Course I -** Research Methodology	4	3 Hr	30	70	100	4
19DPPHCC102	**Course II -** Seminar Presentation (Recent Trends in Pharmaceutical Sciences)	-	-	50	-	50	1
		4					**5**

* 70% of the total syllabus of Research Methodology is common to all discipline across the University while the rest 30% will be discipline specific.

Semester – II							
Course Code	**Course**	**Hrs. of Instruction/ week**	**Exam Duration (Hrs.)**	**Maximum Marks**			**Credits**
				CIA	**SEE**	**Total**	
19PHDCC201	Research and Publication Ethics	2	-	50		50	2
19DPPHDC201 19DPPHDC202 19DPPHDC203 19DPPHDC204 19DPPHDC205 19DPPHDC206 19DPPHDC207 19DPPHDC208	**Course III -** DSE-Core I – Pharmaceutical Product Development II – Biopharmaceutics and Pharmacokinetics III – Pharmaceutical Chemistry IV – Pharmaceutical Analysis V – Advanced Pharmacology – I VI –Advanced Pharmacology – II VII – Natural products & Drug discovery VII – Herbal Drug Formulation and Evaluation	4	3 Hr	30	70	100	4
19DPPHCC201	**Course IV -** Seminar Presentation (Review of Literature)	-	-	50	-	50	1
		6					**7**

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Ph.D – Pharmaceutical Sciences

SEMESTER – I

19DPPHCC101	Course I - Research Methodology	4 Hrs /week	4 Credits

Syllabus:

Unit 1	**Introduction to Research Methodology& Research Design**	**12**
	Meaning of Research, Objectives of Research, Motivations in Research, Types of Research, Research Process, Significance of Research, Criteria for good research; Definition of research problem, Selection of research problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem. Basic Principles and Need of research design, features of good design, Important concepts relating to research design, Measurement in Research; Methods of Data Collection- Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Collection of Secondary Data.	
Unit 2	**Scientific documentation**	**16**
	Definition and kinds of Scientific documents: Research paper, Review paper, Book reviews, Thesis & Technical reports; Standards of research journal: Impact factor, Citation index, H index, I10 index, Eigen factor; Components of a research paper: Title, Authors and addresses, Abstract, Acknowledgements, Tables and illustrations, Documentation of collected literature, Reference Index, Database generation, Basics of Bibliographic Citations, ISBN & ISSN, Different Bibliographic styles; Dealing with publishers: Submission of Manuscript, Ordering reprints.	
Unit 3	**Statistical tests**	**10**
	Statistics in Research; Descriptive Statistics- measure of centraltendency, measure of variance; Student's 't' test: Hypotheses,acceptance and rejections, significance levels (One sampled test, twosampled test-paired and unpaired test);Regression and correlation – bivariate analysis, Analysis of Variance (ANOVA): Generalprinciples, completely randomized and	

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	random-block designANOVA (One-way ANOVA, two-way-ANOVA); Non parametrictests- Chi-square test; Normality tests.	
Unit 4	**Interpretation and Report Writing**	**10**
	Data Analysis, Data sorting and validation of data, Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation; Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing.	
Unit 5	**Pharmaceutical Experimental Design**	**12**
	Quality by Design, Experimental designs for animal experiments, statistical analysis of experiments using laboratory animals, sample size determinations in animal experiments, controlling variability in animal experiments, experimental methodology in clinical trials. Experimental design in planning of synthesis. Statistical experimental designs for development and optimization of formulations.	

Text Book:

1. Mark C. Rogge, David R. Taft. FDA Regulatory Affairs - A guide for prescription drugs, medical devices, and biologics, Preclinical Drug Development. 2nd ed. - ISBN: 9781420084726
2. Gareth A. Lewis, Didier Mathieu, Roger Phan-Tan-Luu, Pharmaceutical Experimental Design, First Edition, CRC Press, Informa Healthcare. ISBN 9780824798604

Reference Books:

1. Yeonwoo Lebovitz, Rebecca A. English and Anne B. Claiborne. Building a national framework for the establishment of regulatory science for drug development: workshop summary - ISBN: 0309158893
2. Howard J. Seltman, Experimental Design and Analysis, http://www.stat.cmu.edu/~hseltman/309/Book/Book.pdf.
3. Updated Act and Regulatory Guidelines.

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SEMESTER – II

Ph.D – Pharmaceutical Sciences

SEMESTER – II

19PHDCC201	Research and Publication Ethics	2 Hrs /week	2 Credits

Syllabus:

Unit 1	**Philosophy and Ethics**	**03**
	• Introduction to philosophy: definition, nature and scope, concept, branches • Ethics: definition, moral philosophy, nature of moral judgements and reactions	
Unit 2	**Scientific Conduct**	**05**
	• Ethics with respect to science and research • Intellectual honesty and research integrity • Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP) • Redundant publications: duplicate and overlapping publications, salami slicing • Selective reporting and misrepresentation of data	
Unit 3	**Publication Ethics**	**07**
	• Publication ethics: definition, introduction and importance • Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. • Conflicts of interest • Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types • Violation of publication ethics, authorship and contributorship • Identification of publication misconduct, complaints and appeals • Predatory publishers and journals	
Unit 4	**Open Access Publishing**	**04**
	• Open access publications and initiatives	

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	• SHERP AlRoMEO online resource to check publisher copyright & self-archiving policies • Software tool to identify predatory publications developed by SPPU • Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer • Journal Suggester, etc.	
Unit 5	**Publication Misconduct**	**04**
	• Group Discussions ▪ Subject specific ethical issues, FFP, authorship ▪ Conflicts of interest ▪ Complaints and appeals: examples and fraud from India and abroad • Software tools • Use of plagiarism software like Turnitin, Urkund and other open source software tools	
Unit 6	**Databases and Research Metrics**	**07**
	• Databases • Indexing databases • Citation databases: Web of Science, Scopus, etc. • Research Metrics • Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP. Cite Score • Metrics: h-index, g index, i10 index, altmetrics	

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Ph.D – Pharmaceutical Sciences
SEMESTER – II

Course Code	Discipline Specific Core Elective I	Hrs./Week	Credits
19DPPHDC201	Pharmaceutical Product Development	4	4

Objectives:

- Formulation of traditional and advanced pharmaceutical dosage forms.
- Understand the characterization of pharmaceutical dosage forms.
- Knowledge of optimization of pharmaceutical dosage forms.

Syllabus:

Unit 1	**Preformulation studies**	**10**
	• Preformulation studies of drug substances • Proteins and peptides • Preformulation work sheet	
Unit 2	**Complexation and Solubilization**	**15**
	• Complexation ▪ Metal and organic molecular complexes ▪ Inclusion compounds with reference to cyclodextrins ▪ Methods of analysis • Solubilization ▪ Solubility and solubilization of nonelectrolyte ▪ Drug solubilization in surfactant systems ▪ Use of co-solvents ▪ Solid-state manipulations and drug derivitization	
Unit 3	**Optimization**	**15**
	• Statistical methods and factorial design • Quality by Design	
Unit 4	**Stability**	**5**
	• Stability of dosage forms as per ICH guidelines	
Unit 5	**Solid State Pharmaceutics**	**15**

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	• Molecular Level ▪ Crystallinity and crystal habit ▪ Polymorphism, amorphous state, ▪ Solvates and hydrates ▪ Analytical techniques for characterization (DSC, PXRD, SEM, FTIR) ▪ Molecular modeling in solid state characterization ▪ Case studies and regulatory perspective • Particle level ▪ Particle size and shape ▪ Porosity, surface area, compaction ▪ Particle engineering in pharmaceuticals and relevance in dosage form designing • Bulk level ▪ Bulk density, compressibility, flow properties ▪ Compaction and consolidation, Cohesivity ▪ Electrostatistics aggregation, agglomeration • Role in formulation development and processing	

Text Book :

1. Khar, R.K. Vyas,S.P. (2013). Theory and Practice of Industrial Pharmacy by Lachmann and Libermann. 4th Edition. New Delhi, India: CBS Publishers.
2. Remington, J., Allen, L.V. (2013). Remington - The Practice of Pharmacy. 22nd Edition.London: Pharmaceutical Press.

Reference Books :

1. Lieberman, H. And Lachman,L. (1980) Pharmaceutical dosage forms: Tablets Vol. 1-3. 2nd Edition. New York, NY:Marcel Dekker Publisher.
2. Lieberman, H.A., Rieger, M.M., Banker, G.S. (1996). Pharmaceutical Dosage forms: Disperse Systems, Vol, 1-2. New York, NY:Marcel Dekker Publisher.

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3. Banker, G.S.,Siepmann, J., Rhodes, C. (2002). Modern Pharmaceutics. 4th Edition. United States: CRS press.
4. Bean, H.S., Beckett, A.H., Carless, J.E. (1964). Advances in Pharmaceutical Sciences. Vol. 1-5.London, England:Academic Press Inc.
5. Martin, A.N.,Sinko, P.J.,Singh, Y. (2011). Martin's Physical Pharmacy & Pharmaceutical Sciences. 7th Edition.Baltimore, MD: Lippincott Williams & Wilkins.
6. Jain,S.K.,Soni, V. (2012). Bentley's Textbook of Pharmaceutics – by Rawlins.Haryana, India: Rajkamal Electric Press.
7. Willig, S.H., Tuckerman, M.M., Hitchings W.S. (1982). Good manufacturing practices for Pharmaceuticals: A plan for total quality control, Second edition. New York, NY:Marcel Dekker Publisher.
8. Kohli, D.P.S., Shah, D.H. (2012). Drug Formulation Manual. 4th Edition.New Delhi: Eastern publishers.
9. Avis, K.E., Lieberman, H. And Lachman, L. (1985). Pharmaceutical Dosage forms: Parenteral medications Vol. 1-2. 2nd Edition. New York, NY:Marcel Dekker Publisher.

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Course Code	Course III – Discipline Specific Core Elective II	Hrs./Week	Credits
19DPPHDC202	Biopharmaceutics and Pharmacokinetics	4	4

Syllabus:

Unit 1	**Pharmacokinetic characterization of drugs**	**12**
	ADME, Absorption rate constants (Wagner-Nelson, Loo-Reigelman methods), limitations, lag-time, pharmacokinetics in presence of lag-time; Flip-flop model.	
Unit 2	**Protein and tissue binding**	**12**
	Factors effecting protein binding, kinetics of protein binding, determination of rate constants and different plots (direct, scatchard and reciprocal); Significance volume of distribution, implications and in vitro methodologies	
Unit 3	**Chronopharmacokinetics**	**12**
	Drug toxicity and forensic, pharmacokinetics; Case study; Pharmacokinetics in elderly; Drug dosage in children, obese patient; First dose size; Kinetics of maternal-fetal drug transfer; Pharmacokinetics- pharmacologic/clinical response; Distribution kinetics; Metabolic kinetics; Dose and time dependencies; Turnover concepts; Small volume of distribution; Dialysis.	
Unit 4	**Drug disposition**	**12**
	Renal clearance, mechanism of clearance, clearance ratio, determination of clearance, hepatic clearance, % drug metabolized, relationship between blood flow, intrinsic clearance, and hepatic clearance.	
Unit 5	**Dosage Regimen**	**12**
	Pharmacokinetics of multiple dosing, dosage regimen design based on mean average, minimum and maximum, plasma/serum concentrations, limited fluctuation methods; Repeated one point method; Dosage adjustment in disease patients.	

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Text Book :

1. Shargel, L., Andrew, B.C.Y. (2016). Applied biopharmaceutics and pharmacokinetics, 7th edition. McGraw HillInernational edition.USA.
2. Brahmankar,D.M., Jaiswal,S.B. (2015). Bio pharmaceutics and Pharmacokinetics-A Treatise, 3rd edition. VallabhPrakashan. Delhi.
3. Gibaldi,M. (2005). Biopharmaceutics and Clinical Pharmacokinetics, 4th edition.Pharmamed Press. India.

Reference Books :

1. Notari,R.F. (1987). Biopharmaceutics and Pharmacokinetics, 4th edition. Marcel Dekker, Inc. New York.
2. Glbaldi, M., Perrier, D. (1982). Pharmacokinetics, 2nd edition. Mercel Dekker Inc. New York.
3. Glbaldi, M., Prescott, L. (1983). Hand Book of Clinical Pharmacokinetics. ADIS Health Science Press.
4. Rowland, M., Tozen, T.N. (1995). Clinical Pharmacokinetics, Concepts and Application. Lea and Febrger, Philadelphia.
5. Abdou, H.M. (1989). Dissolution, Bioavailability and Bioequivalence.Mack Publishing Company, Pennsylvania.
6. Remington, J., Allen, L.V. (2013). Remington - The Practice of Pharmacy. 22nd Edition, London: Pharmaceutical Press.

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Course Code	Course III:Discipline Specific Core Elective III	Hrs./Week	Credits
19DPPHDC203	Pharmaceutical Chemistry	4	4

Syllabus:

Unit 1	**Pharmaceutical Organic Chemistry**	**15**
	• Methods of determining reaction mechanisms (kinetic and non-kinetic methods) • Energy profile diagrams, reaction intermediates, • Crossover experiments and isotopic labelling	
Unit 2	**Order of reactions**	**10**
	• Reversible, consecutive and parallel reactions, • Solvent, ionic strength and salt effects	
Unit 3	**Multi-component reactions of pharmaceutical importance**	**10**
	• Biginelli reaction • Hantzsch reaction • Ugi reaction • Passerini reaction and Strecker synthesis.	
Unit 4	**Pharmaceutical Medicinal Chemistry**	**15**
	• General principles • Identification and study of targets for development of various therapeutic agents, • Rational approach for drug design.	
Unit 5	**Computer aided drug design**	**10**
	• Study of recently developed drugs and molecules in development pipeline.	

Text Book :

1. Martin YC. "Quantitative Drug Design" Dekker, New York, 6th edition, 1977.
2. Delgado JN, Remers WA eds "Wilson & Gisvolds's Text Book of Organic Medicinal & Pharmaceutical Chemistry", Lippincott, New York ,1998.

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Reference Books :

1. W.C.Foye, (2008) Principles of Medicinal chemistry, Lea and Febiger, Philadelphia, 7th edition.
2. Korolkovas A, Burckhalter JH. (1977) "Essentials of Medicinal Chemistry", Wiley Interscience, 3rd edition.
3. H.E.Wolff, edn, (1998) Burgers Medicinal chemistry, Vol I to IV, John Wiley and sons, New york oxford University Press, Oxfords,6th edition.
4. Patrick Graham, L., (2013) An Introduction to Medicinal Chemistry, Oxford University Press 5th edition.
5. Smith HJ, Williams H, eds, "Introduction to the principles of Drug Design", Wright Boston, 4thedition, 1998.
6. Silverman R.B. "The organic Chemistry of Drug Design and Drug Action", Academic Press New York, 3rd edition, 2014.
7. March, J., Advanced Organic Chemistry, Reaction Mechanism and Structure, John Wiley and sons, New York,4th edition, 2007.
8. Indian Heterocyclic chemistry Journal.

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Course Code	Course III: Discipline Specific Core Elective IV	Hrs./Week	Credits
19DPPHDC204	Pharmaceutical Analysis	4	4

Syllabus:

Unit 1	**Pharmaceutical applications of various analytical techniques**	**15**
	- Principles - Methods - Interpretation of data -Various analytical techniques like UV-Visible, IR, NMR spectroscopy; Mass spectrometry; GC, HPLC, HPTLC, Flash Chromatography and hyphenation.	
Unit 2	**Assay of drugs and metabolites in pharmaceuticals**	**10**
	- Methods for Qualitative analysis - Methods for Quantitative analysis	
Unit 3	**Assay of drugs and metabolites in biological fluids**	**10**
	-Methods for Qualitative & Quantitative Assays	
Unit 4	**Analytical and bioanalytical methods validation using ICH Guidelines**	**15**
	- Validation of analytical methods - Validation of analytical Procedure	
Unit 5	**ICH Guidelines**	**10**
	-Stability Testing -Analytical Validation -Impurities -Pharmacopoeias - Good Manufacturing Practices -Pharmaceutical Development -Quality Risk Management -Pharmaceutical Quality System	

Text Book :

1. SharmaY.R. (1980), Organic spectroscopy, 5th Edition, S. Chand Publication, New Delhi.
2. Vogel A.I (1989), Text book of Quantitative Chemical Analysis, 6th Edition, Pearson education, London, UK.

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3. Sharma B.K. (2000), Instrumental Methods of Chemical Analysis, 29th Edition, Krishna Prakashan, New Delhi.

Reference Books :

1. Connors K. (2007), Text book of Pharmaceutical Analysis, 3 rd Edition, Willey India Pvt. Ltd. New York.

2. William K. (2008), Organic spectroscopy, 3 rd Edition, Palgrave Macmillan, London.

3. Sethi P.D. (2007), Quantitative Analysis of Drugs in Pharmaceutical Formulations, 3rdEdition, CBS Publisher, Netherland.

4. Silverstein (1991), Spectrophotometric identification of Organic Compounds, 5th Edition, John Wiley & Sons, USA.

5. Indian pharmacopoeia (1955), 8th Edition, Vol. I, II, III. Indian Pharmacopoeia commission, Ghaziabad.

6. British pharmacopoeia (1864), 13th Edition, Vol. I, II, III. British Pharmacopoeia commission.

7. Beckett A.H. (2009), Practical Pharmaceutical chemistry,3rd Edition, Vol I and II, CBS Publication, New Delhi.

8. Dr. Patel K.G.(2012), Laboratory handbook in instrumental analysis, 1st Edition, Nirav Prakashan, Ahmedabad.

9. ICH guidelines.

10. Evans G. (2004), Handbook of bioanalysis and drug metabolism, CRC Press U.S.

11. John DR (2009), Extraction techniques in analytical sciences, John willey & sons Ltd.

12. Sanford B. (1984), Pharmaceutical stastics clinical and practical application, 3rd Edition, Marcel dekker Inc.

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Course Code	Course III – Discipline Specific Core Elective V	Hrs./Week	Credits
19DPPHDC205	Advanced Pharmacology – I	4	4

Syllabus:

Unit 1	**Breeding techniques and experimentation using laboratory animals**	**20**
	Detailed study of guidelines a) CPCSEA b) OECD c) ICH d) GLP e) ICMR f) Guidelines according to official compendia	
Unit 2	**Recent advances in Transgenic and Knockout animals**.	**10**
	Introduction to Pharmacogenomics, Proteomics and Array technology.	
Unit 3	**Organization of screening**	**10**
	Pharmacological activity of new substances and safety assessment tests.	
Unit 4	**Toxicity studies**	**10**
	Acute, subacute (Repeated dose), subchronic and chronic toxicity.	
Unit 5	**Alternatives to animal experimentation**	**10**
	a) Animal cell lines and their uses b) Radioligand binding assay c) Patch clamp and ELISA d) Stem cell research etc.	

Text Book :

1. Fay A. Rozovsky (2003) Clinical Trials and Human Research: A Practical Guide to Regulatory Compliance, 2nd edition, New Jersey, U.S.A., Wiley Publication.
2. John I. Gallin (2005) Principles and Practices of Clinical Research, 2nd edition Amsterdam, Netherland, Elsevier.

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Reference Books :

1. Anthony C. Cartwright International Pharmaceutical Product Registration: Aspects of Quality, Safety and Efficacy, 2nd edition, U.S.A. Taylor & Francis Inc.
2. Douglas J. Pisano. (2008) FDA regulatory affairs: a guide for prescription drugs, medical devices, and biologics; 2nd edition USA CRC Press.
3. Roger and Walker. (2012) Clinical Pharmacy and Therapeutics 3rd edition, U.S.A. Churchill Livingstone publication.
4. Lionel D. E., Aadrew J.F., Anthony W F. (2007) Principles and practice of pharmaceutical medicine, 2nd edition. New jersey, U S A, Wiley
5. Julia L, Ann R. (1994) Handbook of clinical research. 2nd edition, London, UK, ChurchillLivingstone
6. David Machin, Simon Day (2004) Textbook of Clinical Trials New Jersey, U.S.A., Wiley Publication.
7. Rondels R K, VarleyS A (2000) Clinical Data Management, New jersey, U S AWiley Publications.
8. Central Drugs Standard Control Organization. Good Clinical Practices Guidelines for Clinical Trials on Pharmaceutical Products in India. NewDelhi: Ministry of Health.
9. International Conference on Harmonisation of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonised TripartiteGuideline. Guideline for Good Clinical Practice.E6; May 1996.
10. Ethical Guidelines for Biomedical Research on Human Subjects. IndianCouncil of Medical Research, New Delhi.
11. Goodman & Gilman: JG Hardman, LE Limbard, McGraw Hill Publications.
12. Relevant review articles from recent medical and pharmaceutical literature.

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Course Code	Course III – Discipline Specific Core Elective VI	Hrs./Week	Credits
19DPPHDC206	Advanced Pharmacology – II	4	4

Syllabus:

Unit 1	**Fundamentals of Molecular mechanism of drug action**	**15**
	Receptor occupancy and cellular signaling systems such as G-proteins, cyclic nucleotides, calcium and calcium binding proteins, phosphatidyl inositol. Ion channels and their modulators. Endogenous bioactive molecules: Cytokines, neuropeptides and their modulators, neurosteroids, nitric oxide, phosphodiestrase enzyme and protein kinase C, arachidonic acid metabolites, COX-2 regulators and their role in inflammation, endothelium derived vascular substances (NO, endothelins) and their modulators. Pharmacology of atrial peptides, reactive oxygen intermediates, antioxidants and their therapeutic implications.	
Unit 2	**Recent trends on different classes of receptors and drugs acting on them**	**15**
	a. Angiotensin receptors b. Excitatory amino acid receptors c. Kinin receptors d. Adrenoceptors e. Low molecular weight heparins, hirudins and GP II/IIIa receptor antagonists f. Imidazole receptors g. Cholinergic receptors h. Dopamine receptors i. Serotonin receptors j. Hormone receptors k. GABA and Benzodiazepine receptors l. Opiod receptors m. Purinergic receptors n. Glutamate receptors	
Unit 3	**Apoptosis**	**5**
	Basic functions, mechanisms and role of caspases. Pharmacological and clinical implications.	

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Unit 4	**Chronopharmacology and Immunopharmacology**	**10**
	Basic Concepts of Chronopharmacology and their implications to Drug Therapy. Antibody dependent and cellular cytotoxicity. Monoclonal antibodies and its importance.	
Unit 5	**Gene therapy and Techniques for the study of Molecular Pharmacology**	**15**
	Concept of gene therapy and recent development in the treatment of various hereditary diseases. Human genome mapping and its potential in drug research. Western Blotting, Immunostaining, T-PCR, Cloning, RIA, Cell Cultures etc.	

Text Book :

1. Fay A. Rozovsky (2003) Clinical Trials and Human Research: A Practical Guide to Regulatory Compliance, 2nd edition, New Jersey, U.S.A., Wiley Publication.
2. John I. Gallin (2005) Principles and Practices of Clinical Research, 2nd edition Amsterdam, Netherland, Elsevier.

Reference Books :

1. Anthony C. Cartwright International Pharmaceutical Product Registration: Aspects of Quality, Safety and Efficacy, 2nd edition, U.S.A. Taylor & Francis Inc.
2. Douglas J. Pisano. (2008) FDA regulatory affairs: a guide for prescription drugs, medical devices, and biologics; 2nd edition USA CRC Press.
3. Roger and Walker. (2012) Clinical Pharmacy and Therapeutics 3rd edition, U.S.A. Churchill Livingstone publication.
4. Lionel. D. E.Aadrew.J.F. Anthony W F. (2007) Principles and practice of pharmaceutical medicine, 2nd edition. New jersey, U S A.
5. Julia L Ann R. (1994) Handbook of clinical research. 2nd edition, London, UK, Churchill Livingstone.
6. David Machin, Simon Day (2004) Textbook of Clinical Trials New Jersey, U.S.A., Wiley Publication.

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7. Rondels R K, varleyS A (2000) Clinical Data Management, New jersey, U S A Wiley Publications.
8. Central Drugs Standard Control Organization. Good Clinical Practices Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health.
9. International Conference on Harmonisation of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonised Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 1996.
10. Ethical Guidelines for Biomedical Research on Human Subjects. Indian Council of Medical Research, New Delhi.
11. Goodman & Gilman: JG Hardman, LE Limbard, McGraw Hill Publications.
12. Relevant review articles from recent medical and pharmaceutical literature.

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Course Code	Course III – Discipline Specific Core Elective VII	Hrs./Week	Credits
19DPPHDC207	Natural products & Drug discovery	4	4

Syllabus:

Unit 1	**Introduction**	**12**
	Introduction, use of natural products in traditional medicines, potential of natural products, Natural products in drug discovery and development.	
Unit 2	**Recent development in the Natural medicinal products**	**15**
	Introduction, Biological and Pharmacological activities, Isolation and characterization studies of different class of Phytoconstituents (Alkaloids, Glycosides, Steroids, Saponins etc).	
Unit 3	**Source of Natural product drug**	**09**
	Different sources like Marine, Microbial, Mineral etc.	
Unit 4	**Extraction and Isolation techniques**	**15**
	Introduction, Principle and Applications of different extraction & isolation methods viz Soxhlet extraction, microwave extraction, supercritical fluid extraction, solid phase extraction, Column chromatography, Flash chromatography etc.	
Unit 5	**Marine Pharmacognosy**	**09**
	Recent development in Marine Pharmacognosy	

Text Book :

1. Kaufman, Peter B. (1998). Natural Products from plants. New York: CRC press.
2. Evans, W.C. (2009). Trease and Evans Pharmacognosy. London: W.B. Sounders & Co.

Reference Books :

1. Pharmacopoeia Commission for Indian Medicine & Homoeopathy. (2016).TheAyurvedic Pharmacopoeia of India. Part I and Part II. Govt. of India, Ministry of Health and Family Welfare, Dept. of Indian Systems of Medicine and Homeopathy. Gaziabad, India: Pharmacopoeia Commission for Indian Medicine & Homoeopathy.

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2. Government of India. Ministry of Health and Family Welfare, Department of Indian System of Medicine and Homeopathy. (2011). The Ayurvedic Formulary of India. Vol. I,II and III. New Delhi, India: Government of India, Department of Indian System of Medicine and Homeopathy.
3. Kokate, C. K., Purohit, A. P. and Gokhale S. B. (2014). Pharmacognosy. Pune, India: Nirali Prakashan.
4. Rangari, V.D. (2003). Pharmacognosy & Phytochemistry. Nashik, India: Career Publications.
2. Agrawal, O. P. (2004). Natural Products, Vol I & II, Meerut, India: Goel Publishing
a) House.
3. Bhat, S.V., Nagasampagi, B. A., Meenakshi, S. (2005).Chemistry of Natural products. New Delhi, India: Narosa Publishing House.
4. Anonymous, (2005). The Wealth of India (Raw Material & Industrial Product), New Delhi, India: Council of Scientific Research.
5. Kirtikar and Basu (1999). Indian Medicinal Plants. Dehradun, India: International Book Distributors.
6. Rastogi, R. P., Mehrotra, B. N. (1998). Compendium of Indian Medicinal Plant Vol. 1 to 6.New Delhi, India: CDRI & NISCOM.
7. Indian Herbal Pharmacopoeia. (2002). Mumbai, India: RRL, Jammu and IDMA.
8. Gupta, A K & Neeraj Tundon (2012). Review on Indian Medicinal Plants, Vol I to XI.Indian council of medicinal Research (ICMR).
9. R. D. Chaudhry. (1996). Herbal Drugs Industry: Practical Approach to IndustrialPharmacognosy. New Delhi, India: Eastern Publications.
10. Kalia, A.N. (2009). Text Book of Industrial Pharmacognosy. Pune, India: CBS Publishers
b) & Distributors.
11. Wagner, H. (1984). Plant Drug Analysis. New York: Springer-Verlag GmbH.
12. Peach, M and Tracey, M.V. (2012). Modern methods of Plant analysis. Volume I and II.
c) Mumbai, India: Narosa Publishing House.

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Rajkot

Course Code	Course III – Discipline Specific Core Elective VII	Hrs./Week	Credits
19DPPHDC208	Herbal Drug Formulation and Evaluation	4	4

Syllabus:

Unit 1	**Overview of Novel Herbal formulations**	**12**
	Phytosomes, Liposomes, Microspheres, novel vesicular herbal formulations etc.	
Unit 2	**Conventional methods of standardization of herbal drugs/formulations**	**12**
	Organoleptic or macroscopic evaluation, Microscopic evaluation, Chemical evaluation, Physical evaluation, Biological evaluation etc.	
Unit 3	**Modern methods of standardization of herbal drugs/formulations**	**12**
	Chromatography techniques, Role of genetic markers, RAPD, DNA fingerprinting technique etc.	
Unit 4	**Regulatory guidelines**	**12**
	WHO Guidelines for assessment of crude drugs ▪ Evaluation of identity, purity, and quality of crude drugs. ▪ Determination of pesticide residue ▪ Determination of Micro-organisms ▪ Determination of Arsenic and heavy metals	
Unit 5	**Herbal Drug Regulatory affairs**	**12**
	Role and importance of national and international regulatory bodies in assessment of quality of herbal drugs and formulations.	

Text Book :

1. Ansari SH, (2001) Essentials of pharmacognosy, Birla publications Pvt Ltd, 10-16.
2. Gupta MK and Sharma PK. (2007) Test Book of Pharmacognosy, Ayurvedic formulations, Vol II, Ist edition, Pragati Prakashan, Meerut.

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Reference Books :

1. Brain KR and Turner TD. Practical Evaluation of phytopharmaceuticals. Wright Scientechnica Bristol. 1975.
2. WHO. 1988. Quality Control Methods for Medicinal Plant Materials. World Health organisation, Genava.
3. WHO. 1992. Quality Control Methods for Medicinal Plant Materials. World organisation, Genava.
4. Herbone JB. Phytochemical methods, Chapman and Hall, London, New York, 2nd Edition. 1928

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