3.4.1 The Institution ensures implementation of its stated Code of Ethics for research. The institution has a stated Code of Ethics for research and the implementation of which is ensured through the following:

1. Inclusion of research ethics in the research methodology course work

- **Research Methodology Syllabus**

S.No	Name of the Programme	Name of the Course	Course Code
1	M.Sc Botany	Bioinstrumentation and Research Methods	21PBOC13
2	M.Sc Botany	Research Methodology	19PBOC34
3	M.Com	Research Methodology	21PCOC35
4	M.Sc Computer Science	Research Methodology	21PCSC34
5	M.Sc Computer Science	Research methodology	19PCSC33
6	M.A English Literature	Research Methodology	21PENC33
7	M.Sc Mathematics	Research Methodology	21PMAC35
8	MHRM	Research Methodology	21PHRC31
9	MHRM	Research Methodology	17PHRE31
10	M.Sc Psychology	Research Methodology	21PPSC24
11	M.Sc Zoology	Research Methodology and Biotechniques	21PZOC34
12	M.Sc Zoology	Research Methodology	19PZOC34
13	M.A History	Research Methodology	19PHIC34
14	M.Sc Physics	Research Methodology	21PPHE12

15	M.Sc Microbiology	Research Methodology	21PMIC34
16	M.Sc Microbiology	Laboratory in Food and Dairy Microbiology, Research Methodology	21PMICR6
17	M.A Economics	Research Methodology	21PECC34
18	BBA	Research Methodology	18UBAI51
19	M.Sc Chemistry	Research Methodology	21PCHE31
20	M.Sc Chemistry	Research methodology	19PCHC34

SEMESTER V			
Core Integral – I Research Methodology			
CODE: 18UBAI51	Hrs/week: 5	Hrs/sem: 75	Credits: 4

Vision

To enable the students to learn the basic concepts of Research and its Methodology.

Mission

Provide knowledge on research methods, techniques and process and to develop skills in the application of research methods for solving problems in business.

Course Outcome:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand the objectives of research, types of research and criteria of good research.	1	Un
CO-2	know the research problem and research design.	2	Un.Re
CO-3	gain knowledge of sampling design and methods of data collection.	5	Un,Cr
CO-4	construct the questionnaires and interview schedule.	2	Un,Cr
CO-5	gain insights in the interpretation of data and report writing.	4	Re,Cr
CO - 6	conduct pre-test for doing research.	1,4	Re
CO - 7	understand and undertake pilot study	3	Cr,Ev
CO - 8	write research report.	6	Cr,Ev

SEMESTER V			
Core Integral – I Research Methodology			
CODE: 18UBAI51	Hrs/week: 5	Hrs/Sem: 75	Credits: 4

Unit – I Research methodology:

Meaning of Research - Definition - Types - Research process - Criteria of good research

Unit – II Defining the Research problem and Research design:

Identification and formulation of Research problem - Selection of research topic - Statement of Research object - Hypothesis - Definition - Meaning and Types - Research design - Explorative description - Diagnostic and Experimental design

Unit – III Sampling design and measure of data collection:

Sampling - Meaning and Definition - Types and Sampling - Random and Non-Random sampling - Sample Size - Sample error - Data collection – Observation - Construction of questionnaires and interview schedule - Pilot study and pre-test

Unit – IV Data Analysis: Coding - Data entry -Analysis Interpretation of data -Tabulation – Types- Tools for analysis (Percentage and Chi-square analysis only).

Unit – V Interpretation - Generalization of data - Report writing - Introduction – Chapterisation - References - Bibliography - Presentation and Documentation.

Note : Theory Only

Text Book:

1. Kothari.C.R. 1992, Research Methodology, New Delhi: Vikas Publishing Ltd.,

Books for Reference:

1. Levin J.Kchard 1948, Statistics for Management, New Delhi: 3rd Edition, Prentice Hall

2. Gupta C.B & Kapoor.V.K.1987, Fundamentals of Applied Statistics. New Delhi: Sultan Chand & Sons.

Semester III			
Core XII	**Research Methodology**		
19PBOC34	**Hrs/week:5**	**Hrs/Semester :75**	**Credits : 4**

Vision:

- To know the basic tools in research and to facilitate the students to undergo basic and application oriented research

Mission:

- To infuse the practical knowledge of using various instruments into the vast array of techniques in plant science.
- To motivate the students to do research.

Course Outcome

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	know and explain the importance of the internet in research and be able to use it for gathering their reference materials	1	Un
CO-2	acquainted with different tools and techniques essential for research work	6	Cr
CO-3	examine the basic framework of research process and able to learn how to address research problem and what is to be done to solve it.	8	An
CO-4	develop an understanding of the ethical dimensions of conducting applied research	7	An
CO-5	determine the appropriate quantitative methodologies to be used for the study	1	Ev
CO-6	understand a general concept of paradigms of research design.	7	Un
CO-7	familiarise with mixed methods of research.	6	Cr
CO-8	communicate the research findings to the scientific forums	6	Cr

Semester III			
Core XII	**Research Methodology**		
19PBOC34	**Hrs/week:5**	**Hrs/Semester :75**	**Credits : 4**

Unit I

Microscopy - basic principles, components of compound microscope, phase contrast and fluorescent microscopes. Electron microscopy-principle, components, working mechanism and applications of TEM and SEM. Micro technique: fixatives, stains, dehydration and embedding – sectioning with rotary microtome and staining. Micrometry – principle and methods of measurement of plant cells.

Unit II

pH metry -principle, electrodes, measurement of pH. Spectroscopy- visible and ultraviolet spectrophotometers – Atomic absorption spectrophotometer (AAS). FTIR - principle, working mechanism and its applications. Centrifugations: working principle and applications of clinical centrifuge, high-speed centrifuge, ultra centrifuge and analytical centrifuge.

Unit III

Chromatography- types– adsorption and partition chromatography. Principle and applications of Thin layer chromatography, Gas liquid chromatography and High performance liquid chromatography Photomicrography - principle and methods.

Unit IV

Electrophoresis - basic principles, electrophoretic mobility, factors, isoelectric focusing, types - vertical and horizontal. Agarose and polyacrylamide gel electrophoresis, detection and recovery of electrophorogram. Gel documentation system. Tracer techniques - nature of radioactivity, patterns of radioactive decay, half life - detection, radiation measurement - Geiger Muller counter, Scintillation counter, Autoradiography and applications of isotopes in biology. X- ray crystallography.

Unit V

Choosing the problem for research, literature collection – Primary, secondary and tertiary sources, Bibliography, indexing and abstracting, Reporting the results of research in conferences – Oral and Poster presentation. Manuscript processing –thesis and journal format-preparation of full paper – reviews, bibliometrics, plagiarism

Books for Reference:

1. Anbalagan, K. 1985. *Electrophoresis.* Life Science Book house. Madurai.
2. Bryan C. Williams Keith Wilson, 1983. *A biologists guide to practical techniques of practical biochemistry* second edition. Edward Arnold publications.
3. Ghatak K. L., 2011, *Techniques and methods in Biology*, PHI Learning Private Ltd, New Delhi.

4. Guruamni. N, 2006, *Research Methodology for Biological Sciences,* MJP Publishers, Chennai
5. Gurumani N., 2010. *Scientific thesis writing and paper presentation*. MJP Publishers, Chennai
6. Jayaraman J., 1985. *Laboratory manual in biochemistry*, Wiley Eastern Ltd., New Delhi.
7. Johansen,M., 1940. *Plant Microtechnique* Mc. Graw Hill.
8. Kothari C.R., 2004. *Research Methodology* – Methods and techniques New age International (P) Ltd., Publishers. New Delhi.
9. Plummer, D., 1987. *An introduction to practical Biochemistry*, Tata Mc. Graw Hill.
10 Ramadass P. and A. Wilson Aruni. 2009. *Research and writing across the disciplines,* MJP Publishers, Chennai
11 Rana S.V.S., 2012, *Biotechniques Theory And Practice,* Rastogi publications, New Delhi.
12 Subramanian, 2005. *Biophysics principles and Techniques*. MJP Publishers, Chennai.
13 Veerakumari, L., 2004. *Biochemistry* M.J.P. Publishers, Chennai.
14 Veerakumari, L., 2015. *Bioinstrumentation*, M.J.P. Publishers, Chennai.
15 Wilson, K. and J. Walker, 1997. *Practical biochemistry IV edition,* Cambridge university press.

Practical
Hrs/week: 2

1. Preparation of permanent slides using microtome
2. Measurement of plant cells using micrometer
3. Thin layer chromatographic separation of amino acids
4. Analysis of protein by PAGE
5. Analysis of DNA by AGE
6. Digital photographic display of anatomical samples/ microscopic samples
7. Demonstration-AAS and FTIR
8. Calculation of citation Index
9. Determination of Impact Factor of Author, Article and Journal.

Submission - Record Note Book

Books for Reference:

- Ruth L Willey, 1971. *Microtechnique: A Laboratory Guide*, The Mac Millan Company, NewYork
- Ponmurugan.P, B. Gangathara Prabhu. 2012. *Biotechniques.* MJP publishers. Chennai.
- Donald Alexander Johansen, 1940. *Plant Microtechnique*. New York; London, McGraw-Hill Book Company, Inc.

Semester – III			
Core X	**Research Methodology**		
Code : 19PCHC34	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Vision:

To provide resources to the students to stimulate their basic research interest and other creative endeavors that promote entrepreneurial culture.

Mission:

- To explain about various thermal and electrochemical instrumentation techniques.
- To learn about all the hyphenated techniques used for the separation of compounds.
- To interpret the results of analysis with accuracy.

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	select the research topic and able to survey the literature.	3	Ev
CO - 2	submit the project proposals to the funding agency.	8	Ap
CO - 3	explain the principle, instrumentation and applications of TGA, DTA and DSC.	3,6	Un
CO - 4	compare principle, instrumentation and applications of potentiometry, coulometry and voltammetry.	5	An
CO - 5	describe the different types of Atomic spectroscopy.	1,5	Un
CO - 6	interpret the data using TEM, SEM, XRD and EDAX techniques.	5,7	Ev
CO - 7	Separate the compound from a mixture using various chromatographic techniques.	3,4	An
CO - 8	improve the accuracy of data in chemical analysis.	5	Ev

Semester – III			
Core X	**Research Methodology**		
Code : 19PCHC34	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Unit I Research methodology

Introduction of research- selection of a research topic- Surveying the literature - Sources- primary source and secondary source - Identification of research problem - Assessing the status of the problem guidance from the supervisor - Actual investigation and analysis of experimental results - Reporting the results in the form of communication, paper etc - Dissertation and thesis writing - Project proposals to the funding agency.

Unit II Thermo and electro analytical methods

Thermoanalytical Methods - Principle, instrumentation and applications of Thermogravimetry (TGA), Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC).

Electroanalytical Techniques – Coulometry - Principle, Instrumentation and Applications - Voltammetry - Types (Stripping voltammetry, Cyclic voltammetry, Amperometry) - Principle, instrumentation and applications.

Unit III Spectroscopic techniques

Atomic spectroscopy - Classification (Absorption, emission and fluorescence methods), Principle, Instrumentation and Application.

Principle, instrumentation and data interpretation of Transmission electron microscopy (TEM), Scanning electron microscope (SEM), Energy dispersive spectroscopy (EDAX) and X-ray diffraction (XRD) analysis.

Unit IV Chromatography techniques

Principle, instrumentation and specific applications of Column chromatography, Thin layer chromatography, Gas Chromatography (GC-MS, GC-FTIR), High Performance Liquid Chromatography (HPLC), Size-Exclusion Chromatography (SEC), Ion Chromatography (IC).

Unit V Data analysis

Errors in chemical analysis – Classification of errors – Determination of accuracy of methods – Improving accuracy of analysis - Comparison between precision and accuracy – Significant figures – Mean, median and standard deviation – Comparison of results - “t” test, “f” test and “chi” square test – Rejection of results – Presentation of data - Correlation and linear regression.

Text Books:

1. Gurdeep R. Chatwal, Sham K.Anand, Instrumental Methods of Chemical Analysis, 5th edition, Himalaya Publishing House, Mumbai, 2014.
2. Skoog.D.A, West.D.M F, Holler.J, Crouch.S.R, Fundamentals of Analytical Chemistry, Thomson Asia Pvt. Ltd., Eighth Edition, Third Reprint, 2005.

3. Banwell. C.N, Fundamentals of molecular spectroscopy, 4th Edition, McGraw Hill Education, Noida, 1994.

Books for Reference:

1. Anderson. J, Durston. B. H, Poole. M, Thesis and Assignment Writing, Wiley Eastern, New Delhi, 1986.
2. Sharma. B.K, Instrumental Methods of Chemical Analysis, Goel Publishing House, 23rd Edition, 2004.
3. Willard. H, Merrit Jr. L and Dean. A, Instrumental methods of analysis, CBS Publishers and Distributers, 2004.
4. http://www.dst.gov.in/whats_new/whats_n07/tsd-format.pdf
5. http://www.ugc.ac.in/financialssupport/xiplan/mrpxiplan.pdf

SEMESTER – III			
Core XIII	**Research Methodology**		
Code : 19PCSC33	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Vision:
Achieve outstanding scientific research in various areas of knowledge.

Mission:

Encourage distinguished research work through the creation of an attractive and stimulating environment to achieve goals.

Course Outcome :

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	integrating knowledge of research processes.	8	An
CO-2	identifying the overall process of designing a research study.	8	Re
CO-3	carrying out ethical issues in research.	8	Ap
CO-4	explaining the concepts of research and its methodologies.	2	Un
CO-5	identifying the key elements of a research report.	8	Re
CO-6	finding the problem for research.	8	An
CO-7	understanding Plagiarism and its types.	8	Un
CO-8	apply the knowledge of teaching methods for its wide applicability.	8	Ap

SEMESTER – III			
Core XIII	**Research Methodology**		
Code : 19PCSC33	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Unit - I

Research Methodology– Introduction - Meaning of research – Objectives of research – Types of Research – Research Approaches – Significance of Research – Research Methods versus Methodology – Research and Scientific Method – Research Process - Criteria of Good Research.

Unit – II

Research Problem – Selecting the Problem – Necessity of Defining the Problem – Technique involved in defining a problem – Meaning of Research Design – Features of a good design.

Unit – III

Component of Scientific report – Scientific writing style – Report writing and its types – Reporting and Thesis writing – Citations – Citation Styles – Journal impact Factor – Bibiliography.

Unit – IV

Ethical issues within the research process – Research Commercialisation – Types of intellectual property – Royalty – Plagiarism – Types of plagiarism - Tools for detecting plagiarism

Unit – V

Methodology of teaching – Objectives for teaching – Structure of teaching – Phases of teaching – Various teaching methods.

Text Book:

1. Statistical Methods - S.P. Gupta

Books for Reference:

1. Research Methodology Methods and Techniques - C.R. Kothari
2. Statistics (Theory and Practice) - B.N. Gupta
3. Research Methodology Methods and Statistical Techniques - Santosh Gupta

Semester – III			
Core – XII	**Research Methodology**		
Sub Code : 19PHIC34	**Hrs / Week : 4**	**Hrs / Sem : 90**	**Credits : 4**

Vision: Acquire the knowledge of recent trends and techniques in Research Methodology.

Mission: Enhance the historical writings and articles with research methodology.

Course Outcome:

Co.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	enhance the research skills and recent trends in research.	1,2	Un,Re
CO-2	practice the research skills in writing projects, thesis etc.	3	Ap
CO-3	open new avenues in doing historical research.	3	Ap
CO-4	acquire skills regarding selection of topic, hypothesis, project outline and field work.	1,2	Un,Re
CO-5	equip and expose objectivity and subjectivity to present authentic facts.	1,2	Un,Re
CO-6	analyse the work of Historical writings.	4	An
CO-7	assess the work of various historians .	5	Ev
CO-8	understand the documentation in Thesis writing.	1,2	Un, Re

Semester – III			
Core – XII	**Research Methodology**		
Sub Code : 19PHIC34	**Hrs / Week : 4**	**Hrs / Sem : 90**	**Credits : 4**

Unit I - Research: Meaning and Definition - Types of Research – Pre-Requisites of a Researcher – Inductive and Deductive Methods – Limitations.

Unit II - Selection of Topic: Criteria – Review of Literature – Objectives – Hypothesis – Designing the Study – Project Outline – Sources: Primary – Secondary – Online Sources – Field work.

Unit III - Objectivity and Subjectivity – Bias – Authenticity – Criticism : Internal and External – Collection of Data: Making Notes – Index Card - File system – Plagiarism – Methodology : Case study – Survey – Interview – Questionnaire.

Unit IV - Analysis – Meaning – Characteristics – Analysis of data – Methods: Qualitative and Quantitative – Statistical method – Limitations.

Unit V - Synthesis : Format – Preliminaries – Text - Abstract – Page and Chapter format – Documentation – Foot notes – Tables and Figures – Work cited – End notes,

Glossary – Bibliography and Appendices - Exposition.

Text Book

1. Rajayyan, K. *Historiography – History in Theory and Method.* Ratna Publications, Madurai. 2004.

Books for Reference

1. Ali, Sheik. *History – Its Theory and Method.* Macmillan India Ltd., New Delhi. 1993.
2. Carr, E.H. *What is History?.* Macmillan, London. 1961.
3. Khurana, K.L. *Concepts and Methods of Historiography.* Lakshmi Narain Agarwal, Agra. 2006.
4. Manickkam, S. *Theory of History and Method of Research.* Madurai. 1997.
5. Sreedharan, E. *A Text book of Historiography 500 B.C to A.D. 2000.* Orient Longman, New Delhi. 2000.
6. Subramanian, N. *Historiography.* Koodal Publishers, Madurai. 1993.

SEMESTER – III			
Core XII : Research Methodology			
Code : 19PZOC34	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Vision

To inculcate research aptitude in students

To be leaders in making use of various scientific techniques and research methods available to and usable by scholars

.

Mission

To introduce the principles and applications of various instruments used in Biology and to prepare them to use these techniques in their own research

Provide an environment to students to participate in consulting and improve their skills

To build scientific teams that can combine various techniques and to create novel approaches to understanding

Strengthen research by assisting students using scientific techniques in the most optimal way.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	demonstrate critical thinking and scientific approach in the design and implementation of an experiment.	1,3	Un, Cr
CO-2	effectively communicate scientific ideas in both written and oral formats	1,2	Un, Ev
CO-3	acquire a broad range of basic laboratory skills to perform experiments and for employment prospects	5	Un, Ap
CO-4	demonstrate and apply a working comprehension of the technical and procedural aspects of laboratory testing, safety and ethical standards of practices	4	Ap
CO-5	write a research report and thesis and Appreciate the components of scholarly writing and evaluate its quality.	6	Cr,Ev
CO-6	verify and test important facts and find solutions to scientific problems	7	An
CO-7	develop new scientific tools, concepts and theories to solve and understand scientific problems	7	Cr
CO-8	design and conduct independent laboratory or field research that is consistent with the highest standards and practices of research	8	Ap

SEMESTER – III			
Core XII : Research Methodology			
Code : 19PZOC34	Hrs / Week : 5	Hrs / Sem : 75	Credits : 4

Unit I Research Designing

Introduction – literature collection-sources – literature citation – manuscript preparation of research report, Internet and e-journals- thesis formating and typing – safety measures in a laboratory – Plagiarism (URKUND)

Unit II Microscopy Types

Principle, construction and applications of Phase contrast- Polarization – Electron microscope– types (SEM,TEM)- fixation and staining techniques for EM (freeze - etching and Freeze fracture), fluorescence - flow cytometry - atomic force and magnetic force microscope – micrometry.

Unit III Spectroscopic Techniques

Absorption and emission principles – construction and applications of UV-visible spectrophotometer, FTIR, spectrofluorometer- flame photometer-atomic absorption and emission spectrophotometer -NMR and Mass spectrometer in Biology

Unit IV Centrifugation and Chromatographic Techniques

Principles of centrifugation— ultra centrifuge, differential centrifugation- density gradient– isopycnic- Principle, instrumentation and application of chromatography – column - gas - liquid - HPLC – ion exchange - affinity- gel filteration.

Unit V Electrophoresis & Radioactive Techniques

Principle and applications of electrophoresis – agrose - PAGE- SDS-PAGE- isoelectric focusing- radioisotopes used in Biology GMcounter, solid and liquid scintillation counters – sample preparation for radioactive counting. Autoradiography - calorimetry – bomb calorimeter, calorific value- applications.

Books for Reference

1. Palanichamy S. and M. Shanmugavelu. 1997. *Research Methods in Biological Sciences*. Palani Paramount Publication, Palani.
2. Gurumani. 2011. *Research Methodology for Biological Sciences*. M.J.P. Publishers, Chennai.
3. Veerakumari. L. 2007. *Bioinstrumentatio*n. M.J.P Publishers, Chennai.
4. Aparna Mathur. 2013. *Laboratory Instrumentation*. Black Prints. New Delhi.
5. Chinmoy Goswami, Abhijit Paintal and Rabindra Narain. 2011. *Hand Book of Bioinstrumentation.* South Anarkali Delhi.

6. Debbie Holmes Peter Moody and Diana Dine, 2006. *Research Methods for the Biosciences.* Oxford University Press, UK.
7. Rabindra Narain . 2012. *Practical Immunology*. Wisdom Press, New Delhi.

PRACTICALS
Hrs / Week - 2 **Credits - 1**

1. Fractionation of rat liver by density gradient
2. Measurement of cell size by micrometry
3. Phase contrast microscopic observation of living cells
4. Estimation of lipids (Bragdon method)
5. Absorption spectra of proteins/ pigments
6. Column chromatographic separation of plant pigments.
7. Calculation of citation index in SCI/ Scopus/ Google scholar/ICI
8. Use of different instruments in research methodology.(Spotters)
    i. Electron microscope
    ii. Spectrophotometer
    iii. Chromatography
    iv. HPLC
    v. SDS - PAGE

Books for Reference

1. Gurumani. 2011. *Research Methodology for Biological Sciences*. M.J.P. Publishers, Chennai.
2. Veerakumari. L. 2007. *Bioinstrumentation.* M.J.P. Publishers, Chennai.

Semester I			
Core III	**Bioinstrumentation and Research Methods**		
Course Code: 21PBOC13	**Hrs/week: 5**	**Hrs/Semester: 75**	**Credits: 4**

Objectives:

- To familiarize in collection of data and analysis of data for scientific solution
- To know the basic tools in research and to facilitate the students to undergo basic andapplication-oriented research
- To infuse the practical knowledge of using various scientific instruments to perform researchwork.
- To motivate the students to do research.
- To make them analyze the biological data.

Course Outcomes

CO.No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	know microscope as the basic tool for biological research.	6	Ap
CO-2	acquaint with different tools and techniques essential for research work	6	Cr
CO-3	understand the fundamentals of statistics and statistical analysis	4	Un
CO-4	do statistical analysis and communicate the results of statistical analyses accurately and effectively	4	Ap
CO-5	know and explain the importance of internet in research and gather reference materials	6	Un
CO-6	examine the basic framework of research process and able to learn how to address research problem and what is to be done to solve it.	6	An
CO-7	communicate the research findings to the scientific forums	6	Cr
CO-8	develop an understanding of the ethical dimensions of conducting applied research	7	An

Semester I			
Core III	**Bioinstrumentation and Research Methods**		
Course Code: 21PBOC13	**Hrs/week: 5**	**Hrs/Semester: 75**	**Credits: 4**

UNIT I: Microscopy: Principles, working mechanism and applications of Simple, Compound, Phase- Contrast microscopes, Electron microscopy (SEM). Principles and operations: pH meter, Electrical conductivity meters. Centrifugation: working principle and applications -differential and density gradient centrifugations; types: clinical/ low-speed, high speed, micro and analytical ultracentrifuges.

UNIT II: Chromatography: Principles, working mechanism and applications- Paper, Thin Layer, HPTLC, Column, HPLC and GC-MS. Spectrophotometry: Principles, working mechanism and applications -UV- visible, AAS, FTIR, MALDI.

UNIT III: Electrophoresis - principles, electrophoretic mobility, factors affecting electrophoresis, isoelectric focusing, types - vertical and horizontal. Agarose and polyacrylamide gel electrophoresis, detection and recovery of electrophorogram, gel documentation systems. Tracer techniques – Autoradiography, XRD.

UNIT IV: Biostatistics: Practice of statistical methods in biological research. Descriptive statistics: Measures of Central Tendency - Mean, Median and Mode. Measures of Dispersion- Standard deviation, coefficient of variation and standard error. Simple correlation and linear regression analysis. Inferential Statistics: Tests of statistical significance - Chi-square, t-tests and Analysis of Variance (ANOVA- one way &two-way).

UNIT V: Types of research, scientific research: hypothesis, experimentation,theory. Preparation of Research Article – Layout of a Research Paper, review article, online publications, thesis writing, Citation, referencing and bibliography, editorial process and proof-reading symbols. Journals in Botany-predatory, peer-reviewed, online journal, SCI journals, Web of science journals. Impact factor of Journals, Ethical issues related to publishing. Citation, google scholar, i-10, H index. Plagiarism and Self- Plagiarism. Oral presentation of research papers in conference.

Books for Reference

1. Guruamni N. *Research Methodology for Biological Sciences*, Chennai: MJP Publishers, 2006.
2. Gurumani N. *Scientific thesis writing and paper presentation*. Chennai: MJP Publishers, 2010.

3. Boyer R F. *Modern Experimental Biochemistry*. America: 3rd edn. Prentice HallPubl, 2000.
4. Kothari C.R. *Research Methodology – Methods and techniques*, New Delhi: Newage International (P) Ltd., Publishers, 2004.
5. Veerakumari L. *Bioinstrumentation*, Chennai: M.J.P. Publishers, 2015.
6. Gurumani N. *An Introduction to Biostatistics*, Chennai: 2nd edition M.J.P.Publishers, 2005.
7. Satguru Prasad. *Fundamentals of Biostatistics*, New Delhi:4th edition EmkayPublications, 2003.
8. Veera Bala Rastogi. *Fundamentals of Biostatistics*, Chennai: 2nd edition AneBooks Pvt. Ltd., 2009.

Practical: Hrs/week: 2

- Preparation of Molar, Normal, ppm, percentage and buffer solutions.
- Thin layer chromatographic separation of amino acids
- Separation of protein by PAGE
- Separation of DNA by AGE
- Digital photographic display of anatomical samples/ microscopic samples.
- Estimation of Na and K using flame photometer
- Demonstration-AAS, Fluorimeter and FTIR
- Data analysis with statistical package (SPSS& Excel) -
  mean, median,mode, standarddeviation, standard error
  student t-test, ANOVA
- Preparation of bibliography using reference tool (Zotero)
- Calculation of citation Index
- Determination of Impact Factor of Author, Article and Journal.

Books for Reference

1. Jayaraman J. *Laboratory manual in biochemistry*, New Delhi:Wiley EasternLtd.,1985.
2. Palanisamy S and Manoharan M. *Statistical methods for biologists*, Palani: IIEdition Palani paramount publishers, 1994.
3. Ponmurugan P and Gangathara Prabhu B. *Biotechniques*. Chennai: MJPpublishers, 2012.

Semester – III			
Elective III	**A. Research Methodology**		
Course Code : 21PCHE31	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Objectives:

- To provide resources to the students to stimulate basic research interest and other creative endeavours that promote entrepreneurial culture.
- To explain about various thermal and electrochemical instrumentation techniques.
- To learn about all the hyphenated techniques used for the separation of compounds.
- To interpret the results of analysis with accuracy.

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSOs addressed	CL
CO 1	select the research topic and able to survey the literature.	3	Ev
CO 2	submit the project proposals to the funding agency.	8	Ap
CO 3	explain about the principle, instrumentation and applications of TGA, DTA and DSC.	3,6	Un
CO 4	compare principle, instrumentation and applications of potentiometry, coulometry and voltammetry.	5	An
CO 5	describe different types of Atomic spectroscopy.	1,5	Un
CO 6	interpret data using TEM, SEM, XRD and EDAX techniques.	5,7	Ev
CO 7	improve the accuracy of data in chemical analysis.	5	Ev
CO 8	defend teaching methods.	6,7	Ev

Semester – III			
Elective III	**A. Research Methodology**		
Course Code : 21PCHE31	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Unit I Research methodology

Introduction of research–Selection of a research topic – Surveying the literature– Sources–primary source and secondary source – Identification of research problem – Actual investigation and analysis of experimental results – Reporting the results in the form of communication, paper – Dissertation and thesis writing– Project proposals to funding agency – Impact factor, citations and h-index –Publication and Indexing: Scopus, Web of Science and Google scholar – Concepts of IPR and Plagiarism.

Unit II Thermo and electro analytical methods

Thermoanalytical Methods –Principle, instrumentation and applications of Thermogravimetry (TGA), Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC).

Electroanalytical Techniques – Coulometry – Principle, Instrumentation and Applications. Voltammetry– Types (Stripping voltammetry, Cyclic voltammetry, Amperometry) – Principle, instrumentation and applications

Unit III Spectroscopic & Surface techniques

Principle, instrumentation and applications of Atomic Absorption Spectroscopy, Atomic Fluorescence Spectroscopy and Atomic Emission Spectroscopy.

Principle, instrumentation and applications of Energy dispersive spectroscopy (EDAX), Transmission electron microscopy (TEM), Scanning electron microscope (SEM) and Scanning Probe Microscopes.

Unit IV Data Analysis

Errors in chemical analysis – Classification of errors –Methods for determination of accuracy–Improving accuracy of analysis – Comparison between precision and accuracy – Significant figures – Mean, median, mode and standard deviation – Confidence interval – Propagation of measurement uncertainties – Comparison of results – “t” test, “f” test and “chi” square test – Rejection of results – Presentation of data – Correlation analysis and correlation coefficient – Linear regression – Related Problems.

Unit V Research and Teaching Methodology

Teaching – Objectives of Teaching - Phases of Teaching – Teaching methods: Lecture Method, Discussion Method, Discovery Learning, Inquiry, Problem Solving Method, Project method, Seminar – Integrating ICT in Teaching: Individualized Instruction, Ways for Effective Presentation with Power Point – Documentation – Evaluation: Formative, Summative & Continuous and comprehensive Evaluation – Later Adolescent – Psychology: Meaning, Physical, Cognitive, Emotional, Social and Moral Development – Teaching Later Adolescents.

Text Books

1. Gurdeep R. Chatwal, Sham K.Anand. *Instrumental Methods of Chemical Analysis.* Mumbai: Himalaya Publishing House.5th edition 2014.
2. Skoog D.A, West D.M.F, Holler J, Crouch. S.R. *Fundamentals of Analytical Chemistry.* Thomson Asia Pvt. Ltd. Eighth Edition, Third Reprint 2005.
3. Banwell C.N, *Fundamentals of molecular spectroscopy.* Noida: McGraw Hill Education, 4th Edition 1994.

Books for Reference

1. Anderson J, Durston B.H, Poole. M. *Thesis and Assignment Writing.* New Delhi: Wiley Eastern. 1986.
2. Sharma B.K. *Instrumental Methods of Chemical Analysis.* Goel Publishing House, 23rdEdition 2004.
3. Willard H, Merrit Jr. L, Dean. A. *Instrumental methods of analysis.* CBS Publishers and Distributers. 2004.
4. Rajammal P. Devadas. *A Handbook of Methodology of Research.*Chennai: S.R.K. Vidyalaya Press. 1976.
5. Dominoswki R.L. *Research Methods.* Prentice Hall. 1981.
6. Ebel H.F, Bliefert C, Russey W.E. *The Art of Scientific Writing.* Weinheim: VCH. 1988.
7. Joseph A, *Methodology for Research.* Bangalore: Theological Publications. 1986.
8. Douglas A. Skoog, James Holler F, Stanley R. Crouch. *Instrumental Analysis.* New Delhi, Cengage Learning India Private Limited. Eighth Indian Reprint 2011.
9. Asim K. Das, Mahua Das. *Fundamental Concepts of Inorganic Chemistry.* New Delhi: CBS Publishers & Distributers Pvt. Ltd. Volume 7, First Edition Reprint 2019.

4. Apte P.G .*International Financial Management.* New Delhi :Tata McGraw hill Company, 8th edition 2020

SEMESTER –III			
Core XV	**Research Methodology**		
Course Code: 21PCOC35	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits : 4**

Objective:

- To provide knowledge on research methods, techniques and process of research and develop skills in the application of research methods for business problem solving.

Course Outcomes:

CO No.	Upon completion of this course, students will be able to	PSO addressed	Cognitive Level
CO – 1	understand the research methods and steps in research process	1,2	Un
CO – 2	know the technique involved in defining a research problem	1,2,7	Un,Ap
CO – 3	identify the type of research design for different types of research work.	2,7	An
CO – 4	gain knowledge on sampling design and apply it for research	2,7,8	Un,Ap
CO – 5	understand the use of appropriate method for collection of data.	2, 3,4	An,Ap
CO – 6	process and analyze the data with appropriate statistical tools.	2,4,7	Ev,Ap
CO – 7	evaluate the result of research analysis, make suitable interpretation and use the mechanics in writing the research report.	7,8	Ev,Ap
CO – 8	understand the mechanics in writing a good research report.	7,8	Un,Ap

SEMESTER –III			
Core XV	Research Methodology		
Course Code: 21PCOC35	Hrs/Week: 4	Hrs/Sem: 60	Credits : 4

Unit I Introduction to Research **(10 Hrs)**

Introduction to Research - Meaning - Objectives - Significance - Types of Research - Steps in Research process - Meaning of research problem - Criteria for selecting the research problem - Technique involved in defining a research problem - Review of Literature: Purpose of Review .

Unit II Research Design and Sampling Design **(12 hrs)**

Research design: Meaning - Important concepts used in a research design -Contents of a research design - Types of research design.

Sampling design: Characteristics of a good sample - Criteria for selecting a sampling design - Methods of sampling.

Unit III Collection of Data **(12 Hrs)**

Collection of Data: Meaning of Primary Data and Secondary Data. Methods of Data collection: Questionnaire - Types of questions - Guidelines for designing a questionnaire - Advantages and Limitations of mailed questionnaire. Interview - Types of interviews - Advantages and Limitations of interview technique. Observation: Types of Observation - Observation tools and Recording devices - Advantages and Limitations of observation.

Unit IV Processing and Analysis of Data **(18 Hrs)**

Processing of Data- Processing Operations: Editing - Coding - Classification –Tabulation- Analysis of Data: An outline of commonly used statistical tools in research: Frequency distribution, Mean, Dispersion, Correlation, Regression, t Test, Z Test, F Test, Chi-Square Test, Factor analysis and Scaling techniques – Application of SPSS .

Unit V Interpretation and Report Writing: **(8 Hrs)**

Meaning of Interpretation - Significance of report writing - Types of reports - Steps in reportwriting- Format of a Research report - Mechanics used in writing the research report.

Text Book:

Kothari, C.R. *Research Methodology, Methods and Techniques*.New Delhi:NewAge International (P) Ltd., Publishers. 4th edition 2019

Books for Reference:

1. Krishnaswamy, O.R. and Ranganathan, M. *Methodology of Research in Social Sciences*. NewDelhi: Himalaya Publishing House. 2nd edition 2018.

2. Tripathi, P.C. *A Text Book of Research Methodology in Social Sciences*. New Delhi: Sultan Chand & Sons. Revised 6th edition 2010.

3. Gupta S.P. *Statistical methods*. New Delhi: Sultan Chand & Sons. 46th edition 2021.

SEMESTER – III			
CORE XII - RESEARCH METHODOLOGY			
Course Code : 21PCSC34	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Course Objectives:

- To achieve outstanding scientific research in various areas of knowledge.
- To encourage distinguished research work through the creation of an attractive and stimulating environment to achieve goals.

Course Outcomes:

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	demonstrate knowledge of research processes	8	An
CO-2	compare between methodologies and methods used in research work	8	An
CO-3	understand the fundamental concepts of research problem and research design	8	Un
CO-4	explain the concepts and procedures of sampling, data collection, analysis and reporting	3	Ap
CO-5	assess the basic function and working of analytical research tools used in computer science research	3	Re
CO-6	discuss different methodologies and techniques used in research work	8	An
CO-7	prepare a research report and examine the plagiarism and its types.	8	Ap
CO-8	apply the knowledge of teaching methods for its wide applicability.	8	Ap

Unit - I

Research Methodology– Introduction - Meaning of research – Objectives of research – Types of Research – Research Approaches – Significance of Research – Research Methods versus Methodology – Research and Scientific Method – Research Process - Criteria of Good Research.

Unit – II

Research Problem – Selecting the Problem – Necessity of Defining the Problem – Technique involved in defining a problem – Meaning of Research Design – Features of a good design.

Unit – III

Sampling Design - Methods of Data Collection –Research Tools: Introduction – SPSS –

MATLAB – LaTeX – NS2 – R tool - Case Study: Presentation by students on their area of research

Unit – IV

Report writing and Thesis writing – Citations – Plagiarism – Types of Plagiarism – Tools for detecting Plagiarism – Ethical Issues within the research process – Intellectual Property Rights

Unit – V

Methodology of teaching – Objectives for teaching – Structure of teaching – Phases of teaching - Various teaching methods.

Text Book:

1. Kothari, C.R. *Research Methodology: Methods and Techniques.* New Delhi, New Age International, 2nd Edition, 2012.

Reference Books:

1. Janathan Anderson, Berry H. Durston and Millicent Poole. *Thesis and Assignment Writing*. Wiley Eastern Limited, 1992.
2. EhtiramRaza Khan and Huma Anwar. *Research Methods of Computer Science.* University Science Press, 1st Edition, 2016.
3. Dr.Prabhat Pandey and Dr.Meenu Mishra Pandey. *Research Methodology: Tools and Techniques.* Bridge Center, 1st Edition, 2015.

Semester – III			
Core –XIV	**RESEARCH METHODOLOGY**		
Course Code: 21PECC 34	**Hrs/Week: 5**	**Hrs/ Semester: 75**	**Credits: 4**

Objectives:

- Research is a careful and detailed study of a particular problem or concern, using scientific methods.
- The main objective of research is to explore the unknown and unlock new possibilities.
- It helps the students to pursue further research such as M.Phil. & Ph.D.
- To make the students to know the basic concepts and methods in methodology.
- To make them learn about the use of computer in research.

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CO. No	Upon Completion of this course, students will be able to	PSO addressed	CL
CO - 1	understand a general definition of research design.	5	Le
CO - 2	know why educational research is undertaken, and the audiences that profit from research studies.	3	Kn
CO - 3	identify the overall process of designing a research study from its inception to its report.	1	Un
CO - 4	be familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research	2	Kn
CO - 5	Know the primary characteristics of quantitative research and qualitative research.	2	Le
CO - 6	identify a research problem stated in a study.	4	Kn
CO - 7	familiar with how to write a good introduction to an educational research study and the components that comprise such an introduction	6	Ap
CO - 8	distinguish a purpose statement, a research question or hypothesis, and a research objective.	4	Un

Semester – III			
Core – XIV	**RESEARCH METHODOLOGY**		
Course Code: 21PECC 34	**Hrs/Week: 5**	**Hrs/ Semester: 75**	**Credits: 4**

UNIT-I: Research Formulation and Design **15Hrs**

Motivation and objectives – Research methods vs. Methodology-Types of research – Descriptive vs. Analytical-Applied vs. Fundamental-Quantitative vs. Qualitative-Conceptual vs. Empirical-concept of applied and basic research process- criteria of good research.

UNIT-II: Collection of Data **15 Hrs**

Types of Data: Primary and Secondary data - Methods of collection of Primary Data: Direct Personal Investigation, Indirect oral investigation, Information received through local agents, key informants, correspondents and mailed questionnaire - Secondary data: Sources, Limitations of Secondary Data - Precautions in the use of Secondary Data

UNIT-III: Processing and Analysis of Data **15 Hrs**

Editing, Coding, Classification, Objects, Rules, Tabulation, Preparation of a statistical table- Requisites of a good table - Types of Tables: Format of a simple one way table and three way tables

UNIT-IV: Testing of Hypothesis **15 Hrs**

Definition of Hypothesis, Characteristics, source of Hypothesis – Formulation of Hypothesis - Importance of Hypothesis – Pre-requisites for testing of Hypothesis, testing of Hypothesis, Types of errors in testing of Hypothesis, Level of significance

UNIT-V: Report Writing **15 Hrs**

Reporting - Requirements and mechanics of Report writing -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-Research Reports-Conclusions.

Text Book:

Kothari, C.R. *Research Methodology*. New Delhi: Himalayas Publications, 2nd edition 2013.

Reference Books:

1. Cohen, M.R. and Nagal. *Introduction to Logic and Scientific methods Book-II.* Ireland:Madison Publications, 2nd edition 1934
2. Good and Halt. *Methods in Social Research.* New Delhi:S.Chand Publications,4th edition1993
3. Kurien C.T.A. *Guide to Research in Economics.*New Delhi:S.Chand Publications. 2013

Semester III			
Core XIII	**Research Methodology**		
Course Code : 21PENC33	**Hrs / Week :5**	**Hrs / Sem : 75**	**Credits : 4**

Objectives:

To acquaint students with the fundamentals and mechanics of Research Methodology
To enable students to implement appropriate and competent methods of research writing

Course Outcome:

CO. No.	Upon Completion of this course, students will be able to	PSO addressed	Cognitive Level
CO-1	define and compile the features of Research Writing	1	Un, Ap
CO-2	relate the aspects of creating documentation of a research paper	9	Ap, An
CO-3	develop the ability to identify the different forms of plagiarism and avoid them in research writing.	2, 9	Un, Ap
CO-4	practise and relate the mechanics of MLA style	1, 6	Ap, Ev
CO-5	organise the research paper coherently	8	Ap, Un
CO-6	classify the principles of documentation	9	An, Ev
CO-7	edit and proof read research articles	8,3	Ap, Un
CO-8	distinguish the overall knowledge on the techniques of documentation	6, 2	An, Ev

Semester III			
Core XIII	**Research Methodology**		
Course Code : 21PENC33	**Hrs / Week :5**	**Hrs / Sem : 75**	**Credits : 4**

Unit – I Formatting Your Research Project: (1.1 – 1.6, 1.13 – 1.16)

Margins-Text Formatting-Title-Running Head and Page Numbers-Internal Headings and Subheadings-Placement of the List of works Cited.

Unit – II Mechanics of Prose: (2.1 – 2.139)

Spelling (2.1- 3)-Punctuation (2.4 -59) Italics in Prose (2.60 - 63) Capitalization of Terms (2.64 -70) –Names of Persons in your Prose (2.71- 88) –Titles of Works in Your Prose (2.89-125) -Numbers (2.126 - 139)

Unit – III Documenting Sources: An Overview: (4.1 – 4.16)

Why Plagiarism is a Serious Matter -Avoiding Plagiarism-Careful Research- Giving Credit-When Documentation is Not Needed-Common Knowledge- Passing Mentions-Allusions-Epigraphs.

Unit – IV The List of Works Cited: (5.1 – 5.132)

Creating and Formatting Entries: An Overview -The MLA Core Elements-Author (5.3- 2) Title of Source (5.23-37) -Contributor (5.38-47) Version (5.48- 50) Number (5.51- 53) - Publisher (5.54- 67) - Publication Date (5.68- 83) Location (5.84- 99) -Ordering the List of Work Cited (5.123- 130) -Cross Reference (5.131)

Unit – V Citing Sources in the Text & Notes: (6.1 – 6. 62 & 6.78 – 7.4)

In-Text Citations (6.1-30) - Quoting and Paraphrasing Sources (6.31) -Integrating Quotations into Prose (6.32-42) -Placement of Parenthetical Citations (6.43-46) -Omitting Citations for Repeated Quotations and Terms (6.47)-Punctuation with Quotations (6.48- 53)-Capitalization with Quotations (6.54-57)-Using an Ellipsis to Mark Material Omitted from Quotations (6.58-62) -Citations in Forms Other Than Print (6.78- 82) -Notes(7.1-4)

Text Book:

MLA Hand Book Ninth Edition. The Modern Language Association of America, 2021.

Books for Reference:

1. Barzun, Jacques. *Simple and Direct: Rhetoric for Writers*. 4th ed. Harper, 2001.
2. Baskerville, R. *Risk Analysis as a source of Professional Knowledge*. Maxwell Publication, 2008.
3. *MLA Style Manual and Guide to Scholarly Publishing*. 3rd ed. MLA, 2008.
4. Smith, Charles K. *Styles and Structures: Alternative Approaches to College Writing*. Nortan, 1974.

SEMESTER III			
Core XII	Research Methodology		
Code: 21PHRC31	Hrs/Week: 5	Hrs/Sem:90	Credits: 4

Objectives:

- To impart the firm belief in the students that research is a crucial aspect for analysing business issues and also for providing sustainable solutions.
- To enable students to gain knowledge about the different tools and approaches of research methodology and habituate them to process the data meaningfully and draw relevant insights and arrive at sustainable solutions to the requirements of the organisation and business.

Course Outcome

CO No.	Course Outcome On completion of this course students will be able to	PSOs Addressed	CL
CO-1	to help students develop a thorough understanding of the fundamental theoretical ideas and logic of research.	7	Ap
CO-2	understand the objectives of research, types of research and criteria of good research.	7	Un
CO-3	demonstrate the research problem and research design.	7	Ap
CO-4	gain knowledge of sampling design and scaling techniques and demonstrate the knowledge of scaling methods.	7	Un ,Ev
CO-5	understand and decide the methods of data collection and process the data collected.	7	Un , An
CO-6	experiment with the collection, processing and interpretation of data.	7	Ap
CO-7	to train students in learning the accepted formats for writing research report.	7	An
CO-8	analyse the findings and formulate their own reports.	7	Cr

SEMESTER III			
Core XII	Research Methodology		
Code: 21PHRC31	Hrs/Week: 5	Hrs/Sem:90	Credits: 4

Unit I **Introduction to Research and Research design**

Meaning of Research – Objectives of Research – Types of Research – Research Process– Criteria of Good Research — Research Problem: Meaning- Selecting the problem –Techniques involved in defining a research problem- Review of literature-Research gap – Sources of literature.

Research Design: Meaning– Concepts relating to research design- Types of research designs: Explorative, descriptive, diagnostic and experimental designs – Challenges in research.

Unit II **Sampling Method**

Sample Design: Definition – Steps of sampling design - Types of sampling designs – Sampling Errors - Scaling: Meaning- Goodness of Measurement scales- Scaling Techniques- Comparative: Paired Comparison, Rank Order, Constant sum and Non-comparative – Graphic rating. Itemized rating (Likert, Semantic, Stapel), Single/ multiple category scale, verbal frequency scale, Multidimensional scale.

Unit III **Data Collection**

Data Collection: Primary Methods- Observation, Interview, Questionnaire, Schedule – Difference between questionnaire and schedule- Guidelines for constructing questionnaire –Projective techniques - Collection of Secondary Data – Selection of appropriate method for data collection- Case study method - Data preparation Process – Problems in preparation process.

Unit IV **Data Analytics**

Measures of Central Tendency Model – Multiple Correlation Model – Simple and Multiple regression Model – Time series model- Extraction of Charts – Basics of SPSS.

Unit V **Interpretation and Report Writing**

Interpretation: Meaning- Techniques- Precautions. Report Writing – Steps in report writing- Layout of the research report- Types of reports - Mechanics of writing a research report- Oral presentation- Precautions for writing research reports.

Text Book:

1. Kothari. C.R. *Research Methodology*. New Delhi; Vikas Publishing Ltd,2004.

Books for Reference:

1. Gupta S.C and Kapoor.V.K. *Fundamentals of Applied Statistics Sultan*. New Delhi; Chand & Sons, 2006.
2. William Josiah Goode and Paul K. Hatt.*Methods of Social Research*.New Delhi;

Semester III			
Core XIV	**Research Methodology**		
Course Code: 21PMAC35	**Hrs/ week: 4**	**Hrs/Semester: 60**	**Credits: 4**

Course Objectives

- To contribute to the development of the new statistical methodology to address substantive problems and to promote the use of these methods through publications.
- To identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design and implementing a research projects.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	use Mathematical and Statistical techniques for research.	5,8	Ap
CO-2	acquire basic knowledge about various instruments and techniques in Mathematical research.	5,1	Un
CO-3	acquire knowledge in research publication and thesis writing.	5	Un
CO-4	understand the basic aspects in research.	5	Un
CO-5	practice and improve the research presentation skills with latest tools.	5	Re
CO-6	organize and conduct research in a more appropriate manner.	5	Cr
CO-7	identify appropriate research topics.	5	Ap
CO-8	select and define appropriate research problems and parameters.	5	Re

Semester III			
Core XIV	**Research Methodology**		
Course Code: 21PMAC35	**Hrs/ week: 4**	**Hrs/Semester: 60**	**Credits: 4**

Unit I

An Introduction: Meaning of Research- Objectives of Research- Motivation of Research- Types of Research- Research approaches- Significance of Research- Research methods versus Methodology- Research and scientific method.

(**Text Book: 1, Chapter: 1, pages 1-9)**

Unit II

Importance of knowing how research is done - Research Process - Criteria of Good Research.

(**Text Book: 1, Chapter: 1, pages 10-20)**

Unit III

Planning the Thesis: Selecting a topic-Reviewing the literature-Designing the study-The chapter outline. Writing the Thesis: The preliminaries - The text-The reference material-The abstract - The final product-Chapter divisions and subdivisions – Spacing – Pagination - Margins- Paragraph indentation-Sample pages.

(Text Book: 2, Chapter: 3, 5)

Unit IV

Revising the Thesis: Editing the final draft-Evaluating the final draft - Proof reading the final typed copy - Plagiarism - What is Plagiarism - Types of Plagiarism- Glossary – preventing plagiarism when writing.

(Text Book: 2, Chapter: 6, 12, http://www.plagiarism.org/plagiarism-101/what-is-plagiarism/

Unit V

Writing language of theorem: Introduction and Motivation - Mathematical style - Terminology and notation (especially in discrete mathematics) - English usage in mathematical writing.

(Text Book: 3, Pages 1-31)

Text Books

1. C.R. Kothari. *Research Methodology*, New Age International (P) Limited, Publishers, Second Revised Edition, 2009.
2. Janathan Anderson, Berry H. Durston& Millicent Poole. *Thesis and assignment Writing.* Wiley Eastern limited, Eleventh Reprint, 1991.
3. Douglas B. West *The Grammar According to West.*

Book for Reference

1. Leonie Elphinstone and Robert Schweitzer. *How to get a research degree* . A Surival Guide, Allen and Unwin Publication, 1998.

SEMESTER –III			
Core – XII Research Methodology			
Course Code : 21PMIC34	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Objectives:

1. To impart advanced level information in the subject of Research methodology.
2. To show various biological techniques used in research, and study about research project, paper presentation and article publication.

Course Outcome:

CO No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	Analyse the laboratory equipment's	2	An
CO-2	Evaluate the rights granted by IPR	6	Ev
CO-3	determine the process involved in centrifugation and chromatography techniques	6	Ev
CO-4	Examine electrophoresis techniques	6	An
CO-5	Apply research methods in biological science.	1	Ap
CO-6	Estimate project writing method and to estimate Data's used in projects.	1	Ev
CO-7	Identify the journals to publish articles	1	AP
CO-8	Design article to present on seminar and the conference	5	Cr

SEMESTER –III			
Core – XII Research Methodology			
Course Code : 21PMIC34	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Unit – I: Isolation, Fractionation and Separation

Isolation, Fractionation and Separation of cellular constituents – Isolation of chloroplasts, mitochondria and nucleic acids – homogenization –Manual, mechanical and sonication –centrifugation-centrifuges and their uses- Micro centrifuge, high speed refrigerated centrifuges, ultra centrifuges, differential and density gradient centrifugation – Chromatography –paper, thin layer-separation of amino acids and sugars-Gas liquid chromatography, HPLC and HPTLC.

Unit – II: Separation and estimation of macromolecules and other compounds

Electrophoresis –principles, factors affecting electrophoretic mobility – Agarose Gel Electrophoresis, PAGE, SDS-PAGE and Starch gel electrophoresis. Spectroscopic techniques – principles, mechanism and applications of UV –visible, Flame photometer and AAS - Estimation of cellular constituents- Sugars, amino acids and proteins.

Unit – III: Research and Project writing methods, Article publication

Research-definition, objectives, types and importance - Research methods in biological sciences - Research process- Literature survey – sources –scientific databases- Research report writing – Parts of Thesis and Dissertation – Presentation in seminars and conferences – Writing scientific paper – Organization of scientific paper – Importance of title – Publication in research journals – Standards of Research journals- Peer – review – impact factor – citation index – Preparation of manuscript – Proof correction – proof correction marks- method of correcting proof- Writing chapters in books – Preparation of Research proposal and funding agencies – Research fellowships.

Unit – IV: Biostatistics

Basic definitions and applications of biostatistics – Population, Sample, Data, variable, sampling. Data Collection and presentation – Types of data - methods of collection of primary and secondary data - methods of data presentation – Graphical presentation. Measures of central tendency: Mean, Median, Mode. Correlation – Positive and Negative correlation and calculation of Karl Pearson's coefficient of correlation. Regression – Linear regression and multiple linear regression - regression equation. ANOVA, one way and two way classification.

Unit – V:IPR

Introduction to Intellectual property rights, copyright, related rights, trademarks, geographical indication, industrial design, patents and protection of new varieties of plants.

Textbooks:

1. Veerakumari L. *Bioinstrumentation*. Chennai: MJP Publishers. 2006.
2. Gurumani N. *Scientific thesis writing and Paper presentation*. Chennai: MJP Publishers. 2010.

Books for Reference:

1. Dr. Simmi Kharb. *Scientific Writing and Project management in Biotechnology*. NewDelhi: University Science Press. 2009.
2. 4 Gurumani. N. *Research Methodology for Biological Sciences*. Chennai: MJP Publishers. 2006.
3. Vijayalakshmi Ponnuraj. G. and C. Sivapragasam. *Research Methods (Tips and Techniques)*. Chennai: MJP Publishers. 2008.

SEMESTER - I			
ELECTIVE -I	**B. RESEARCH METHODOLOGY**		
Code : 21PPHE12	**Hrs/Week: 6**	**Hrs/Semester:90**	**Credits: 4**

Objectives:

- Enable the students to understand research problem and research design
- Enable the students to understand the steps behind research paper writing

Course Outcomes:

CO No.	Upon completion of this course, students will be able to	PSOs addressed	CL
CO 1	List the types of research depending on the approaches	1	Re
CO 2	Explain the criteria of a good research	6	Un
CO 3	Examine the selection process of the problem based on necessity.	4	An
CO 4	Recall the features of good research	4	Re
CO 5	Apply secondary data methods of collecting primary data	6	Ap
CO 6	Grade the formulation of the selected problem	4	Ev
CO 7	Identify the meaning of interpretation techniques	4	An
CO 8	Predict the types of reports based on the research mechanism	6	Cr

SEMESTER - I			
ELECTIVE -I (B) RESEARCH METHODOLOGY			
Code : 21PPHE12	Hrs/Week: 6	Hrs/Semester:90	Credits: 4

UNIT I: An Introduction to Research Methodology

Meaning of research-Objectives-Types of research- Research Approaches-Significance-Research methods versus methodology- Research and scientific method- Importance of knowing how research is done- Research process- Criteria of good research- Problems encountered by researchers in India.

UNIT II: Defining the Research Problem and Research design

Research problem- Selecting the problem- Necessity of defining a problem-Technique involved in defining a problem- Meaning of research design- Need- Features of good Design-Important Concepts-Basic principles of experimental designs.

UNIT III: Plagiarism

Plagiarism - Forms of plagiarism - Unintentional plagiarism - Examples of plagiarism - Consequences - How to avoid plagiarism - Being aware of and identifying different types of plagiarism - Things you can do to avoid plagiarism - Types of plagiarism - Online plagiarism - Web of science - h-index - Scopus.

UNIT IV: Review of literature

Need for reviewing literature- What to review and for what purpose - Literature search procedure- Sources of literature- Planning the review work – Note taking – The planning process- Selection of a problem for research- Formulation of selected problem.

UNIT V: Interpretation and report writing

Meaning of interpretation- Technique- Precaution- Significance- Different steps- Layout of research reports - Types of reports- Oral presentation- Mechanics of writing a research report- Precautions for writing a research report.

Text Books:

1. Kothari C R and Gaurav Garg. *Research methodology methods and techniques.* Delhi: New age international. 3rd Edition 2014.
2. Krishna swamy O R, Ranganatham M. *Methodology of research in social studies.* Mumbai*:* Himalaya Publishing House. 2nd Edition 2011.
3. https://www.ox.ac.uk/students/academic/guidance/skills/plagiarism (Plagiarism)
4. https://www.scanmyessay.com/plagiarism/consequences-of-plagiarism.php (Consequences)
5. https://www.scanmyessay.com/plagiarism/types-of-plagiarism.php (Types of plagiarism)
6. https://www.scanmyessay.com/plagiarism/how-to-avoid-plagiarism.php (How to avoid plagiarism)
7. https://www.scanmyessay.com/plagiarism/online-factors.php (Online plagiarism)
8. https://en.m.wikipedia.org/wiki/Web_of_Science (Web of science)
9. https://en.m.wikipedia.org/wiki/H-index (h-index)
10. https://en.m.wikipedia.org/wiki/Scopus (Scopus)

Books for Reference:

1. Gupta S P. *Statistical methods. New Delhi:* Sultan Chand & Sons. 40th Edition. 2011.
2. Saravanavel P. *Research Methodology.* Jaipur: Kitab Mahal. Reprint, 16th Edition 2010.

SEMESTER II			
Core VIII Research Methodology			
Code: 21PPSC24	**Hrs/Week:4**	**Hrs/ Sem: 60**	**Credit: 4**

Vision: To impart the knowledge of Research methodology

Mission: To sow the seeds of proper research in the minds of the students

Course Outcomes:

CO No	Upon completion of this course, the person will be able to	PSO Addressed	CL
CO 1	learn the basic concepts of research methods	1,4	Re
CO 2	gain knowledge about the various methods of doing research in Psychology	1,4,5	Re, Un
CO 3	analyze the various steps in research methodology	4	An
CO 4	create new methods of research designs	4,5	Un, Cr
CO 5	learn the skills of doing research in Psychology	1,5	Un
CO 6	understand and analyze various research methods	1,5	Un, An
CO 7	gain knowledge on the means of improving research skills	4,5	Un, Ev
CO 8	create new research techniques	4	Cr

Unit I – Introduction

Meaning – Objectives – Types – Research methods vs Methodology – Significance of research - Thinking like a researcher – Criteria for good research – Scientific approach to research – Problems encountered by researchers – Ethical issues

Unit II – Research design, measurement and scaling

Research design: Meaning – Need – Features – Important concepts related to research design – Types

Measurement and scaling: Qualitative and quantitative data – Measurement scales – Central tendency, dispersion – Hypothesis testing - Sources of error in measurement – Techniques of developing measurement tools – Scaling.

Unit III - Descriptive and Experimental methods

Descriptive methods: Observation – Definition – Methods – Recording behaviour – Analysis – Survey – Uses – Characteristics – Types – Sampling in survey research – Sampling research designs – Questionnaires

Experimental methods: Meaning – Independent group designs - Types – Analysis and interpretation – Establishing external validity – Repeated measures design – Purpose

Unit IV- Analysis and interpretation

Computer assisted data analysis – Parametric and non parametric measures of analysis – Analysis of variance – Regression analysis - Other multivariate techniques

Unit V – Report writing and communication in Psychology

Report writing: Significance of report writing – Steps – Layout – Types – Oral presentation – Mechanics of writing a research report – Precautions

Communication: Internet and research – Guidelines for effective writing

Text books:

1. Kothari C.R., Garg G., Research methodology – Methods and techniques III Edition (2018) New age International Publishers, London

Reference book:

1. Shaughnessy J., Zechmeister E., Zechmeister J., *Research methods in Psychology* IX Edition (2012) Mc Graw Hill Publications, New York.
2. Kerlinger, F. N. (2000). *Foundations of behaviour research*, (5THed).New York: Reinhart Publishers.
3. McBurney, D. H. (2001). *Research Methods*.(5thed). US: Wadsworth.
4. Khan, J.A. (2011). *Research Methodology*. New Delhi: APH Publishing
5. Gravetter (2015), *Research Methods for the Behavioral Sciences*, 5th Edition, Wadsworth, 2015.

SEMESTER III			
Core XII	**Research Methodology and Biotechniques**		
Course Code : 21PZOC34	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Objectives

- To make students familiar with various research methods that are obligatory to do quality research in future.
- To equip the students with the knowledge of scientific paper writing
- To prepare the students to utilize the biological techniques in their research

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	demonstrate critical thinking and scientific approach in the design and implementation of an experiment.	7	Un, Ap
CO-2	develop skills to communicate scientific ideas in both written and oral formats	7	Ap
CO-3	apply a range of qualitative and quantitative research techniques to the scientific issues.	4	Ap
CO-4	identify a working comprehension of the technical and procedural aspects of laboratory testing, safety and ethical standards of practices	6	Ap
CO-5	list different methodologies to be adopted for conducting research in more appropriate manner.	6	An
CO-6	choose new scientific tools, concepts and theories to understand and solve scientific problems.	6	Ev
CO-7	develop a broad range of laboratory skills to perform experiments for employment prospects.	7	Cr
CO-8	design and conduct independent laboratory or field research that is consistent with the highest standards and practices of research	8	Cr

Unit I Research Designing

Introduction - literature collection – sources - Internet and e-journals - literature citation - experimental design - thesis formatting and typing - manuscript preparation, interpretation and report writing and Plagiarism.

Unit II Research Publication & Ethics

IPR: Patent, Copy right, H-index, I-10 index, Ethical Committee, Laboratory safety measures. Calculation of citation index in SCI/ Scopus/ Google scholar/ ICI.

Unit III Microscopy Types

Principle, construction and applications of Phase contrast – Polarization – Electron microscope – types (SEM, TEM) - fixation and staining techniques for EM (Positive and Negative staining, Metal shadowing and Freeze fracture), fluorescence – atomic force and magnetic force microscope – micrometry.

Unit IV Spectroscopic Techniques

Absorption and emission principles – construction and applications of spectrophotometer – UV - visible spectrophotometer, FTIR, spectrofluorimeter - flame photometer - atomic absorption and emission spectrophotometer, ESR and NMR.

Unit V Principles and Applications of Biotechniques

Centrifuge – types: ultra, cooling and density gradient centrifuge, column chromatography, electrophoresis: SDS-PAGE, isoelectric focusing, GM counter – sample preparation for radioactive counting – biochemical application of radioisotopes - autoradiography.

Books for Reference

1. Palanichamy S. and M. Shanmugavelu. *Research Methods in Biological Sciences*. Palani : Palani Paramount Publication.1997.
2. Gurumani. *Research Methodology for Biological Sciences*. Chennai: M.J.P. Publishers. 2011.

3. Veerakumari. L. *Bioinstrumentatio*n. Chennai: M.J.P Publishers. 2007.
4. Aparna Mathur. *Laboratory Instrumentation*. New Delhi: Black Prints. 2013.
5. Chinmoy Goswami, Abhijit Paintal and Rabindra Narain. *Hand Book of Bioinstrumentation.* Delhi: South Anarkali. 2011.
6. Debbie Holmes Peter Moody and Diana Dine. *Research Methods for the Biosciences.* U.K. Oxford University Press. 2006.
7. Rabindra Narain. *Practical Immunology*. New Delhi: Wisdom Press. 2012.

PRACTICALS

Course Code: 21PZOCR6

Hrs/ Week : 2 **Credit : 1**

1. Fractionation of fish liver by density gradient centrifugation
2. Measurement of cell size by micrometry
3. Phase contrast microscopic observation of living cells
4. Estimation of lipids (Bragdon method)
5. Absorption spectra of proteins/ pigments
6. Column chromatographic separation of plant pigments.
7. Checking plagiarism by URKUND (online Demo).
8. Use of different instruments in research methodology (Spotters)
    a. Electronmicroscope
    b. Chromatography – HPLC
    c. SDS-PAGE
    d. G.M Counter

Books for Reference

1. Gurumani. R*esearch Methodology for Biological Sciences*. Chennai: M.J.P. Publishers. 2011.
2. Veerakumari. L. *Bioinstrumentation.* Chennai: M.J.P. Publishers. 2007.

SEMESTER -III			
Core Practical VI - Laboratory in Food and Dairy Microbiology, Research Methodology			
Course Code: 21PMICR6	**Hrs/Week:6**	**Hrs/Sem:90**	**Credits:4**

Objectives:

To impart advanced level practical training in food, dairy Microbiology and Research Methodology and to make the students skilled in the field of food, dairy Microbiology and Research Methodology.

Course Outcome:

CO NO	Upon completion of this course, students will be able to	PSO Addressed	CL
CO -1	interpret the viable count of bacteria	1	Ev
CO -2	assess the quantitative analysis of milk	3	Un
CO- 3	outline the microbial examination of milk test	4	Un
CO- 4	examine isolation of detection and determination of coliforms, faecal coliforms and E.*coli* in food & beverages.	5	An
CO- 5	Examine isolation of detection & confirmation of *Salmonella ,Shigella*,V*ibrio* species in food.	3	An
CO -6	Assess the isolation of microbial examination of canned foods.	3	Un
CO -7	Evaluate agarose gel electrophoresis of DNA	3	Ev
CO -8	Evaluate P^H meter, spectrophotometer	3	Ev

SEMESTER-III			
Core Practical VI - Laboratory in Food and Dairy Microbiology, Research Methodology			
Course Code: 21PMICR6	**Hrs/Week:6**	**Hrs/Sem:90**	**Credits:4**

1. Viable count of bacteria in milk.
2. Phosphatase test.
3. Microbial examination of milk by Methylene blue test
4. Microbial examination of milk by Resazurin test
5. Quantitative analysis of Milk by standard plate count method.
6. Detection of mastitis and isolation of microorganisms through the infected milk.
7. Isolation of lipolytic organism from butter.
8. Detection and determination of coliforms in food &beverages.
9. Detection and determination of faecal coliforms in food &beverages.
10. Detection and determination of *E.coli* in food &beverages.
11. Detection & confirmation of *Salmonella* species in food.
12. Detection & confirmation of *Shigella* species in food.
13. Detection & confirmation of pathogenic *Vibrio* in food.
14. Estimation of molds & yeast from fruit juice.
15. Microbial examination of canned foods.
16. Preparation of buffer and determination of pH using pH meter.
17. Verification of Beer-Lambert's Law using Spectrophotometer.
18. Agarose gel electrophoresis of DNA.
19. PCR-Demonstration.
20. Visit to food and dairy industry.

Books for Reference:

1. J.G. Cappuccino and N.Sherman. *Microbiology* – A lab manual. NewYork: Benjamin Cummins. 1996.
2. Kannan, N. *Laboratory Manual in General Microbiology*. Palani: Palani Paramount Publication, 1996.
3. Jayaraman, J. *Laboratory Manual in Biochemistry.* New Delhi: Wiley Eastern Ltd., 1985.
4. Plummer, D.T. *An Introduction to Practical Biochemistry.* New Delhi: Tata McGraw-Hill.. 1998.
5. Harley Precott. *Laboratory Exercises in Microbiology* The MacGraw Hill companies. 5 thedition. 2002.