(COMMON TO ALL ENGINEERING & TECHNOLOGY STREAMS)

COURSE CODE	COURSE TITLE	L	T	P	C
40210GE101	**RESEARCH METHODOLOGY**	**3**	**1**	**0**	**4**

Course Category: Foundation Course

a.   Preamble:

Today research is of immense importance in every field of life. Hence students need sound initiation in the world of research. Thus this syllabus is prepared to equip students with the basics of research methodology and also provide them acquaintance with the main ingredients of collection of data, analysis of data, quantitative methods, optimization IPR and report writing.

b.   Prerequisite Courses:

This course has no prerequisites

c.   Related Courses:

Research and Publication Ethics.

d.   Course educational objectives:

To impart knowledge and skills required for research:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Be able to read and interpret statistical information
- Know the basics of different evolutionary algorithms.
- Patent drafting and filing patents.

e.   Course Outcomes:

Upon the successful completion of the course, scholar will be able to:

CO Nos.	Course Outcomes	Knowledge level (Based on revised Bloom's Taxonomy)
CO1	Formulate the research problem through fundamentals of research and literature review.	K3
CO2	Identify and apply research design principles and make use of data collection and analysis techniques.	K3
CO3	Apply quantitative methods to solve research problem.	K3
CO4	Analyze the optimization techniques in solving the real problem.	K3
CO5	Interpret the research problem into registering IPR and filing patents.	K2

f. Course Content

UNIT I – INTRODUCTION AND RESEARCH FORMULATION   L-9 + T-2

Introduction to Research: Definitions and Characteristics of Research, 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.

Defining and Formulating the Research Problem: Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem.

Literature Review: Objectives of Review of Literature, Importance of Literature Review in Defining a Problem, Primary and Secondary Sources, Reviews, Treatise, Monographs, Patents, Web as a Source, Searching in the Web, Critical Literature Review, Identifying Gap Areas from Literature Review and Research Database, Development of Working Hypothesis.

UNIT II – RESEARCH DESIGN, DATA COLLECTION AND ANALYSIS   L-9 + T-4

Research Design: Basic Principles, Need of Research Design, Features of Good Design, Different Research Designs, Experimental Designs, Research Databases, Development of Models, Developing a Research Plan, Exploration, Description, Diagnosis, and Experimentation.

Data Collection and Analysis: Primary and Secondary Data, Methods of Data Collection, Sampling Methods, Data Processing and Analysis Strategies and Tools, Data Analysis with Statistical Packages (Sigma STAT, SPSS for Student's t-test), Testing of Hypothesis (Student's t-test), ANOVA Technique.

UNIT III – QUANTITATIVE METHODS FOR PROBLEM SOLVING   L-9 + T-3

Basic Statistical Distributions and their Applications (No Derivations): Binomial, Poisson, Normal and their Applications in Research Studies. Fundamentals of Statistical Analysis and Inference, Multivariate methods, Concepts of Correlation and Regression Analysis, Fundamentals of Time Series Analysis and Spectral Analysis.

UNIT IV – OPTIMIZATION TECHNIQUES IN SOFT COMPUTING   L-9 + T-4

Optimization Definition, Need and Application, Formulation of Optimization Problems. Introduction to Evolutionary Algorithms, Fundamentals of Genetic Algorithms, Particle Swarm Optimization, Simulated Annealing, Introduction to Neural Networks, Neural Network Based Optimization, Introduction to Fuzzy Sets and Fuzzy Logic, Optimization of Fuzzy Logic.

UNIT V – IPR AND REPORT WRITING   L-9 + T-2

IPR: Intellectual Property Rights and Patent Law, Commercialization, Copy Right, Royalty, Trade Related aspects of Intellectual Property Rights (TRIPS).

Report Writing: Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Oral Presentation, Design of Research Paper, Citation, Plagiarism, Basic Knowledge of funding agencies, Proposal Submission for Funding Agencies.

Total: 60 Hours

g.   **Learning Resources**

i.   **Reference Books:**

1. C.R. Kothari and Gaurav Garg, "Research Methodology: Methods and Techniques", New Age International (P) Ltd., Publishers, Fourth Multi Colour Edition, 2020.
2. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical statistics, Sultan Chand & Sons, New Delhi, 12th Revised Edition, 2020.
3. Lawrence M. Leemis, Mathematical Statistics, Ascended Ideas, UK, 2020.
4. Paolo Brandimarte, Quantitative Methods: An Introduction for Business Management, John Wiley & Sons, 2011.
5. Sukanta Nayak, Fundamentals of Optimization Techniques with Algorithms, Academic Press, 2020.
6. Priya Rai, R.K. Sharma, P.K. Jain and Akash Singh, Transforming Dimension of IPR Challenges for New Age Libraries, National Law University Delhi Press, 2015.
7. Dr P M Bulakh, Dr P. S. Patki and Dr A S Chodhary, Research Methodology, Expert Trading Corporation Dahisar West, Mumbai, 2010.
8. Fink, A., Conducting Research Literature Reviews: From the Internet to Paper, Sage Publications, 5th edition, 2009.
9. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, An introduction to Research Methodology, RBSA Publishers, U.K., 2002.
10. Douglas C. Montgomery and George C. Runger. Applied Statistics and Probability for Engineers, 5th edition, John Wiley and Sons, Inc., New York, 2011.
11. Singiresu S. Rao, Engineering Optimization: Theory And Practice, New Age International Publishers, 5th edition 2020.
12. Panneerselvam, R. Research Methodology, PHI Publications, Second edition, 2014.
13. Jeannette Lawrence, Introduction to Neural Networks: Design, Theory, and Applications, California Scientific Software, sixth edition, 1994.
14. Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley publications, 4th Edition, 2016.

ii.   **Online resources:**

1. https://www.soas.ac.uk/cedep-demos/000_P506_RM_3736-Demo/module/pdfs/p506_unit_01.pdf
2. https://repository.up.ac.za/bitstream/handle/2263/27704/01chapter1.pdf?sequence=2&isAllowed=y
3. http://egyankosh.ac.in/bitstream/123456789/41939/1/Unit-4.pdf
4. https://www.formpl.us/blog/data-collection-method
5. https://www.questionpro.com/blog/data-collection/
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4485510/
7. https://www.questionpro.com/blog/quantitative-research/
8. https://hls.harvard.edu/content/uploads/2011/12/quantitative_methods.pdf
9. https://libguides.usc.edu/writingguide/quantitative
10. https://mech.iitm.ac.in/nspch52.pdf
11. https://www.kdd.org/kdd2016/topics/view/optimization-techniques
12. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3217699/
13. https://iare.ac.in/sites/default/files/M.Tech-RM%20%26%20IPR%20%28ECE%29%20PPTS.pdf