COURSE TYPE	COURSE CODE	NAME OF THE COURSE	L	T	P	CREDIT
DC	NFMC595	Research Methodology	3	0	0	3

PREREQUISITE: NONE

COURSE OBJECTIVE
This course aims to equip students with the knowledge to identify, formulate and pursue a research program with preliminary exposure to data analysis.
LEARNING OUTCOMES
At the end of this course, students will be able to • Perform research work thoroughly and systematically • Carry out data analysis • Document and deliver a presentation on their research

NO.	TOPICS TO BE COVERED	HOURS	LEARNING OUTCOME
1	**Research:** Objectives and motivation, Chronological development of research	2	Understanding of the basics of research
2	**Introduction to research for Engineers:** What is Research, Specific Approaches and their applicability, Basic modes of approaching research, Research Methods vs methodology, Significance of research, how to use Scopus, Science Direct, web of science etc., Use of reference management software.	4	Understanding of the fundamentals of engineering research
3	**Research Formulation:** Identifying a problem of practical merit, Necessity of defining a problem, identifying suitable research advisor/guide, Literature review, Critical analysis of a research paper, Documentation of research proposal with possible outcomes, Common issues encountered in engineering research	5	Knowledge of the methods for research formulation
4	**Research Methodology:** Sampling, Design of experiments for a specific objective, Instrumentation and techniques for analysis, Conducting experiments, Characterization, Data Collection.	6	Knowledge of the methodology of research
5	**Statistics:** Univariate (frequency tables, bar charts, pie charts, percentages), Bivariate (Cross tabulations and Chi-square test including the testing hypothesis of association), Multivariate analysis using regression techniques. Measures	10	Familiarization with data analysis techniques

	of central tendency and dispersion. Data visualization techniques. Estimation (e.g., confidence intervals). Hypothesis testing (e.g., one-sample, two-sample tests). ANOVA. Non-parametric methods.		
6	**Data Analysis:** Model diagnostics and validation.Numerical methods, Error Analysis.Data reconciliation. Mass balance and energy balance for data reconciliation. Statistical methods for data reconciliation. Introduction to ANN.	9	Understanding of the data analysis techniques required for research
7	**Documentation and Presentation:** Report and Synopsis writing, Paper Writing, Thesis writing (Elements of English style, reference and referencing tools), Presenting research (Data visualization and presentation in 2 and 3-D, flowsheet drawing), Plagiarism.	3	Knowledge of the research documentation and presentation techniques
8	**Research Ethics and IPR:** Ethics in Engineering Research, Intellectual Property Rights, Codes and Standards, Patent, trademark and copyright	2	Knowledge of the ethics and IPR in research
9	**Future research:** A glimpse into the future of engineering research	1	Information about the future of engineering research
	Total	**42**	

TEXT BOOKS:

1. Research Methodology by C.R. Kothari, New Age International

REFERENCE BOOKS:

1. Research Methods for Engineers by David Thiel, Cambridge University Press
2. The Elements of Style by William Strunk, Jr, SWB Books
3. Ethics in engineering practice and research by Caroline Whitbeck, Cambridge University Press
4. Statistical Methods for Engineers by Geoffrey Vining, Scott Kowalski, Cengage Learning
5. Applied Predictive Modeling by Max Kuhn, Kjell Johnson, Springer
6. Process Data Reconciliation and Gross Error Detection: An Intelligent Use of Process Data by Shankar Narasimhan, Cornelius Jordache, CRC Press

Neural Networks and Deep Learning by Michael Nielsen, Determination Press