Mandatory GE Courses to grant minor status in UG programmes: Electronics

Prog.	Level 100	Level 200	Level 300	Remarks
Electronics	• GE 1: .Fundamentals of Electronics (Semester 1/2) • GE 2: Data Engineering and Analytics (Semester 1/2) • GE 3: Digital System Design (Semester 1/2) • GE 4: Data Visualization Techniques (Semester 1/2)	• **GE 5: Instrumentation (Semester 3/4/5/6)** • **GE 6: Electronic Circuits and Interfacing (Semester 3/4/5/6)** • GE 7: Fundamentals of 8085 Microprocessor (Semester 3/4/5/6) • GE 8: Microcontroller Systems(Semester 3/4/5/6) • GE 9: Arduino/ Rpi App Development (2:2) (Semester 3/4/5/6) • GE 10: Modelling and Simulation (Semester 3/4/5/6) • GE 11: Mobile Application Development (1:3) (Semester 3/4/5/6) • GE 12:Signals and Systems (Semester 3/4/5/6) • GE 13: Artificial Intelligence and Machine Learning (Semester 3/4/5/6)	• **GE 14: Communication Systems (Semester 5/6/7/8)** • GE 15: Semiconductor Devices and their applications(Semester 5/6/7/8) • GE 16: Embedded System (Semester 5/6/7/8) • GE 17: Digital System Design using VHDL /Verilog (Semester 5/6/7/8) • GE 18: VLSI: Technology and Design (Semester 5/6/7/8) • GE 19: Digital Signal Processing (Semester 5/6/7/8) • GE 20: Process Control Systems (Semester 5/6/7/8) • GE 21: Internet of Things (Semester 5/6/7/8) • GE 22: Neural Networks (Semester 5/6/7/8) • GE 23: Robotics (Semester 5/6/7/8) • GE 24: Nanoelectronics (Semester 5/6/7/8)	Following GEs are **mandatory** papers for minor in Electronics discipline: **GE 5: Instrumentation** **GE 6: Electronic Circuits and Interfacing** **GE 14: Communication Systems**

DISCIPLINE SPECIFIC ELECTIVE COURSE: Research Methodology (ELDSE6C)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Research Methodology (ELDSE6C)	04	03	-	01	Course admission eligibility	Basic Statistics

Learning Objectives
The Learning Objectives of this course are as follows:
• To understand some basic concepts of research and its methodologies
• To select and define appropriate research problem and parameters
• To write a research report and thesis

Learning outcomes
The Learning Outcomes of this course are as follows:
● Acquire the basic knowledge of different types of research
● Understand various components of Research design
● Learn various paradigms in preparing a good quality research proposal/paper
● Learn various mathematical tools required for data collection and analysis as well as modelling and simulation

SYLLABUS OF DSE
Unit -1 (10 hours)
Introduction: Meaning, objectives and motivations in research, Characteristics and limitations of research – Components of research work - Criteria of good research, Research process – Types of Research, Fundamental, Pure or Theoretical Research – Applied Research –Descriptive Research – Evaluation Research –Experimental Research –Survey Research – Qualitative Research – Quantitative Research – Historical Research.

Unit – 2 (12 hours)
Research Design – definition – essentials and types of research design – errors and types of errors in research design. Research problem: Selecting and analyzing the research problem – problem statement formulation – formulation of hypothesis.

Literature review: purpose, sources, and importance - literature review procedure. Objectives: Learning Objectives; Definitions; Formulation of the research objectives. Validation: Identify problem and experimental/theoretical data for comparison with your model, learn how to extrapolate/scale data for validation with acceptable level of error and justification

Unit -3 (11 hours)

Tools and Techniques: Various tools for literature survey-Searching journals, metrics of Journals, e book, monograph, patents, Citations, Intellectual Property Rights., Reference Management Software like Zotero/Mendeley/others, Software for paper formatting like LaTeX/MS Office/others, Layout of a research paper, Software for presentation like MS Power point/Canva/ Others , Open Access publication, Ethical issues related to publishing, Plagiarism and Self-Plagiarism, Software for detection of Plagiarism
Mathematical tools in Electronics: Error estimation in instruments using descriptive statistics, combined errors

Unit - 4 (12 hours)

Data Collection methods – primary and secondary data , Secondary data like XRD/UV-Vis/FTIR/Raman/Others plotting and analysis using Origin/Ms Excel/other software
Curve Fitting Techniques: Interpolation, linear regression, higher order polynomial form, exponential form using Origin/Ms Excel/other software
Modelling Techniques: Monte Carlo Method for static System, Discrete and continuous Markov Models.
Simulation Techniques: Differential Equation System Specification DESS, Discrete Event System Specification DEVS, Discrete Time System Specification DTSS.

Practical component: (30 hours)
Use latest software package for data plotting and analysis, curve fitting, modelling and simulation, paper writing, presentation, referencing, plagiarism check etc. based on:

1. Error Estimation Problems using Descriptive Statistics
2. Secondary data plotting and analysis problems
3. Curve fitting using different techniques
4. Modelling and Simulation model implementation
5. Review writing of one book/research paper.

Essential/recommended readings

1. Ranjit Kumar, Research Methodology, A step by step guide for beginners, SAGE Publications (2015)
2. D. C. Montgomery, Introduction to Statistical Quality Control, 8th edition, John Wiley and sons (2019).
3. Business Research Methods – Donald Cooper & Pamela Schindler, TMH, 9th edition
4. C.R Kothari, Research Methodology: Methods and Techniques, New Age International Publishers (2015)
5. Bernard P. Zeigler, Alexandre Muzy, Ernesto Kofman, 3ed, Theory of Modelling and Simulation, Academic Press : Elsevier 1985.

Suggestive readings

1. Prabhat Pandey, Meenu Mishra Pandey, Research Methodology: Tools and Techniques, Bridge Center (2015)
2. S.P Gupta, Statistical Methods, 46th edition, Sultan Chand & Sons (2021)
3. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
4. Leedy, P. D. and Ormrod, J. E., 2004 Practical Research: Planning and Design, Prentice Hall.
5. Creswell, J.W. and Creswell, J.D., 2017. Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.
6. Relevant Select references from the Internet

Note: **Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**