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SYLLABUS for FOUR YEAR UNDERGRADUATE PROGRAMME (FYUGP) in ELECTRONICS of DIBRUGARH UNIVERSITY for its AFFILIATED COLLEGES as per NEP-2020 Guidelines

Approved by the Meeting of the Board of Studies in Electronics held on July 3, 2024

Preamble

The model curriculum for the FYUGP in Electronics is designed as per NEP 2020 guidelines and intended to enable the graduates to respond to the current needs of the industry and equip them with skills relevant for national and global standards. The objective of this programme is to prepare the students for the society at large.

The programme is in the best interest of the students to provide outcome-based courses at the undergraduate level with the teaching-learning experiences in a more student-centric manner. This will strengthen students' experiences as they engage themselves in the programme of their choice. This Under-Graduate Programmes will prepare the students for both academia and employability.

The new curriculum of FYUGP in Electronic offers the undergraduates a complete package to have an in-depth understanding of basic to advance electronics. They can equip themselves to the fundamentals of electronics to a complete skill set compatible to industry standards. The curriculum will prepare the students to pursue higher education as well compete in the job market.

It is hoped that the FYUGP in Electronics will help students in making an informed decision regarding the goals that they wish to pursue in further education and life.

Introduction

The FYUGP in Electronics curriculum framework is intended to prepare the graduates to respond to the current needs of the industry and equip them with skills relevant for national and global standards. The curriculum is designed to help students to analyse, appreciate, understand and critically engage with learning of the subject and also to provide better learning experience to the stake holders. Apart from imparting disciplinary knowledge, the curriculum is aimed to equip the students with competencies like problem solving and analytical reasoning which provide them high professional competence. The University is expected to encourage its faculty concerned to make suitable pedagogical innovations, in addition to teaching learning processes suggested in the model curriculum, so that the Course/Programme learning outcomes can be achieved. The FYUGP is prepared on the basics and curricular structure of CBCS provided by the UGC.

Programme Duration

The FYUGP in Electronics will be of four years duration. Each year will be called an academic year and will be divided into two semesters. Hence, there will be a total of eight semesters.

Multiple exit system is available in the program. Students on exit after first year shall be awarded Undergraduate Certificate on securing the requisite 40 credits in Semester I and Semester II. Students on exit shall be awarded Undergraduate Diploma after securing the requisite 80 credits on completion of Semester III and Semester IV. Students on exit shall be awarded 3 Year Bachelor Degree with Honours after securing the requisite 120 credits on completion of Semester V and Semester VI. Students on completion shall be awarded 4 Year

Bachelor Degree with Honours or Honours with Research after securing the requisite 160 credits on completion of Semester VII and Semester VIII.

Design of Programme

The teaching-learning will involve theory classes (L) of one hour duration, tutorials (T) and practical (P) classes. The curriculum will be delivered through various methods including chalk and talk, power point presentations, audio, video tools, E-learning/E-content, lab sessions, virtual labs, simulations, experiments, field trips/Industry visits, seminars, workshops, projects, models, class discussions and other suggestive ways. The assessment broadly will comprise of Internal Assessment (Continuous Evaluation) and End Semester Examination. Each theory paper will be of 80 marks with 20 marks for Internal Assessment. The internal Assessment will be through sessional test, assignment, oral presentation, short project, attendance in the classes and other suggested methods.

Programme Structure

The programme will consist of four-credit courses and three-credit courses. Four credit courses without practical will comprise of theory classes only. For theory or tutorial classes, one credit indicates a one-hour lecture per week while for practical one credit indicates a two-hour session per week.

The programme includes Core Courses (CC) and Elective Courses (EC). The core courses are all compulsory courses. There are three kinds of elective courses: Discipline Specific Elective (DSE), Generic Elective (GE) and Skill Enhancement Course (SEC). In addition, there are two compulsory Ability Enhancement Courses (AEC).

Aim

The overall aims of the FYUGP in Electronics are to provide students with learning experiences that develop broad knowledge and understanding of key concepts of electronic science and equip students with advanced scientific/technological capabilities for analyzing and tackling the issues and problems in the field of electronics. Develop ability to apply knowledge and skills they have acquired to the solution of specific theoretical and applied problems in electronics. Develop abilities in students to design and develop innovative solutions for benefits of society, by diligence, leadership, team work and lifelong learning. Provide students with skills that enable them to get employment in industries or pursue higher studies or research assignments or turn as entrepreneurs.

Graduate Attributes:

Graduates Attributes form a set of individually assessable outcomes that are the components indicative of the graduate’s potential to acquire competence to practice at the appropriate level. The Graduate Attributes of FYUGP in Electronics are listed below:

- **Disciplinary Knowledge:** Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyse and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.
- **Communication:** Communicate with the scientific/technological community, and with society at large, regarding complex scientific/technological activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
- **Problem Solving and Critical Thinking:** Think laterally and originally, conceptualize and solve scientific/technological problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

  Analyse complex scientific/technological problems critically; apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
- **Usage of Modern Tools:** Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex scientific/technological activities with an understanding of the limitations.
- **Collaborative and Multidisciplinary Work:** Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
- **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
- **Moral and Ethical Practices:** Acquire professional and intellectual integrity, professional code of conduct, ethics of research, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

Programme Learning Outcomes

The FYUGP in Electronics needs to develop a specialized skill set among the graduates to cater the need of industries. In recent years, Electronic Science has made unprecedented growth in terms of new technologies, new ideas and principles. The research organizations and industries that work in this frontier area are in need of highly skilled and scientifically oriented manpower.

This manpower can be available only with flexible, adaptive and progressive training programs and a cohesive interaction among the research organizations, academicians and industries. The key areas of study within subject area of Electronics comprises of Semiconductor Devices, Analog and Digital Circuit Design, Microprocessors & Microcontroller systems, Communication Techniques, IoT and computation techniques for Electronics, computer coding/programming in high level languages and with applied fields such as embedded system, advanced computer and data communication, robotics, control systems, VLSI Design, Nanoelectronics, Artificial Intelligence, Internet of Things etc. etc.

The present learning outcomes-based model curriculum of FYUGP in Electronics is designed to provide better learning experience to the graduates. Besides, imparting disciplinary knowledge, curriculum is aimed to equip the graduates with competencies like problem solving, analytical reasoning and leadership which provide them high professional competence The following program outcomes of FYUGP in Electronics:

- Ability to apply knowledge of mathematics & science in solving electronics related problems
- Ability to design and conduct electronics experiments, as well as to analyse and interpret data
- Ability to design and manage electronic systems or processes that conforms to a given specification within ethical and economic constraints
- Ability to identify, formulate, solve and analyse the problems in various disciplines of electronics
- Ability to function as a member of a multidisciplinary team with sense of ethics, integrity and social responsibility
- Ability to communicate effectively in term of oral and written communication skills
- Recognize the need for, and be able to engage in lifelong learning
- Ability to use techniques, skills and modern technological/scientific/engineering software/tools for professional practices

Teaching Learning Process

As the FYUGP in Electronics is designed to encourage the acquisition of knowledge of electronics, understanding and professional skills required for the industrial/professional jobs. Development of practical/experimental skills should constitute an important aspect of the teaching-learning process. Methods which actively involve students are more effective than lectures for encouraging them to take intense approaches which are likely to result in developing understanding and encouraging critical thinking. Students learn more effectively when lectures include activities which engage their thoughts and motivation.

The following general approaches are suggested for more outcome oriented and participative learning.

a) **Lectures:** Lectures should be designed to provide the learners with interesting and fresh perspectives on the subject matter. Lectures should be interactive in a way that students work with their teachers to get new insights in the subject area, on which they can build their own bridges to higher learning. In order to make every lecture outcome oriented, faculty may specify the lecture outcomes in the beginning and at the end, the main points covered during the lecture should be summarized.

b) **Case Studies**: Real case studies, wherever possible, should be encouraged in order to challenge students to find creative solutions to complex problems faced by electronics industry, community, society and various aspects of knowledge domain concerned. Student may be asked to communicate findings of the study in the form of a report and seminar.

c) **SWAYAM Portal:** The platform provides the best teaching learning e-resources to all. Students can enrich the learning experience by using audio-video and multi-media and state of the art pedagogy / technology on SWAYAM portal. The courses hosted on SWAYAM are in 4 quadrants: (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-assessment tests through tests and quizzes and (4) an online discussion forum for clearing the doubts.

d) **Lab Sessions:** In traditional laboratory a student follows a given procedure to obtain pre-determined outcome. This allows student to manipulate equipment, learn standard techniques, collect data, interpret data and write report. It has to be recognized that for students to obtain the necessary laboratory skills, to use lab facilities effectively, requires a significant commitment of time for both the instructor and the student.
In order to enhance the lab experience of the students following should be implemented:

- **Simulations:** Simulations can be used as a pre-lab experience to give students some idea of what they will encounter in an actual experiment. Student should be given opportunity to work on simulation tools like MATLAB, Scilab, MULTISIM/ PSPICE, LabVIEW etc. to support their laboratory work.

- **Optional Experiments:** Students must be given wide range of options in selecting the experiments. After completion of mandatory experiments, they should be required to select few out of the multiple optional laboratory experiments relating to their field of interest. Hence, experiments designed for a particular course should be more than the minimum required experiments.

- **Problem solving:** Instead of following an established procedure given in laboratory manual, student will be given a scientific problem and will be able to design his/her own way of solving the problem. Student involvement in the laboratories increases if the experiments are designed and executed by the students themselves.

- **Mini Projects:** Mini-projects provide opportunities for the students to develop project management skills while working in a team. They may be assigned circuit/system design related problems for solving.

- **Virtual Remote Laboratory:** Virtual and remote laboratories are e-learning resources that enhance the accessibility of experimental setups providing a distance teaching framework which meets the student's hands-on learning needs. The use of virtual remote laboratory should be encouraged as it enhances student's life-long learning capabilities along with routine subject/experimental skills.

- **Lab Report:** The Lab report should clearly reflect the student's experience during the lab sessions. Primarily student should be able to establish the science behind the experiment. That is, laboratory procedure is expected to yield certain results and to a certain extent, the quality of the experiment depends on whether or not those results are obtained. One should be able to clearly relate the theory with the laboratory findings. The lab report should systematically include the introduction, procedure of experiment, data collection, results and conclusion of experiment.

e) Project-Based Learning: Students learn to work on their individual skills regarding critical thinking and problem solving, creativity and innovation, collaboration/teamwork and leadership, communications, learning self-reliance and project management. Project-based learning can be used in single sequences (a combination of lecture and project-based learning) or as the predominant teaching method in a module. Accordingly, the assessment has to consider both the result and the working process. Adequate examination requirements for individual marking are practical tests of the result/product, presentations with discussions and seminar papers of the working process and the result/product.

f) Summer Training/Internship: Industrial training in Electronics is necessary in industrial career exposure. The benefits of such training contribute to the development of generic employability skills and provide a direction for the graduates at the outset of their careers.

After the period of training, it is expected that students should achieve the course outcomes below:

- Recognize the duties, responsibilities and ethics of profession.
- Ability to communicate effectively in the work environment.
- Understand general and specific work procedures in electronics industry.
- Gain exposure and practical experience in the relevant field.
- Ability to prepare technical reports for the training.
- Ability to apply knowledge learned to solve problems in the industry.

g) Industrial/Field Visits: Industrial/Field visit are important to help bridge the gap between education and hands-on experience. They are a vital requirement as students will be able to appreciate state of the art technology in place. They will help students acquire knowledge, hands-on experience, technology at work and understand societal requirements and challenges. It will help in raising curiosity in them and finding answers to their queries.

h) Invited Talks and Hands-on Workshops shall be organized on regular basis as it will help students interact with various subject experts from outside the institute domain. It will help them apprise about the latest technological as well as research developments, industrial needs and market requirements. It will assist them in developing self-confidence through the art of self-doing.

Assessment Methods

Electronic Science is a professional academic programme, so there is need to focus more on activity-based evaluation rather than purely written examination. A variety of assessment methods that are appropriate within the disciplinary area of electronics must be used. The assessment of learners' achievement in FYUGP in Electronics will be aligned with the following:

- Course Outcomes,
- Program Outcomes.

Allowing for the diversity in learning and pedagogical methods adopted by different Universities and Institutions, Universities are expected to ensure that the assessment techniques are able to provide clear information about the attainment level of course outcomes and program outcomes for each and every student.

Assessment Priorities: Institutions will be required to prioritize formative assessments (in-semester activities including tests done at the department rather than giving heavy and final weightage to summative assessments (end-semester). Progress of learners towards achieving learning outcomes may be assessed making creative use of the following, either independently or in combination:

- Time-constrained examinations.
- Closed-book and open-book tests.
- Problem based assignments.
- Quizzes.
- Real life projects.
- Lab reports.
- Individual/Team project reports.
- Oral presentations, including seminar presentation.
- Viva voce.
- Computerized adaptive testing for MCQ.
- Peer and self-assessment etc.
- Any other pedagogic approaches.

Programme Outcomes (POs)

PO1: Disciplinary Knowledge: Students will **develop** an adequate foundation of theoretical concepts and experimental techniques in electronics.

PO2: Problem Solving Capacity: Students will be able to apply the knowledge of electronics to identify, formulate, and solve complex problems in electronics by applying principles of mathematics, science, and engineering, and by conducting experiments, analyzing data, and interpreting results.

PO3: Communication and Presentation Skills: Students will be able to effectively communicate technical information, ideas and findings in written, oral, and graphical forms.

PO4: Analytical and Critical Thinking: Students will be able to **evaluate** the validity of information & evidence and to **assess** different methodologies & tools. They will be able to critically analyze the existing knowledge and diverse situations.

PO5: Digital and ICT Efficiency: Students will be able to use modern ICT tools in a variety of learning environments and work situations to broaden the capability and improve efficiency.

PO6: Teamwork and Leadership: Students will be able to develop teamwork and leadership abilities to work effectively in a co-operative and coordinated manner within diverse teams and peer groups.

PO7: Research and Inquiry: The students will develop the skills of observation and inquiries, and the ability to identify and articulate problems/issues.

PO8: Multidisciplinary Learning: Students will be able to analyze a problem through a multidisciplinary approach for solving real world problems.

PO9: Ethics and Values: Students will follow ethical conduct and adhere to professional standards in learning.

PO10: Employability: Students will acquire enough skills and knowledge to make them employable in different sectors in connection with research, academics, industries, and administration and others.

General structure and distribution of number of Courses in the FYUGP in Electronics

Semester	Core (4)	Minor (4)	AEC (4)	GEC (3)	SEC (3)	VAC (2)	Intern./ CE/ Project (4)	Research	DSE (4)	Total Credit
I	1	1	1	1	1	1	×	×	×	20
II	1	1	1	1	1	1	×	×	×	20
III	2	1	×	1	1	1	×	×	×	20
IV	4	1	×	×	×	×	×	×	×	20
V	3	1	×	×	×	×	1	×	×	20
VI	4	1	×	×	×	×	×	×	×	20
VII	3	1	×	×	×	×	×	RM (4)	×	20
VIII	2	1	×	×	×	×	×	Diss. (8)	2 (In lieu of Diss.)	20

Program Structure

Year	Semester	Course	Title of the Course	Total Credits
Year 01	1st Semester	**C - 1**	Basic Circuit Theory and Network Analysis	4
		Minor 1	Basic Circuit Theory and Network Analysis (for disciplines other than Electronics)	4
		GEC - 1	Circuit Theory	3
		AEC - 1	Modern Indian Language	4
		SEC - 1	Electrical Wiring and Maintenance	3
		VAC - 1	Value Added Course	2
			Total of Semester 1	**20**
	2nd Semester	**C - 2**	Semiconductor Devices	4
		Minor 2	Semiconductor Devices (for disciplines other than Electronics)	4
		GEC - 2	Electronic Devices and Circuits	3
		AEC - 2	English Language and Communication Skills	4
		SEC - 2	Design and Fabrication of Printed Circuit Boards **OR** Basic Instrumentation Skills	3
		VAC - 2	Value Added Course	2
			Total of Semester 2	**20**
	Grand Total (Semester 1 and 2)			**40**
Students on exit shall be awarded Undergraduate Certificate (in the field of study/ discipline) after securing the requisite 40 credits in Sem 1 and 2 provided they secure 2 credits in work based vocational courses offered during summer term or internship/ apprenticeship in addition to 6 credits from skill-based courses earned during 1st and 2nd Semester.				
	3rd Semester	**C - 3**	Electronic Circuits	4
		C - 4	Operational Amplifiers and Applications	4
		Minor 3	Electronics Circuits (for disciplines other than Electronics)	4
		GEC - 3	Digital Logic Circuits	3
		SEC - 3	Domestic Equipment Maintenance	3

Year 02		**VAC - 3**	Value Added Course	2
			Total of Semester 3	**20**
	4th Semester	**C - 5**	Data Structures, C & C++ Programming	4
		C - 6	Digital Electronics	4
		C - 7	Electronic Instrumentation	4
		C - 8	Electronics Lab-I (Major)	4
		Minor 4	Electronics Lab-I (for disciplines other than Electronics)	4
			Total of Semester 4	**20**
	Grand Total (Semester 1 to 4)			**80**
Students on exit shall be awarded Undergraduate Diploma (in the field of study/ discipline) after securing the requisite 80 credits on completion of Sem 4 provided they secure additional 4 credit in skill based vocational course offered during 1st year or 2nd year summer term.				
Year 03	**5th Semester**	**C - 9**	Analog Communication	4
		C - 10	Signals and Systems	4
		C - 11	Electronics Lab-II (Major)	4
		Minor 5	Communication Electronics	4
		Internship/ Community Engagement	Internship (2) + Comm. Engmnt. (2) **OR** Internship (4) / Comm. Engmnt. (4)	4
			Total of Semester 5	**20**
	6th Semester	**C - 12**	Advanced Communication System	4
		C - 13	Microprocessors and Microcontrollers	4
		C - 14	Robotics	4
		C - 15	Electronics Lab-III (Major)	4
		Minor - 6	Digital Electronics	4
			Total of Semester 6	**20**
	Grand Total (Semester 1 to 6)			**120**
Students on exit shall be awarded Bachelor of (in the field of study/ discipline) Honours (3 years) after securing the requisite 120 credits on completion of Semester 6.				

Year 4	**Semester 7**	**C - 16**	Embedded System	4
		C - 17	Digital Signal Processing	4
		C - 18	Power Electronics	4
		Minor - 7	Microprocessors and Microcontrollers	4
		Research	Research Methodology	4
			Total of Semester 7	**20**
	Semester 8	**C - 19**	VLSI Designing	4
		C - 20	Digital Image Processing	4
		Minor 8	Electronics Lab-II (Minor)	4
		Research / DSE	Research Project / Dissertation (8) **OR** DSE - I (4) + DSE - II (4)	8
			Total of Semester 8	**20**
	Grand Total (Semester 1 to 8)			**160**
Students shall be awarded Bachelor of (Electronics) Honours (4 years) / Honours with Research (4 years) after securing the requisite 160 credits on completion of Sem 8.				

Abbreviations used:

1. C = Major
2. GEC = Generic Elective Course / Multidisciplinary Course
3. AEC = Ability Enhancement Course
4. SEC = Skill Enhancement Course
5. VAC = Value Added Course
6. DSE = Discipline Specific Elective
7. LO = Learning Objective
8. L = Lectures
9. T = Theory
10. P = Practical
11. M = Marks
12. H = Hours

List of Major Core Courses:

Semester	Course Code	Course Title (Major)	Credits
I	ELT-C-1	Basic Circuit Theory and Network	4
II	ELT-C-2	Semiconductor Devices	4
III	ELT-C-3	Electronic Circuits	4
	ELT-C-4	Operational Amplifiers and Applications	4
IV	ELT-C-5	Data Structures, C & C++ Programming	4
	ELT-C-6	Digital Electronics	4
	ELT-C-7	Electronic Instrumentation	4
	ELT-C-8	Electronics Lab-I	4
V	ELT-C-9	Analog Communication	4
	ELT-C-10	Signals and Systems	4
	ELT-C-11	Electronics Lab-II	4
VI	ELT-C-12	Advanced Communication System	4
	ELT-C-13	Microprocessors and Microcontrollers	4
	ELT-C-14	Robotics	4
	ELT-C-15	Electronics Lab-III	4
VII	ELT-C-16	Embedded Systems	4
	ELT-C-17	Digital Signal Processing	4
	ELT-C-18	Power Electronics	4
VIII	ELT-C-19	VLSI Designing	4
	ELT-C-20	Digital Image Processing	4

List of Discipline Specific Elective Courses (For 8th Semester):

DSE Group I (in lieu of dissertation, any one)

Semester	Course Code	Course Title	Credits
VIII	ELT-DSE-IA	Transmission Lines, Antenna and Wave	4
	ELT-DSE-IB	Control Systems	4
	ELT-DSE-IC	Internet of Things	4
	ELT-DSE-ID	Computer Networks	4

DSE Group II (in lieu of dissertation, any one)

Semester	Course Code	Course Title	Credits
VIII	ELT-DSE-IIA	Fundamentals of Applied Physics	4
	ELT-DSE-IIB	Electromagnetics	4
	ELT-DSE-IIC	Photonics	4

	ELT-DSE-IID	Nano Electronics	4

List of Skill Enhancement Courses:

Semester	Course Code	Course Title	Credits
I	ELT-SEC-1	Electrical Wiring and Maintenance	3
II	ELT-SEC-2A **OR** ELT-SEC-2B	Design and Fabrication of Electronic Circuits **OR** Basic Instrumentation Skills	3
III	ELT-SEC-3	Domestic Equipment Maintenance	3

List of Generic Elective Courses:

Semester	Course Code	Course Title	Credits
I	ELT-GEC-1	Circuit Theory	3
II	ELT-GEC-2	Electronic Devices and Circuits	3
III	ELT-GEC-3	Digital Logic Circuits	3

List of Minor Courses:

Semester	Course Code	Course Title	Credits
I	ELT-MIN-1	Basic Circuit Theory and Network Analysis	4
II	ELT-MIN-2	Semiconductor Devices	4
III	ELT-MIN-3	Electronics Circuits	4
IV	ELT-MIN-4	Electronics Lab-I	4
V	ELT-MIN-5	Communication Electronics	4
VI	ELT-MIN-6	Digital Electronics	4
VII	ELT-MIN-7	Microprocessors and Microcontrollers	4
VIII	ELT-MIN-8	Electronics Lab-II	4

DETAILED SYLLABUS OF CORE COURSES

Semester I

Course title: Basic Circuit Theory and Network Analysis
Course code: ELT-C-1
Nature of the course: Core
Total credits: 4
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides a comprehensive introduction to the fundamental concepts and techniques used in the analysis and design of electrical circuits and networks. It covers the basic principles governing electrical circuits, methods for analyzing complex circuits, and the use of network theorems to simplify circuit analysis. The course is essential for students pursuing a degree in electronics, laying the groundwork for advanced studies in circuit design, signal processing, and system analysis.

Course Objectives: The course objectives are designed to equip students with comprehensive knowledge and practical skills in electrical circuit analysis. Students will delve into fundamental concepts such as voltage, current, resistance, capacitance, and inductance, both in DC and AC circuits. They will learn to apply Kirchhoff's laws, mesh and node analysis, and various network theorems (such as Thevenin's and Norton's) to analyze and solve complex circuits. Practical aspects include understanding transient responses, resonance in RLC circuits, and the behavior of passive filters. The course also emphasizes phasor analysis for evaluating AC circuit characteristics and introduces students to impedance and transmission parameters in two-port networks.

Prerequisites:

- Fundamentals of mathematics
- Basic electricity and magnetism
- Basic electronic components

Course Outcomes (COs): The students will able to

CO1: Understand fundamental concepts of voltage, current, resistors, inductors, and capacitors in DC circuits.
- **LO1.1:** Identify and differentiate between various types of resistors and their applications in series and parallel circuits.
- **LO1.2:** Explain the principles of inductance and calculate energy stored in an inductor.
- **LO1.3:** Describe the principles of capacitance, types of capacitors, and their applications in electronic circuits.

CO2: Apply Kirchhoff's laws and circuit analysis techniques to analyze DC circuits.
- **LO2.1:** Apply Kirchhoff's Current Law (KCL) and Voltage Law (KVL) to solve circuit problems.

LO2.2: Analyze DC transient responses in RC and RL circuits using time constants.
LO2.3: Analyze series RLC circuits and understand their DC response characteristics.

CO3: Analyze AC circuits using phasor analysis and understand power relationships in sinusoidal circuits.
LO3.1: Describe sinusoidal voltage and current waveforms and calculate RMS and average values.
LO3.2: Apply phasor analysis to solve AC circuit problems involving resistors, inductors, and capacitors.
LO3.3: Analyze resonance phenomena in RLC circuits and design passive filters based on frequency response.

CO4: Apply network theorems and parameters to analyze AC circuits and understand two-port network characteristics.
LO4.1: Apply network theorems such as Superposition, Thevenin's, and Norton's theorems to simplify AC circuits.
LO4.2: Analyze AC circuits using impedance, admittance, hybrid, and transmission parameters.
LO4.3: Apply maximum power transfer theorem and understand the concept of reciprocity in AC circuit analysis.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1	LO1.2, LO1.3				
Conceptual		LO3.1		CO3, LO3.3		
Procedural			CO1, CO2, LO2.1, LO2.2, LO2.3, LO3.2, LO3.3	CO4, LO4.2		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	W	M	W	W	W	M	M	S
CO2	S	S	W	S	M	W	W	M	M	S
CO3	S	S	M	S	M	W	W	M	M	S
CO4	S	S	W	S	M	W	W	M	M	S

S: Strong, M: Medium, W: Weak

Course Contents:

Unit I: Basic Circuit Concepts **(L 15, H 15, M 15)**

Voltage and Current Sources, Resistors: Fixed and Variable resistors, Construction and Characteristics, Colour coding of resistors, resistors in series and parallel.

Inductors: Fixed and Variable inductors, Self and mutual inductance, Faraday's law and Lenz's law of electromagnetic induction, Energy stored in an inductor, Inductance in series and parallel, testing of resistance and inductance using multimeter.

Capacitors: Principles of capacitance, parallel plate capacitor, permittivity, definition of dielectric constant, dielectric strength, Energy stored in a capacitor, Air, Paper, Mica, Teflon, Ceramic, Plastic and Electrolytic capacitor, construction and application, capacitors in series and parallel, factors governing the value of capacitors, testing of capacitors using multimeter.

Unit-II: Circuit Analysis **(L 12, H 12, M 12)**

Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis, Star-Delta Conversion.

DC Transient Analysis:

RC Circuit- Charging and discharging with initial charge, RL Circuit with Initial Current, Time Constant, RL and RC Circuits with Sources, DC Response of Series RLC Circuits.

Unit-III: AC Circuit Analysis **(L 18, H 18, M 18)**

Sinusoidal Voltage and Current, Definition of Instantaneous, Peak, Peak to Peak, Root Mean Square and Average Values. Voltage-Current relationship in Resistor, Inductor and Capacitor, Phasor, Complex Impedance, Power in AC Circuits: Instantaneous Power, Average Power, Reactive Power, Power Factor. Sinusoidal Circuit Analysis for RL, RC and RLC Circuits.

Resonance in Series and Parallel RLC Circuits, Frequency Response of Series and Parallel RLC Circuits, Quality (Q) Factor and Bandwidth. Passive Filters: Low Pass, High Pass, Band Pass and Band Stop.

Unit-IV: Networks **(L 15, H 15, M 15)**

Network Theorems: Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem. AC circuit analysis using Network theorems.

Two Port Networks: Impedance (Z) Parameters, Admittance (Y) Parameters, Hybrid (h) Parameters, Transmission (ABCD) Parameters.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examination **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.**(20 Marks)**

Recommended Readings:

1. Electric Circuits, *S. A. Nasar*, Schaum's outline series, Tata McGraw Hill.
2. Electrical Circuits, *M. Nahvi and J. Edminister*, Schaum's Outline Series, Tata McGraw-Hill.

3. Essentials of Circuit Analysis, *Robert L. Boylestad*, Pearson Education.
4. Engineering Circuit Analysis, *W. H. Hayt, J. E. Kemmerly, S. M. Durbin*, Tata McGraw Hill.
5. Fundamentals of Electric Circuits, *Alexander and M. Sadiku*, McGraw Hill.

Semester II

Course title: Semiconductor Devices
Course code: ELT-C-2
Nature of the course: Core
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides an in-depth understanding of electronic devices and their applications in circuits. It covers the fundamental principles of semiconductors, the operation of various diodes and transistors, and the characteristics of advanced electronic components. The course is designed to equip students with both theoretical knowledge and practical skills necessary for analyzing and designing electronic circuits.

Course Objectives: The course objectives for Semiconductor Devices focus on providing students with a comprehensive understanding of the fundamental principles, characteristics, and applications of semiconductor. Students will explore the foundational concepts of semiconductor materials, including energy bands, charge carriers, and doping mechanisms. They will study the operational principles and characteristics of semiconductor devices such as diodes, bipolar junction transistors (BJTs), field-effect transistors (FETs), and optoelectronic devices, gaining insights into their behavior in electronic circuits. The course aims to develop students' ability to analyze and design basic semiconductor circuits, applying theoretical knowledge to practical applications.

Prerequisites:

- Fundamental knowledge of electromagnetism, quantum mechanics and solid-state physics.
- Proficiency in calculus, differential equations, and linear algebra, as these are often used in modeling semiconductor devices and analyzing their behavior.
- Basic understanding of materials properties, especially semiconductor materials like silicon, germanium, and compound semiconductors.

Course Outcomes (COs): The students will able to

CO1: Understanding Semiconductor Materials and Basics.

LO1.1: Understand of semiconductor materials, crystal structures, Miller indices, and energy bands in solids.

LO1.2: Explain the concepts of effective mass, density of states, and carrier concentration at equilibrium in intrinsic and extrinsic semiconductors.

LO1.3: Derive and interpret the Fermi level for intrinsic and extrinsic semiconductors and understand its temperature dependence.

LO1.4: Analyze carrier drift, mobility, resistivity, Hall effect, and diffusion processes.

CO2: Understanding and Applying P-N Junction Diode Concepts.

LO2.1: Explain the formation of the depletion layer, space charge at a junction, and electrostatic potential difference at thermal equilibrium.

LO2.2: Derive and analyze the depletion width, depletion capacitance, and diode equation.

LO2.3: Understand and apply the concepts of Zener and avalanche breakdown mechanisms and the characteristics of various diodes such as tunnel diodes, varactor diodes, and solar cells.

CO3: Analyzing Bipolar Junction Transistors (BJTs).

LO3.1: Understand the structure and operation of PNP and NPN transistors, including emitter efficiency, base transport factor, and current gain.

LO3.2: Perform quantitative analysis of static characteristics, including minority carrier distribution and terminal currents.

LO3.3: Analyze input and output characteristics of BJTs in common base (CB), common emitter (CE), and common collector (CC) configurations.

CO4: Understanding and Analyzing Field Effect Transistors (FETs) and Power devices.

LO4.1: Understand the construction, channel formation, pinch-off, and saturation voltage of JFETs.

LO4.2: Analyze current-voltage characteristics of MOSFETs, including both depletion and enhancement types for N-channel and P-channel MOSFETs.

LO4.3: Understand the operation and applications of CMOS technology.

LO4.4: Explain the construction, working principles, and characteristics of power devices such as UJT, SCR, Triac, Diac, IGBT, and MESFET.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	LO1.1	LO1.2 LO4.3	LO1.4			
Conceptual		LO1.3 LO4.4	LO2.1, LO2.3	LO2.2	LO3.1	
Procedural			LO2.2	LO3.2	LO4.1, LO4.2	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	W	W	W	M	W	M
CO2	S	S	M	S	M	M	W	S	W	S
CO3	S	S	M	S	M	M	W	S	W	S
CO4	S	S	M	S	S	S	W	S	W	S

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Semiconductor Basics **(L 12, H 12, M 12)**

Introduction to semiconductor materials, crystal Structure, Planes and Miller Indices, Energy Band in Solids, Concept of Effective Mass, Density of States, Carrier Concentration at Normal Equilibrium in Intrinsic Semiconductors, Derivation of Fermi Level for Intrinsic & Extrinsic Semiconductors, Donors, Acceptors, Dependence of Fermi Level on Temperature and Doping Concentration, Temperature Dependence of Carrier Concentrations.

Carrier Transport Phenomena: Carrier Drift, Mobility, Resistivity, Hall Effect, Diffusion Process, Einstein Relation, Current Density Equation, Carrier Injection, Generation and Recombination Processes, Continuity Equation.

Unit-II: P-N Junction Diode **(L 15, H 15, M 15)**

Formation of Depletion Layer, Space Charge at a Junction, Derivation of Electrostatic Potential Difference at Thermal Equilibrium, Depletion width and Depletion capacitance of an abrupt junction. Concept of linearly graded junction, Derivation of Diode Equation and I-V Characteristics. Zener and Avalanche Junction Breakdown Mechanism.

Tunnel diode, varactor diode, solar cell: circuit symbol, characteristics, applications.

Unit-III: Bipolar Junction Transistors (BJT) **(L 15, H 15, M 15)**

PNP and NPN Transistors, Basic Transistor Action, Emitter Efficiency, Base Transport Factor, Current Gain, Energy Band Diagram of Transistor in Thermal Equilibrium, Quantitative Analysis of Static Characteristics (Minority Carrier Distribution and Terminal Currents), Base-width Modulation, Modes of operation, Input and Output Characteristics of CB, CE and CC Configurations. Metal Semiconductor Junctions: Ohmic and Rectifying Contacts.

Unit-IV: Field Effect Transistors **(L 18, H 18, M 18)**

JFET, Construction, Idea of Channel Formation, Pinch-Off and Saturation Voltage, Current-Voltage Output Characteristics. MOSFET, types of MOSFETs, Circuit symbols, Working and Characteristic curves of Depletion type MOSFET (both N channel and P Channel) and Enhancement type MOSFET (both N channel and P channel). Complimentary MOS (CMOS).

Power Devices: UJT, Basic construction and working, Equivalent circuit, intrinsic Standoff Ratio, Characteristics and relaxation oscillator-expression. SCR, Construction, Working and

Characteristics, Triac, Diac, IGBT, MESFET, Circuit symbols, Basic constructional features, Operation and Applications.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examination **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.**(20 Marks)**

Recommended Readings:

1. Semiconductor Devices: Physics and Technology, *S. M. Sze*, Wiley India.
2. Solid State Electronic Devices, *Ben G Streetman and S. Banerjee*, Pearson Education.
3. Transistors, *Dennis Le Croissette*, Pearson Education.
4. Semiconductor Devices: Basic Principles, *Jasprit Singh*, John Wiley and Sons.
5. Semiconductor Devices, *Kanaan Kano*, Pearson Education.
6. Semiconductor Device Fundamentals, *Robert F. Pierret*, Pearson Education.

Semester III

Course title: Electronic Circuits
Nature of the course: Core
Course code: ELT-C-3
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course explores fundamental principles and practical applications in electronic circuits and devices. Beginning with diode circuits and rectifiers, it progresses to bipolar junction transistors (BJTs) and field-effect transistors (MOSFETs), covering biasing techniques, amplifier configurations, feedback amplifiers, and oscillators. The curriculum delves into power amplifiers, including Class A, B, and C designs, and examines single-tuned amplifiers. Students learn through theoretical study and practical circuit analysis, focusing on characteristics, performance metrics, and applications of various electronic components and circuits. Emphasis is placed on understanding circuit behavior, design considerations, and applications in modern electronic systems.

Course Objectives: The primary objective of the Electronic Circuits course is to provide students with a thorough understanding of the fundamental principles and applications of electronic circuits. This course aims to equip students with the skills necessary to analyze and design various electronic circuits involving diodes, transistors, and operational amplifiers. Students will gain proficiency in circuit analysis techniques, including dc and ac load line analysis, and will learn to use hybrid models for transistor circuits. The course will also cover the concepts of feedback in amplifiers, enabling students to understand and design both negative and positive feedback circuits, as well as oscillators. Additionally, the course will introduce students to MOSFET circuits, power amplifiers, and single tuned amplifiers, providing a comprehensive understanding of their operation, design, and applications. Through a combination of theoretical knowledge and practical laboratory experiments, students will develop problem-solving skills and the ability to apply their learning to real-world electronic circuit design and analysis.

Prerequisites:

- Proficiency in algebra, calculus, and differential equations.
- Fundamental knowledge of electromagnetism and electric circuits.
- Basic knowledge of electronic components (resistors, capacitors, inductors) and simple circuits.

Course Outcomes (COs): The students will able to

CO1: Understanding Diode Circuits.

- **LO1.1:** Demonstrate knowledge of ideal diodes, piecewise linear equivalent circuits, and dc load line analysis.
- **LO1.2:** Design and analyze clipping and clamping circuits, rectifiers, and filters.
- **LO1.3:** Understand the operation and limitations of Zener diode regulator circuits.

CO2: Proficiency in Bipolar Junction Transistors (BJTs).

- **LO2.1:** Analyze CE and CB characteristics and regions of operation of BJTs.
- **LO2.2:** Apply different transistor biasing techniques and analyze dc load lines, operating points, and stability factors.
- **LO2.3:** Design and analyze BJT amplifiers, including hybrid models and frequency response of CE amplifiers.

CO3: Understanding Feedback Amplifiers

- **LO3.1:** Explain the concepts and impact of negative and positive feedback on amplifier performance.
- **LO3.2:** Analyze various feedback amplifiers and oscillator circuits, understanding their working principles and applications.

CO4: Knowledge of MOSFET Circuits and Power Amplifiers

- **LO4.1:** Demonstrate an understanding of MOSFET operation, biasing, and small signal parameters.
- **LO4.2:** Analyze common source amplifiers and CMOS circuits.
- **LO4.3:** Understand the classification, operation, and efficiency of power amplifiers, and analyze single tuned amplifiers.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1	LO1.2	LO1.3, CO1			
Conceptual		LO4.3	LO2.1	LO2.2, LO2.3 CO2	LO3.1 CO3	
Procedural			LO2.2, LO2.3	LO3.2	LO4.2 CO4	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	W	W	W	M	W	M
CO2	S	S	M	S	M	M	W	S	W	S
CO3	S	S	M	S	M	M	W	S	W	S
CO4	S	S	M	S	S	S	W	S	W	S

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Diode Circuits. (L 14, H 14, M 14)

Ideal diode, piecewise linear equivalent circuit, dc load line analysis, Quiescent (Q) point. Clipping and clamping circuits. Rectifiers: HWR, FWR (center tapped and bridge). Circuit diagrams, working and waveforms, ripple factor & efficiency, comparison. Filters: types, circuit diagram and explanation of shunt capacitor filter with waveforms.

Zener diode regulator circuit diagram and explanation for load and line regulation, disadvantages of Zener diode regulator.

Unit-II: Bipolar Junction Transistor (L 14, H 14, M 14)

Review of CE, CB Characteristics and regions of operation. Hybrid parameters. Transistor biasing, DC load line, operating point, thermal runaway, stability and stability factor, Fixed bias without and with RE, collector to base bias, voltage divider bias and emitter bias ($+V_{CC}$ and $-V_{EE}$ bias), circuit diagrams and their working.

Transistor as a switch, circuit and working, Darlington pair and its applications.

BJT amplifier (CE), dc and ac load line analysis, hybrid model of CE configuration, Quantitative study of the frequency response of a CE amplifier, Effect on gain and bandwidth for Cascaded CE amplifiers (RC coupled).

Unit-III: Feedback Amplifiers (L 12, H 12, M 12)

Concept of feedback, negative and positive feedback, advantages and disadvantages of negative feedback, voltage (series and shunt), current (series and shunt) feedback amplifiers, gain, input and output impedances. Barkhausen criteria for oscillations, Study of phase shift oscillator, Colpitts oscillator and Hartley oscillator.

Unit-IV: MOSFET Circuits **(L 20, H 20, M 20)**

Review of depletion and enhancement MOSFET, Biasing of MOSFETs, Small Signal Parameters, Common Source amplifier circuit analysis, CMOS circuits.

Power Amplifiers: Difference between voltage and power amplifier, classification of power amplifiers, Class A, Class B, Class C and their comparisons. Operation of a Class A single ended power amplifier. Operation of Transformer coupled Class A power amplifier, overall efficiency. Circuit operation of complementary symmetry Class B push pull power amplifier, crossover distortion, heat sinks.

Single tuned amplifiers: Circuit diagram, Working and Frequency Response for each, Limitations of single tuned amplifier, Applications of tuned amplifiers in communication circuits.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examination **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.**(20 Marks)**

Recommended Readings:

1. Electronic Devices and circuit theory, *Robert Boylstead and Louis Nashelsky*, PHI.
2. Electronic devices, *David A Bell*, Reston Publishing Company.
3. Electronic Circuits: Discrete and Integrated, *D. L. Schilling and C. Belove*, Tata McGraw Hill.
4. Electronic Circuit Analysis and Design, *Donald A. Neamen*, Tata McGraw Hill.
5. Integrated Electronics, *J. Millman and C. C. Halkias*, Tata McGraw Hill.
6. Microelectronic Circuit Design, *J. R. C. Jaegar and T. N. Blalock*, Tata McGraw Hill.
7. 2000 Solved Problems in Electronics, *J. J. Cathey*, Schaum's outline Series, Tata McGraw Hill.
8. Electronic Devices and Circuits, *Allen Mottershed*, Goodyear Publishing Corporation.

Course title: Operational Amplifiers and Applications
Nature of the course: Core
Course code: ELT-C-4
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides a comprehensive study of operational amplifiers (Op-Amps) and their applications in electronic circuits. Starting with basic concepts and operational parameters of Op-Amps such as differential amplifiers and current mirrors, it progresses to various configurations including inverting, non-inverting, summing, and difference amplifiers. The course covers advanced topics like integrators, differentiators, comparators, and signal generators such as oscillators and voltage-controlled oscillators. Additionally, it explores multivibrators, phase-locked loops (PLL), and signal conditioning circuits like active filters and regulators. Practical circuit design, analysis techniques, and applications in signal processing are emphasized throughout the course.

Course Objectives: This course offers a comprehensive study of electronic circuits, emphasizing operational amplifiers (op-amps) and their diverse applications. Topics covered include differential amplifiers, op-amp parameters, and various amplifier configurations (inverting, non-inverting, summing, and difference amplifiers). Students will also explore comparators, signal generators (oscillators, square, triangle, sawtooth wave generators), multivibrators (IC 555), phase-locked loops (IC 565), and IC regulators (IC 78xx, 79xx, LM317). The course includes signal conditioning circuits such as active filters and log amplifiers. Through both theoretical learning and practical exercises, students will gain skills in designing, analyzing, and implementing electronic circuits.

Prerequisites:

- Fundamental knowledge of electromagnetism and electric circuits.
- Proficiency in algebra, calculus, and differential equations.
- Familiarity with basic electronic components and circuits.

Course Outcomes (COs): The students will able to

CO1: Understand the principles and applications of operational amplifiers (Op-Amps).
- **LO1.1:** Explain the concept of differential amplifiers and their applications.
- **LO1.2:** Analyze the operational parameters of Op-Amps, such as input offset voltage and common mode rejection ratio.
- **LO1.3:** Design and analyze basic Op-Amp circuits including current mirrors and level translators.

CO2: Apply Op-Amps in various configurations for signal processing and amplification.
- **LO2.1:** Design and simulate inverting, non-inverting, summing, and difference amplifier circuits.
- **LO2.2:** Construct and analyze integrators and differentiators using Op-Amps.
- **LO2.3:** Implement voltage-to-current and current-to-voltage converters using

Op-Amps.

CO3: Understand the operation and applications of multivibrators and signal generators.

LO3.1: Construct and analyze astable and monostable multivibrators using IC 555.

LO3.2: Design and simulate phase shift oscillators and Wein bridge oscillators.

LO3.3: Implement voltage-controlled oscillators (VCOs) and understand their frequency modulation characteristics.

CO4: Design and analyze signal conditioning circuits using active filters and regulators.

LO4.1: Design and simulate sample and hold circuits for signal processing.

LO4.2: Implement first-order and second-order active filters (low pass, high pass, band pass, band reject).

LO4.3: Analyze the behavior of log and antilog amplifiers in signal conditioning applications.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual		LO1.1				
Conceptual		LO1.2 CO1 LO3.3		LO2.1 CO2	LO3.1 CO3	
Procedural			LO2.2, LO2.3	LO3.2	LO4.1, LO4.3 CO4	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	W	W	M	W	M
CO2	S	S	M	S	M	M	W	S	W	S
CO3	S	S	M	S	M	M	W	S	W	S
CO4	S	S	M	S	S	S	W	S	W	S

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Basic Operational Amplifier (L 18, H 18, M 18)

Concept of differential amplifiers (Dual input balanced and unbalanced output), constant current bias, current mirror, cascaded differential amplifier stages with concept of level translator, block diagram of an operational amplifier (IC 741)

Op-Amp parameters: Input offset voltage, input offset current, input bias current, differential input resistance, input capacitance, offset voltage adjustment range, input voltage range, common mode rejection ratio, slew rate, supply voltage rejection ratio

Unit-II: Op-Amp Circuits **(L 18, H 18, M 18)**

Open and closed loop configuration, Frequency response of an op-amp in open loop and closed loop configurations, Inverting, Non-inverting, Summing and difference amplifier, Integrator, Differentiator, Voltage to current converter, Current to voltage converter.

Comparators: Basic comparator, Level detector, Voltage limiters, Schmitt Trigger.

Signal generators: Phase shift oscillator, Wein bridge oscillator, square wave generator, triangle wave generator, saw tooth wave generator, and Voltage controlled oscillator (IC 566).

Unit-III: Multivibrators (IC 555) **(L 12, H 12, M 12)**

Block diagram, Astable and monostable multivibrator circuit, Applications of Monostable and Astable multivibrators. Phase locked loops (PLL): Block diagram, phase detectors, IC565.

Fixed and variable IC regulators:

IC 78xx and IC 79xx - concepts only, IC LM317- output voltage equation.

Unit-IV: Signal Conditioning circuits **(L 12, H 12, M 12)**

Sample and hold systems, Active filters: First order low pass and high pass Butterworth filter, Second order filters, Band pass filter, Band reject filter, All pass filter, Log and antilog amplifiers.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examination **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.**(20 Marks)**

Recommended Readings:

1. Op-Amps and Linear IC's, *R. A. Gayakwad*, Pearson Education.
2. Operational amplifiers and Linear Integrated circuits, *R. F. Coughlin and F. F. Driscoll*, Pearson Education.
3. Integrated Electronics, *J. Millman and C. C. Halkias*, Tata McGraw-Hill.
4. Electronic Principals, *A. P. Malvino*, Tata McGraw-Hill.
5. OP-AMP and Linear Integrated Circuits, *K. L. Kishore*, Pearson.

Semester IV

Course title: Data Structures, C & C++ Programming
Nature of the course: Core
Course code: ELT-C-5
Total credit assigned: 4
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course introduces C programming, covering fundamentals such as language structure, operators, arrays, and I/O functions. It progresses to decision-making constructs, loops, functions, and pointers, emphasizing practical application through structures and basic C++ concepts. Further, it explores data structures including stacks, queues, linked lists, and introduces sorting algorithms and binary search trees. By the end, students gain proficiency in C programming essentials and foundational knowledge in data structures and algorithms.

Course Objectives: This course aims to equip students with a solid foundation in C programming, emphasizing its syntax, operators, and data types. Students will learn to implement decision-making structures, loops, and functions effectively. The course also introduces them to advanced concepts like pointers, structures, and basic C++ principles. Additionally, it focuses on developing proficiency in implementing fundamental data structures such as stacks, queues, and linked lists, along with sorting algorithms and binary search trees. By the end, students will be adept in both C programming essentials and introductory data structure applications.

Prerequisites:

- Basic understanding of programming concepts and logic.
- Familiarity with variables, control structures (if-else, loops), and basic data types.
- Understanding of algorithms and problem-solving techniques.
- Familiarity with any programming language (preferably).

Course Outcomes (COs): The students will able to

CO1: Understand the fundamentals of the C programming language and its importance in software development.

- **LO1.1:** Describe the character set, tokens, keywords, and basic data types in C.
- **LO1.2:** Implement arithmetic, relational, logical, assignment, and bitwise operators in C programs.
- **LO1.3:** Utilize arrays, including multi-dimensional arrays, and understand input/output operations and library functions in C.

CO2: Develop proficiency in decision-making constructs, looping, and function usage in C.

- **LO2.1:** Implement decision-making statements (if, if-else, switch) and iterative structures (for, while, do-while).

LO2.2: Define and use functions effectively with arguments and return values.

LO2.3: Understand and apply concepts of structures, pointers, and their relationship with arrays and functions.

CO3: Learn fundamental data structures like stacks, queues, and linked lists, and their implementations in C.

LO3.1: Define and implement stacks and queues using arrays and linked lists.

LO3.2: Perform conversion of infix to prefix/postfix expressions and evaluate postfix expressions.

LO3.3: Implement linked lists including circular and doubly linked lists, and their operations like insertion and deletion.

CO4: Gain proficiency in sorting and searching algorithms and understand basic tree structures.

LO4.1: Implement sorting algorithms such as insertion sort, selection sort, and merge sort.

LO4.2: Implement searching algorithms like linear search and binary search.

LO4.3: Understand binary search trees (BST), perform insertion, searching, and traversals (preorder, inorder, postorder) recursively.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual		LO1.1	LO1.2, LO2.1 CO1	LO3.1		
Conceptual		LO2.3		LO3.2, LO4.3 CO3	LO4.1 CO4	
Procedural		LO2.2 CO2	LO3.3	LO4.2		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	S	W	W	W	W	S
CO2	S	S	M	S	M	W	M	S	W	S
CO3	S	S	M	S	M	W	M	S	W	S
CO4	S	S	M	S	S	W	M	S	W	S

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: C Programming Language **(L 12, H 12, M 12)**
Introduction, Importance of C, Character set, Tokens, keywords, identifier, constants, basic data types, variables: declaration & assigning values. Structure of C program Arithmetic operators, relational operators, logical operators, assignment operators, increment and decrement operators, conditional operators, bit wise operators, expressions and evaluation of expressions, type cast operator, implicit conversions, precedence of operators. Arrays-concepts, declaration, accessing elements, storing elements, two-dimensional and multi-dimensional arrays. Input output statement and library functions.

Unit-II: Decision making, branching & looping **(L 20, H 20, M 20)**
Decision making, branching and looping: if, if-else, else-if, switch statement, break, for loop, while loop and do loop. Functions: Defining functions, function arguments and passing, returning values from functions.

Structures: Defining and declaring a structure variable, accessing structure members, initializing a structure, copying and comparing structure variables, array of structures, arrays within structures, structures within structures, structures and functions. Pointers.

Introduction to C++: Object oriented programming, characteristics of an object-oriented language**.**

Unit-III: Data Structures **(L 14, H 14, M 14)**
Definition of stack, array implementation of stack, conversion of infix expression to prefix, postfix expressions, evaluation of postfix expression. Definition of Queue, Circular queues, Array implementation of queues. Linked List and its implementation, Link list implementation of stack and queue, Circular and doubly linked list**.**

Unit-IV: Searching and sorting **(L 14, H 14, M 14)**
Insertion sort, selection sort, bubble sort, merge sort, linear Search, binary search.

Trees: Introduction to trees, Binary search tree, Insertion and searching in a BST, pre order, post order and in order traversal (recursive).

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.**(20 Marks)**

Recommended Readings:

1. Let Us C, *Yashavant Kanetkar*, BPB Publications.
2. Programming in ANSI C, *Balagurusamy*, TMH.
3. Programming with C, *Byron S Gottfried*, Schaum Series.

4. The C Programming Language, *Brian W. Kernighan, Dennis M. Ritchie*, Prentice Hall
5. Pointers in C, *Yashavant Kanetkar*, BPB Publications.
6. Data Structures, *S. Sahni and E. Horowitz*, Galgotia Publications
7. Data Structures using C, *Tanenbaum*, Pearson/PHI.
8. Fundamentals of Computer Algorithms, *Ellis Horowitz and Sartaz Sahani*, Computer Science Press.

Course title: Digital Electronics
Nature of the course: Core
Course code: ELT-C-6
Total credits: 4
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course comprehensively covers digital electronics and logic design fundamentals. It begins with an in-depth study of number systems (decimal, binary, hexadecimal, octal), their conversions, and arithmetic operations. Students delve into Boolean algebra, exploring logic gates (AND, OR, NOT) and advanced operators (XOR, XNOR). Digital logic families (TTL, CMOS) are analyzed in terms of performance metrics and characteristics. Combinational logic analysis includes SOP, POS representations, Karnaugh map minimization, and designing multiplexers, decoders, adders, subtractors. Sequential logic design covers flip-flops (SR, JK, D), counters (synchronous, asynchronous), and programmable logic devices (ROM, PLA, PAL, CPLD, FPGA). Introduction to Verilog/VHDL covers module structure, data flow, behavioral, structural design styles, and simulation techniques.

Course Objectives: The course aims to provide a solid foundation in digital electronics and logic design. Students will master number systems and arithmetic operations, apply Boolean algebra to design logic circuits using basic and advanced gates, and minimize logic functions using Karnaugh maps. They will design and analyze combinational logic circuits like multiplexers, decoders, and adders/subtractors, and explore sequential logic circuits using flip-flops, registers, and counters. Additionally, students will gain practical experience with programmable logic devices and introductory proficiency in Verilog/VHDL for digital circuit description and simulation using various design styles.

Prerequisites:

- Basic understanding of mathematics, including arithmetic operations and number systems.
- Familiarity with fundamental concepts of logic and Boolean algebra.
- Prior knowledge of basic electronic components and circuits.
- Proficiency in problem-solving and analytical skills.

- Familiarity with any programming language or exposure to digital design concepts would be advantageous but not mandatory.

Course Outcomes (COs): The students will able to

CO1: Understand and apply various number systems and codes in digital systems.

LO1.1: Convert between decimal, binary, hexadecimal, and octal number systems.

LO1.2: Perform arithmetic operations (addition, subtraction, multiplication) in binary, octal, and hexadecimal systems.

LO1.3: Describe and apply Binary Coded Decimal (BCD) code and its representation.

CO2: Analyze and design combinational logic circuits using Boolean algebra and minimization techniques.

LO2.1: Simplify logic functions using Karnaugh maps and implement them using SOP and POS forms.

LO2.2: Design and analyze multiplexers, demultiplexers, encoders, and decoders.

LO2.3: Construct and analyze binary adders, subtractors, and parallel adder/subtractors.

CO3: Design and analyze sequential logic circuits using flip-flops and counters.

LO3.1: Describe and analyze different types of flip-flops (S-R, J-K, D, T) and their applications.

LO3.2: Design and analyze registers, synchronous and asynchronous counters, including ripple counters.

LO3.3: Explain state tables, state diagrams, and design sequential circuits using excitation tables and equations.

CO4: Introduce students to hardware description languages (Verilog/VHDL) for digital design.

LO4.1: Compare VHDL and Verilog, and understand their structure and design methodologies.

LO4.2: Describe the syntax and semantics of HDLs, including data flow, behavioral, and structural styles.

LO4.3: Demonstrate basic simulation of designs using Verilog/VHDL and understand different types of data types and expressions in HDLs.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		LO1.1	LO1.2	LO1.3 CO1		
Conceptual		LO2.1, LO2.2 LO3.1		LO3.1	LO4.1, LO4.2 CO4	
Procedural		LO2.3 CO2	LO3.2, LO3.3 CO3	LO4.3		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	S	M	M	W	M	M	M
CO2	M	S	M	S	M	S	M	M	S	S
CO3	M	M	S	S	M	M	S	S	M	M
CO4	M	M	M	S	M	S	S	S	M	S

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Number System and Codes **(L 17, H 17, M 17)**

Decimal, Binary, Hexadecimal and Octal number systems, base conversions, Binary, Octal and Hexadecimal arithmetic (addition, subtraction by complement method, multiplication), representation of signed and unsigned numbers, Binary Coded Decimal code.

Logic Gates and Boolean algebra: Introduction to Boolean algebra and Boolean operators, Truth tables of basic gates, Basic postulates and fundamental theorems of Boolean algebra, construction and symbolic representation of XOR, XNOR, Universal (NOR and NAND) gates.

Digital Logic families: Fan-in, Fan out, Noise Margin, Power Dissipation, Figure of merit, Speed power product, TTL and CMOS families and their comparison and interfacing.

Unit-II: Combinational Logic Analysis and Design **(L 17, H 17, M 17)**

Standard representation of logic functions (SOP and POS), Karnaugh map minimization, Encoder and Decoder, Multiplexers and Demultiplexers, Implementing logic functions with multiplexer, binary Adder, half and full adder, binary subtractor, parallel adder/subtractor.

Unit-III: Sequential Logic Design **(L 18, H 18, M 18)**

Latches and Flip flops, S-R Flip flop, J-K Flip flop, T and D type Flip flop, Clocked and edge triggered Flip flops, master slave flip flop, Registers, Counters (synchronous and asynchronous and modulo-N), Ripple counter, up and down counter State Table, State Diagrams, counter design using excitation table and equations, Ring counter and Johnson counter.

Programmable Logic Devices: Basic concepts- ROM, PLA, PAL, CPLD, FPGA

Unit-IV: Introduction to Verilog/VHDL **(L 8, H 8, M 8)**

A Brief History of HDL, Structure of HDL Module, Comparison of VHDL and Verilog, data flow style, behavioural style, structural style, mixed design style, simulating design.

Introduction to Language Elements, Keywords, Identifiers, White Space Characters, Comments, format, Integers, reals and strings. Logic Values, Data Types-net types, undeclared nets, scalars and vector nets, Register type, Parameters. Expressions, Operands, Operators, types of Expressions.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.**(20 Marks)**

Recommended Readings:

1. Digital System Design, *M. Morris Mano*, Pearson Education Asia.
2. Digital Fundamentals, *Thomas L. Flyod*, Pearson Education Asia.
3. Digital Electronics: An Introduction To Theory And Practice, *W. H. Gothmann*, Prentice Hall of India.
4. Digital Principles, *R. L. Tokheim*, Schaum's Outline Series, Tata McGraw- Hill.
5. A Verilog HDL Primer, *J. Bhasker*, BSP.
6. Verilog HDL-A guide to digital design and synthesis, *Samir Palnitkar*, Pearson.

Course title: Electronic Instrumentation
Course code: ELT-C-7
Nature of the course: Core
Total credits: 4
Distribution of marks: 80 (End sem) **+ 20** (In-sem)

Course Description: This course covers essential topics in instrumentation focusing on measurement principles and instruments. It begins with an exploration of measurement qualities, error analysis, and statistical methods. Students will study basic measurement instruments including PMMC instruments, galvanometers, and digital meters for DC and AC measurements. The curriculum includes in-depth discussions on measurement techniques for resistance, impedance, capacitance, and inductance using various bridge methods. Additionally, students will learn about A-D and D-A conversion techniques, oscilloscopes, signal generators, and various types of transducers for measuring physical quantities like displacement, pressure, temperature, and light.

Course Objectives: The objective of this course is to equip students with comprehensive knowledge and practical skills in instrumentation. By the end of the course, students will demonstrate proficiency in analyzing and minimizing measurement errors, understanding the characteristics and applications of basic measurement instruments, and utilizing various measurement techniques such as bridge methods for accurate determination of resistance, impedance, capacitance, and inductance. They will also gain hands-on experience with A-D and D-A conversion, oscilloscopes, signal generators, and different types of transducers for measuring diverse physical parameters effectively in real-world applications.

Prerequisites:

- Familiarity with electronic components, circuits, and their behavior, including basic measurement concepts such as voltage, current, and resistance.

- Understanding of fundamental principles in physics such as electricity, magnetism, and basic circuit theory. Proficiency in mathematics including algebra, trigonometry, and calculus is beneficial.

Course Outcomes (COs): The students will able to

CO1: Understand the specifications and characteristics of measurement instruments and their errors.

LO1.1: Differentiate between static and dynamic characteristics of instruments.

LO1.2: Analyze different types of errors in measurements (gross, systematic, absolute, relative) and perform uncertainty analysis.

LO1.3: Apply statistical methods for data analysis and curve fitting in measurement processes.

CO2: Learn various methods and bridges for measuring resistance, impedance, inductance, capacitance, and frequency.

LO2.1: Describe and apply Kelvin's double bridge method for low resistance measurements.

LO2.2: Explain the working principles of Wheatstone, Maxwell's, Hay's, and Anderson's bridges for different types of measurements.

LO2.3: Understand the principles and circuits of analog-to-digital (A-D) and digital-to-analog (D-A) converters, including binary weighted resistor and R-2R ladder types.

CO3: Understand the principles, applications, and specifications of oscilloscopes, spectrum analyzers, and signal generators.

LO3.1: Describe the working principles and specifications of CRT, digital storage, and sampling oscilloscopes.

LO3.2: Explain the principles and applications of spectrum analyzers and vector network analyzers.

LO3.3: Understand the operation and applications of various signal generators including audio oscillators, pulse generators, and function generators.

CO4: Learn about different types of transducers and sensors used in measurement systems.

LO4.1: Classify transducers based on their operation and characteristics as active or passive.

LO4.2: Describe the principles and applications of resistive, capacitive, inductive, and piezoelectric transducers.

LO4.3: Explain the measurement principles and applications of sensors for displacement, velocity, acceleration, pressure, temperature, and light.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual		LO1.1	LO2.1, LO2.2 CO2 LO4.1			
Conceptual		LO1.2, LO2.3 CO1	LO4.3 CO4			
Procedural		LO1.3	LO3.1, CO3 LO4.2			
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	W	W	W	W	S
CO2	S	S	M	M	M	W	W	W	W	S
CO3	S	S	M	M	M	W	W	W	W	S
CO4	S	S	M	M	M	W	W	W	W	S

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Qualities of Measurement (L 15, H 15, M 15)

Specifications of instruments, their static and dynamic characteristics, Error (Gross error, systematic error, absolute error and relative error) and uncertainty analysis. Statistical analysis of data and curve fitting.

Basic Measurement Instruments: Permanent Magnet Moving Coil (PMMC) instrument, galvanometer, DC measurement - ammeter, voltmeter, ohm meter, AC measurement, Digital voltmeter systems: integrating and non-integrating types, digital multimeters, digital frequency meter system: different modes and universal counter.

Connectors and Probes: Low capacitance probes, high voltage probes, current probes, identifying electronic connectors – audio and video, RF/Coaxial, USB etc.

Unit-II: Measurement of Impedance (L 15, H 15, M 15)

Low Resistance: Kelvin's double bridge method, Medium Resistance by Voltmeter Ammeter method, Wheatstone bridge method, High Resistance by Megger. A.C. bridges, Measurement of Self Inductance, Maxwell's bridge, Hay's bridge, and Anderson's bridge, Measurement of Capacitance, Schering's bridge, DeSauty's bridge, Measurement of frequency, Wien's bridge.

A-D and D-A Conversion: 4-bit binary weighted resistor type D-A conversion, circuit and working. Circuit of R-2R ladder. A-D conversion characteristics, successive approximation ADC and associated integrated circuits.

Unit-III: Oscilloscopes and Analyser **(L 15, H 15, M 15)**

CRT, wave form display and electrostatic focusing, time base and sweep synchronization, measurement of voltage, frequency and phase by CRO, Oscilloscope probes, Dual trace oscilloscope, Sampling Oscilloscope, DSO and Power scope: Block diagram, principle and working, Advantages and applications, CRO specifications (bandwidth, sensitivity, rise time). Spectrum analyser, Vector network analyser, LCR meter.

Signal Generators: Audio oscillator, Pulse Generator, Function generators**.**

Unit-IV: Sensors and Transducers **(L 15, H 15, M 15)**

Classification of transducers, Basic requirement/characteristics of transducers, active & passive transducers, Resistive (Potentiometer, Strain gauge – Theory, types, temperature compensation and applications), Capacitive (Variable Area Type – Variable Air Gap type – Variable Permittivity type), Inductive (LVDT) and piezoelectric transducers.

Measurement of displacement, velocity and acceleration (translational and rotational). Measurement of pressure (manometers, diaphragm, bellows), Measurement of temperature (RTD, thermistor, thermocouple, semiconductor IC sensors), Light transducers (photoresistors, photovoltaic cells, photodiodes).

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.**(20 Marks)**

Recommended Readings:

1. Electronic Instrumentation, *H. S. Kalsi*, TMH.
2. Electronic Instrumentation and Measurement Techniques, *W. D. Cooper and A. D. Helfrick*, Prentice-Hall.
3. Instrumentation Measurement and analysis, *B. C. Nakra, K. Chaudry*, TMH.
4. Measurement Systems: Application and Design, *E.O. Doebelin*, McGraw Hill.
5. Elements of Electronic Instrumentation and Measurement, *Joseph J Carr*, Pearson Education.
6. Electronic Instrumentation and Measurements, *David A. Bell*, Prentice Hall.
7. Electronic Measurements and Instrumentation, *Oliver and Cage*, TMH.
8. Measurement and Instrumentation Principles. *Alan S. Morris*, Elsevier.
9. Electrical and Electronics Measurements and Instrumentation, *K Sawhney*, Dhanpat Rai and Sons.
10. Instrumentation Devices and Systems, *S. Rangan, G. R. Sarma and V. S. Mani*, Tata McGraw Hills

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Course title: Electronics Lab I (Major)
Course code: ELT-C-8
Nature of the course: Core
Total credit assigned: 4
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course series provides hands-on experience in fundamental principles and practical applications of electronic circuits and devices. Students engage in experiments covering circuit elements such as resistors, capacitors, and inductors in various configurations, along with measurements using instruments like multimeters and oscilloscopes. They explore semiconductor devices including diodes, transistors, and operational amplifiers, studying their characteristics and applications. Practical sessions include designing rectifiers, power supplies, amplifiers, oscillators, and filters using discrete components and integrated circuits. The labs aim to develop skills in circuit analysis, measurement techniques, and the implementation of electronic circuits for diverse engineering applications.

Course Objectives: The objective of this laboratory course series is to provide students with hands-on experience and practical skills in fundamental electronic circuits and devices. Through a series of structured experiments, students will develop proficiency in analyzing, designing, and testing electronic circuits including resistive, capacitive, and inductive elements. They will study semiconductor devices such as diodes, transistors, operational amplifiers, and integrated circuits, exploring their characteristics and applications in detail. By the end of the course, students will be adept at using measurement instruments, designing circuit configurations, and applying theoretical concepts to real-world engineering challenges in electronics and instrumentation.

Prerequisites:

- Familiarity with fundamental concepts such as Ohm's law, Kirchhoff's laws, series and parallel circuits, and basic circuit analysis techniques.
- Understanding of diode and transistor operation, including I-V characteristics and basic configurations like CE, CB, and CC.
- Proficiency in using electronic components such as resistors, capacitors, and inductors in circuit configurations.

Course Outcomes (COs): The students will able to

CO1: Understanding Circuit Elements and Laws

- **LO1.1:** Apply knowledge of resistors, capacitors, and inductors in series, parallel, and series-parallel configurations to analyze and design circuits.
- **LO1.2:** Demonstrate understanding of voltage sources in different configurations and analyze voltage and current dividers.
- **LO1.4:** Perform accurate measurements of amplitude, frequency, and phase difference using a Cathode Ray Oscilloscope (CRO).
- **LO1.5:** Apply Kirchhoff's laws and verify Norton's, Thevenin's, Superposition, and Maximum Power Transfer theorems in practical circuits.

LO1.6: Analyze and predict the behavior of RC circuits including time constant, differentiator, and integrator circuits.

LO1.7: Design and evaluate frequency response characteristics of Low Pass and High Pass RC Filters.

LO1.8: Analyze and determine critical parameters of LCR circuits including resonant frequency, impedance at resonance, quality factor (Q), and bandwidth.

CO2: Study of Semiconductor Device Characteristics

LO2.1: Analyze and interpret I-V characteristics of diodes (ordinary and Zener), and different configurations of Bipolar Junction Transistors (BJTs) and Field Effect Transistors (FETs).

LO2.2: Study and interpret characteristics of specialized semiconductor devices like UJT, SCR, and Solar Cells.

LO2.3: Apply knowledge of semiconductor devices to practical applications such as amplifiers, oscillators, and sensors.

CO3: Understand Rectifiers and Power Supplies

LO3.1: Design, simulate, and test half wave and full wave rectifiers and design and test power supply circuits using different configurations including C filter and Zener diode.

LO3.2: Design, simulate, and test different amplifier configurations including CE amplifier and Class A, B, and C power amplifiers.

LO3.3: Design and analyze oscillators including Colpitts, Hartley, and Phase Shift Oscillators.

CO4: Understand Op-Amp Characteristics and Applications

LO4.1: Analyze characteristics such as CMRR and Slew Rate of operational amplifiers (op-amps).

LO4.2: Design and test various op-amp circuits including inverting and non-inverting amplifiers, adders, subtractors, integrators, and differentiators.

LO4.3: Study and implement IC 555 Timer circuits as astable and monostable multivibrators.

LO4.4: Design and test voltage regulator circuits using IC regulators (78 series and 79 series).

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual		LO1.2, LO1.4, LO2.2,	LO1.1, LO1.7, LO3.1, LO4.1	LO1.5, LO2.1, LO3.3, CO2		
Conceptual		LO1.8,	LO2.3			
Procedural		LO1.1, LO1.6, LO1.7, LO3.1, LO3.2, LO3.3	LO3.1, LO3.2, LO4.2, LO4.3	LO1.6, LO1.8 CO1 LO4.1,		

				CO3 CO4		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	W	W	W	W	S
CO2	S	S	M	M	M	W	W	W	W	S
CO3	S	S	M	M	M	W	W	W	W	S
CO4	S	S	M	M	M	W	W	W	W	S

S: Strong, M: Medium, W: Weak

List of Experiments:

A. Basic Circuit Theory and Network Analysis Lab

1. Familiarization with
   a. Resistance in series, parallel and series – parallel.
   b. Capacitors & inductors in series & parallel.
   c. Multimeter – Testing of components.
   d. Voltage sources in series, parallel and series – parallel.
   e. Voltage and current dividers.
2. Measurement of Amplitude, Frequency & Phase difference using CRO.
3. Verification of Kirchhoff's Law.
4. Verification of Norton's theorem.
5. Verification of Thevenin's theorem.
6. Verification of Superposition theorem.
7. Verification of the Maximum Power Transfer theorem.
8. RC Circuits: Time Constant, Differentiator, Integrator.
9. Designing of a Low Pass RC Filter and study of its Frequency Response.
10. Designing of a High Pass RC Filter and study of its Frequency Response.
11. Study of the Frequency Response of a Series LCR Circuit and determination of its (a) Resonant Frequency, (b) Impedance at Resonance, (c) Quality Factor Q, and (d) Band Width.

B. Semiconductor Devices Lab

1. Study of the I-V Characteristics of Diode – Ordinary and Zener Diode.
2. Study of the I-V Characteristics of the CE configuration of BJT and obtain r_i, r_o, β.
3. Study of the I-V Characteristics of the Common Base Configuration of BJT and obtain r_i, r_o, α.
4. Study of the I-V Characteristics of the Common Collector Configuration of BJT and obtain voltage gain, r_i, r_o,.

5. Study of the I-V Characteristics of the UJT.
6. Study of the I-V Characteristics of the SCR.
7. Study of the I-V Characteristics of JFET.
8. Study of the I-V Characteristics of MOSFET.
9. Study of Characteristics of Solar Cell
10. Study of Hall Effect.

C. Electronics Circuit Lab

1. Study of the half wave rectifier and Full wave rectifier.
2. Study of power supply using C filter and Zener diode.
3. Designing and testing of 5V/9 V DC regulated power supply and find its load-regulation.
4. Study of clipping and clamping circuits.
5. Study of Fixed Bias, Voltage divider and Collector-to-Base bias Feedback configuration for transistors.
6. Designing of a Single Stage CE amplifier.
7. Study of Class A, B and C Power Amplifier.
8. Study of the Colpitts's Oscillator.
9. Study of the Hartley's Oscillator.
10. Study of the Phase Shift Oscillator
11. Study of the frequency response of Common Source FET amplifier.

D. Operational Amplifiers and Application Lab

1. Study of op-amp characteristics: CMRR and Slew rate.
2. Designing of an amplifier of given gain for an inverting and non-inverting configuration using an op-amp.
3. Designing of analog adder and subtractor circuit.
4. Designing of an integrator using op-amp for a given specification and study its frequency response.
5. Designing of a differentiator using op-amp for a given specification and study its frequency response.
6. Designing of a First Order Low-pass filter using op-amp.
7. Designing of a First Order High-pass filter using op-amp.
8. Designing of a RC Phase Shift Oscillator using op-amp.
9. Study of IC 555 as an astable multivibrator.
10. Study of IC 555 as monostable multivibrator.
11. Designing of Fixed voltage power supply using IC regulators using 78 series and 79 series.

(Total Practical Classes 60, Total Contact Hours 120, Total Marks 60)

At least 30% of the experiments must be performed from each unit.

Mode of In-semester Assessment:

1. Viva-voce: **(Marks 20)**
2. Attendance / Laboratory performance / Notebook: **(Marks 20)**

Mode of End-semester Assessment:

Examination on Laboratory Experiments: **(Marks 60)**

Two experiments (not more than one from a single unit) from the list to be performed.

Semester V

Course title: Analog Communication
Course code: ELT-C-9
Nature of the course: Core
Total credit assigned: 4
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides an in-depth understanding of electronic communication systems, including modulation techniques, noise analysis, and digital communication methods. Students will learn the fundamentals of amplitude, frequency, and phase modulation, and explore both analog and digital pulse modulation techniques. The course covers the design and functioning of AM and FM transmitters and receivers, as well as along with pulse analog modulation techniques such as PAM, PDM, and PPM. The course also introduces information theory and coding, emphasizing Shannon's theorem and channel capacity. Through theoretical insights and practical applications, students will gain a comprehensive understanding of modern communication systems and their real-world implementations.

Course Objectives: The objective of this course is to equip students with a comprehensive understanding of electronic communication systems. Students will gain insights into the electromagnetic spectrum, noise types, and the necessity of modulation. The course aims to develop proficiency in amplitude, frequency, and phase modulation techniques, and their respective transmitters and receivers. Additionally, students will learn about pulse analog modulation, pulse code modulation, and understand the significance of channel capacity and information theory. By the end of the course, students will be adept at analyzing and designing analog communication systems, addressing real-world engineering challenges.

Prerequisites:

- **Basic Electronics:** Understanding of fundamental electronic components and circuits.
- **Signal and Systems:** Familiarity with basic concepts of signals, systems, and Fourier transforms.

- **Mathematics:** Proficiency in algebra, calculus, and probability for noise analysis and modulation techniques.

Course Outcomes (COs): The students will able to

CO1: Understand the fundamentals of electronic communication systems, including modulation concepts and noise characteristics.

LO1.1: Describe the block diagram of an electronic communication system and explain its components.

LO1.2: Define electromagnetic spectrum bands and their applications in communication.

LO1.3: Explain the need for modulation, types of channels, and characteristics of base-band signals and noise.

CO2: Gain knowledge of amplitude modulation (AM) and angle modulation (FM, PM), their generation, detection methods, and spectral characteristics.

LO2.1: Describe amplitude modulation (AM), modulation index, and the frequency spectrum of AM signals.

LO2.2: Explain the generation and detection of AM signals, including double side band suppressed carrier (DSB-SC) and single side band (SSB) modulation.

LO2.3: Understand frequency modulation (FM), phase modulation (PM), their equivalence, and the techniques for FM generation and detection.

CO3: Learn about pulse analog modulation techniques (PAM, PDM, PPM), multiplexing (TDM, FDM), and pulse code modulation (PCM) principles.

LO3.1: Describe pulse analog modulation techniques (PAM, PDM, PPM) and their applications.

LO3.2: Explain the concepts of channel capacity, sampling theorem, and multiplexing techniques (TDM, FDM).

LO3.2: Understand pulse code modulation (PCM), quantization processes, companding, coding, decoding, and regeneration in digital transmission.

CO4: Understand the concepts of information theory and coding.

LO4.1: Understand the concepts of discrete messages, information content, and average information.

LO4.2: Explain Shannon's theorem and channel capacity.

LO4.3: Understand the concept of Gaussian channels and the bandwidth S/N trade-off.

LO4.4: Evaluate the efficiency of different coding schemes in increasing average information per bit.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual		LO1.1, LO2.1		LO3.1, LO4.1		
Conceptual		LO1.2, LO2.3, CO1	LO3.2	LO4.2	LO4.3 CO4	

Procedural		LO1.4, LO2.2, LO3.3, CO2	LO3.1, LO4.4, CO3			
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	M	W	M	W	W	S
CO2	S	S	W	S	W	W	W	W	W	S
CO3	S	S	W	S	M	W	W	M	W	S
CO4	S	S	W	S	S	W	W	M	W	S

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Electronic communication (L 10, H 10, M 10)
Block diagram of an electronic communication system, Concept of Noise, Types of Noise, Signal to noise ratio, Noise Figure, Noise Temperature, Friss formula, electromagnetic spectrum-band designations and applications, need for modulation, concept of channels and base-band signals.

Unit-II: Amplitude Modulation (L 20, H 20, M 20)
Amplitude Modulation, modulation index and frequency spectrum. Generation of AM, Amplitude Demodulation (diode detector), Concept of Double side band suppressed carrier, Single side band suppressed carrier, Pilot Carrier Modulation, Vestigial Side Band modulation, Independent Side Band Modulation; block diagram of AM Transmitter and Receiver.

Angle modulation: Frequency and Phase modulation, modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM (direct and indirect methods), PLL as FM detector; Block diagram of FM Transmitter and Receiver Comparison between AM, FM and PM.

Unit-III: Pulse Analog and Code Modulations (L 20, H 20, M 20)
Channel capacity, Sampling theorem, PAM, PDM, PPM modulation and detection techniques, DPCM, DM, ADM, Multiplexing, TDM and FDM.

Need for digital transmission, Quantizing, Uniform and Non-uniform Quantization, Quantization Noise, Companding, Coding, Decoding, Regeneration.

Unit-IV: Information Theory and Coding (L 10, H 10, M 10)
Discrete Messages, concepts of information content, average information, entropy, information rate, coding to increase average information per bit, Shannon’s theorem, channel capacity, concept of Gaussian channel, bandwidth S/N trade-off.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.**(20 Marks)**

Recommended Readings:

1. Electronic communication systems, *Kennedy*, McGraw international publications.
2. Principles of Electronic communication systems. *Frenzel*, McGraw Hill.
3. Communication Systems, *S. Haykin*, Wiley India.
4. Advanced electronic communications systems, *Tomasi*, PHI.
5. Communication Systems, *S. Haykin*, Wiley India.
6. Principle of Communication Systems, *Taub, Schilling*, Tata McGraw Hill.

Course title: Signals and Systems
Course code: ELT-C-10
Nature of the course: Core
Total credits: 4
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course introduces the fundamental concepts of signals and systems, emphasizing both continuous and discrete-time signals and systems. Students will explore linear time-invariant (LTI) systems, the convolution operation, and key system properties. The course also covers the Fourier series and Fourier transform for signal representation and analysis, along with their properties and applications in frequency-selective filtering. Additionally, students will learn about the Laplace transform and its application in circuit analysis, providing a comprehensive understanding of signal processing and system behavior.

Course Objectives: The objective of this course is to provide students with a solid foundation in signals and systems. Students will learn to classify and transform continuous and discrete-time signals and understand the properties and behaviors of LTI systems. The course aims to develop proficiency in using the Fourier series and Fourier transform for signal analysis and the Laplace transform for solving circuit equations. By the end of the course, students will be able to apply these mathematical tools to analyze and design systems in various engineering applications.

Prerequisites:

- **Basic Mathematics:** Proficiency in calculus, differential equations, and linear algebra.
- **Basic Circuit Theory:** Understanding of fundamental electrical circuit concepts and components.

Course Outcomes (COs): The students will able to

CO1: Understand the fundamentals of continuous and discrete-time signals and systems, including basic properties and transformations.

- **LO1.1:** Differentiate between continuous and discrete-time signals and their transformation properties.
- **LO1.2:** Identify and analyze exponential, sinusoidal, impulse, and unit step functions.
- **LO1.3:** Describe the properties of continuous-time and discrete-time systems and their basic characteristics.

CO2: Gain knowledge of linear time-invariant systems, including convolution, system properties, and differential/difference equation formulations.

- **LO2.1:** Explain the concept of linear time-invariant (LTI) systems and their convolution sum/integral.
- **LO2.2:** Analyze properties such as commutativity, distributivity, and associativity in LTI systems.
- **LO2.3:** Evaluate the stability, causality, and unit step response of LTI systems, both with and without memory.

CO3: Understand Fourier series representation of periodic signals and Fourier transform for aperiodic signals, along with frequency-selective filters.

- **LO3.1:** Analyze continuous-time and discrete-time periodic signals and their Fourier series representation.
- **LO3.2:** Discuss the convergence and properties of Fourier series and Fourier transform.
- **LO3.2:** Apply Fourier transform techniques to analyze signals, including convolution properties and basic transform pairs.

CO4: Learn Laplace transform methods for circuit analysis, including impulse response and step response of RL, RC, and RLC circuits.

- **LO4.1:** Understand the Laplace transform and its properties, including inverse Laplace transform and transform pairs.
- **LO4.2:** Apply Laplace transform techniques to analyze signals in circuit analysis, focusing on RL, RC, and RLC circuits.
- **LO4.3:** Analyze the impulse and step responses of systems using Laplace transform methods, including system stability and time-domain analysis.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual				LO1.1, LO3.1		
Conceptual		LO1.2, LO1.3	LO2.1, LO3.2	LO2.2, LO3.2 CO1 CO2 CO3	LO4.1 CO4	
Procedural			LO4.2, LO4.3	LO2.3		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	M	W	M	W	W	S
CO2	S	S	W	S	W	W	W	W	W	S
CO3	S	S	W	S	M	W	W	M	W	S
CO4	S	S	W	S	S	W	W	M	W	S

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Signals and Systems **(L 18, H 18, M 18)**
Continuous and discrete time signals, Transformation of the independent variable, Exponential and sinusoidal signals, Impulse and unit step functions, Continuous-Time and Discrete-Time Systems, Basic System Properties.

Unit-II: Linear Time -Invariant Systems (LTI) **(L 12, H 12, M 12)**
Discrete time LTI systems, the Convolution Sum, Continuous time LTI systems, the Convolution integral. Properties of LTI systems, Commutative, Distributive, Associative systems with and without memory, Invariability, Causality, Stability, Unit Step response. Differential and Difference equation formulation, Block diagram representation of first order systems.

Unit-III: Fourier Series Representation of Periodic Signals **(L 18, H 18, M 18)**
Continuous-Time periodic signals, Convergence of the Fourier series, Properties of continuous-Time Fourier series, Discrete-Time periodic signals, Properties of Discrete-Time Fourier series. Frequency-Selective filters, Simple RC high-pass and low-pass filters.

Fourier Transform: Aperiodic signals, Periodic signals, Properties of Continuous-time Fourier transform, Convolution and Multiplication Properties, Properties of Fourier transform and basic Fourier transform Pairs.

Unit-IV: Laplace Transform **(L 12, H 12, M 12)**
Laplace Transform, Inverse Laplace Transform, Properties of the Laplace Transform, Laplace Transform Pairs, Laplace Transform for signals, Laplace Transform Methods in Circuit Analysis, Impulse and Step response of RL, RC and RLC circuits.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.**(20 Marks)**

Recommended Readings:

1. Signals and Systems, *V. Oppenheim, A. S. Wilsky and S. H. Nawab*, Pearson Education.

2. Signal and Systems, *S. Haykin and B. V. Veen*, John Wiley & Sons.
3. Fundamentals of Electric Circuits, *C. Alexander and M. Sadiku*, McGraw Hill.
4. Signals and Systems, *H. P. Hsu*, Tata McGraw Hill.
5. Signal and Systems: with MATLAB Computing and Simulink Modelling, *S. T. Karris*, Orchard Publications.
6. Signals and Systems with MATLAB, *W. Y. Young*, Springer.
7. Fundamentals of Signals and Systems, *M. Roberts*, Tata McGraw Hill.

Course title: Electronics Lab II
Course code: ELT-C-11
Nature of the course: Core
Total credits: 4
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This comprehensive course on programming and digital systems provides practical and theoretical knowledge essential for mastering both C programming and various fundamental electronics concepts. The course is divided into several units covering diverse topics:

1. **Data Structures, C & C++ Programming**: Students will gain hands-on experience in C programming, focusing on algorithms, data manipulation, and implementing data structures such as arrays, matrices, linked lists, stacks, queues, and trees. Key programming concepts such as recursion, sorting, and searching algorithms are emphasized to build a strong foundation in computer science.
2. **Digital Electronics**: The lab component includes designing and verifying logic gates, adders, subtractors, multiplexers, flip-flops, counters, and shift registers. This unit emphasizes the practical application of digital circuit design and analysis using logic gate ICs and coding.
3. **Electronics Instrumentation**: Students will learn to design and use various measurement instruments, such as ammeters, voltmeters, and bridges for resistance, capacitance, and inductance measurement. The unit also covers transducer characteristics and the use of sensors for temperature, strain, light, and more.
4. **Analog Communication**: Students will explore amplitude and frequency modulation/demodulation, pulse modulation techniques, and the basics of digital communication systems. Practical lab exercises include working with AM and FM transmitters/receivers, and studying various modulation schemes like PAM, PWM, PCM.
5. **Signals and Systems**: The course covers the analysis of continuous and discrete signals, transformation of signals, and system properties. Students will learn about

linear time-invariant systems, Fourier series and transforms, Laplace transforms, and their applications in signal processing and circuit analysis.

Course Objectives: This course aims to provide students with a solid foundation in both programming and digital electronics, preparing them for advanced studies and professional careers in the fields of electronics, computer science, and engineering. The primary objectives of this course are:

1. **Develop Proficiency in C Programming**: Equip students with the skills to write efficient C programs, focusing on algorithms, data manipulation, and the implementation of data structures such as arrays, linked lists, stacks, queues, and trees.
2. **Understand Digital Electronics Concepts**: Enable students to design, analyze, and implement digital circuits using logic gates, adders, subtractors, multiplexers, flip-flops, counters, and shift registers, enhancing their practical skills in digital system design.
3. **Master Electronics Instrumentation Techniques**: Teach students to design and use various measurement instruments, understand the characteristics and applications of different transducers and sensors, and perform accurate measurements of resistance, capacitance, inductance, and temperature.
4. **Gain Practical Experience with Microprocessors and Microcontrollers**: Provide hands-on experience with 8085 microprocessor assembly language programming and PIC microcontroller C programming, focusing on data transfer, arithmetic operations, and interfacing with peripherals like LEDs, relays, and stepper motors.
5. **Explore Communication Electronics**: Familiarize students with the principles of amplitude and frequency modulation/demodulation, pulse modulation techniques, and digital communication systems, including practical exercises with AM and FM transmitters/receivers and various modulation schemes like PAM, PWM, and PCM.
6. **Analyze Signals and Systems**: Introduce students to the analysis of continuous and discrete signals, transformation techniques, linear time-invariant systems, and the application of Fourier series, Fourier transforms, and Laplace transforms in signal processing and circuit analysis.

Prerequisites:

- **Basic Knowledge of Mathematics**: Familiarity with algebra, calculus, and linear algebra to understand signal transformations, system properties, and the behavior of electronic circuits.
- **Fundamentals of Physics**: Understanding of basic physics concepts, especially in electricity and magnetism, which are essential for grasping electronic circuit theory and signal behavior.
- **Introduction to Programming**: Basic programming skills, preferably in C or a similar language, to handle algorithms and implement data structures efficiently.

- **Foundations of Electrical Circuits**: Basic understanding of electrical circuits, including components like resistors, capacitors, and inductors, as well as basic circuit laws and theorems such as Ohm's law and Kirchhoff's laws.
- **Basic Digital Logic**: Familiarity with digital logic concepts, including binary numbers, basic logic gates, and Boolean algebra, to facilitate learning in digital electronics and circuit design

Course Outcomes (COs): The students will able to

CO1: Understand fundamental concepts of C & C++ Programming Language.

- **LO1.1:** Identify and use basic syntax and semantics of C programming language.
- **LO1.2:** Demonstrate understanding of data types, variables, and constants in C.
- **LO1.3:** Implement control structures such as loops and decision-making statements in C programs.
- **LO1.4:** Develop functions and understand function calling mechanisms in C.
- **LO1.5:** Utilize arrays and strings effectively in C programs.
- **LO1.6:** Apply pointers and dynamic memory allocation in C programming.

CO2: Implement fundamental data structures in C & C++.

- **LO2.1:** Implement arrays, linked lists (linear and circular), stacks, and queues using C & C++ programming.
- **LO2.2:** Perform basic operations (insertion, deletion, traversal) on implemented data structures.
- **LO2.3:** Analyze and compare the efficiency of different data structures in terms of time and space complexity.

CO3: Apply algorithms for sorting and searching.

- **LO3.1:** Implement sorting algorithms (e.g., Insertion sort, Merge sort) and analyze their performance in C & C++.
- **LO3.2:** Implement searching algorithms (e.g., Linear search, Binary search) and evaluate their efficiency in C & C++.

CO4: Develop problem-solving skills using C & C++ programming.

- **LO4.1:** Analyze problem statements and formulate solutions using structured programming techniques in C & C++.
- **LO4.2:** Apply debugging and testing techniques to identify and fix errors in C & C++ programs.
- **LO4.3:** Develop modular and reusable code by applying principles of software engineering in C & C++ programming.

CO5: Understand the basics of memory management in C & C++.

- **LO5.1:** Explain the concepts of static, stack, and heap memory allocation in C & C++.
- **LO5.2:** Implement dynamic memory allocation and deallocation using malloc(), calloc(), realloc(), and free() functions in C.

CO6: Gain proficiency in problem analysis and algorithm design.

- **LO6.1:** Analyze algorithmic problems and design efficient algorithms using C & C++ programming constructs.
- **LO6.2:** Evaluate the correctness and efficiency of algorithms through testing and benchmarking in C & C++.

CO7: Understand Basic Digital Logic Circuits and Components.

- **LO7.1:** Explain the operation and truth tables of basic logic gates (AND, OR, NOT, XOR).
- **LO7.2:** Design AND, OR, NOT, and XOR gates using NAND gates and verify their functionality.
- **LO7.3:** Convert Boolean expressions into logic gate circuits and implement them using logic gate ICs.
- **LO7.4:** Analyze and interpret the behavior of basic digital circuits.

CO8: Design and Implement Arithmetic Circuits.

- **LO8.1:** Design Half Adder and Full Adder circuits using basic logic gates.
- **LO8.2:** Design Half Subtractor and Full Subtractor circuits using basic logic gates.
- **LO8.3:** Construct and verify the functionality of a 4-bit Adder circuit.
- **LO8.4:** Understand the applications and limitations of arithmetic circuits in digital systems.

CO9: Explore Sequential Logic Design.

- **LO9.1:** Construct Flip-Flop circuits (RS, Clocked RS, D-type) using elementary gates.
- **LO9.2:** Design and implement counters using D, T, and JK Flip-Flops.
- **LO9.3:** Design a shift register and study serial and parallel shifting of data.
- **LO9.4:** Analyze the behavior of sequential circuits under different clocking conditions.

CO10: Master Advanced Digital Logic Circuits.

- **LO10.1:** Implement Multiplexers (4x1, 8x1) and Demultiplexers using logic gates.
- **LO10.2:** Design and implement Decoders (2x4, 3x8), Encoders, and Priority Encoders.
- **LO10.3:** Construct and simulate a 2-bit Magnitude Comparator circuit.
- **LO10.4:** Implement and analyze the operation of a 3-bit Ripple Counter.

CO11: Apply Digital Logic Skills to Practical Applications.

- **LO11.1:** Write code to realize basic and derived logic gates.
- **LO11.2:** Develop troubleshooting and debugging skills for digital circuits.
- **LO11.3:** Demonstrate effective teamwork and collaboration in lab experiments.
- **LO11.4:** Document experimental results and present findings effectively.

CO12: Understand Basic Measurement Techniques and Instrumentation Principles.

- **LO12.1:** Design multi-range ammeter and voltmeter circuits using galvanometer principles.
- **LO12.2:** Analyze the operation and calibration of ammeters and voltmeters for accurate measurement.
- **LO12.3:** Demonstrate proficiency in using basic measurement instruments in practical applications.

CO13: Resistance Measurement Techniques.

- **LO13.1:** Perform resistance measurements using Wheatstone bridge configuration.
- **LO13.2:** Measure bridge sensitivity and understand its implications in measurement accuracy.
- **LO13.3:** Utilize Kelvin's double bridge for accurate measurement of low resistances.

CO14: Learn Capacitance Measurement Techniques.

- **LO14.1:** Measure capacitance using de'Sauty's bridge method.
- **LO14.2:** Understand the principles of capacitive measurement and bridge balance.

CO15: Explore Transducer Characteristics.

- **LO15.1:** Determine the characteristics of resistance transducers such as Strain Gauges using half and full bridge configurations.
- **LO15.2:** Study the characteristics of LVDT (Linear Variable Differential Transformer) and understand its application in displacement measurement.

CO16: Study Temperature Measurement Techniques.

- **LO16.1:** Measure temperature using Thermocouples and understand the principles of thermoelectric measurement.
- **LO16.2:** Study temperature sensors like AD590, PT-100, J-type, and K-type thermocouples for their characteristics and applications.

CO17: Understand Optoelectronic Sensors.

- **LO17.2:** Study the characteristics of Light Dependent Resistors (LDR), Photodiodes, and Phototransistors.
- **LO17.3:** Perform experiments on variable illumination and linear displacement using optoelectronic sensors.

CO18: Explore Advanced Sensors.

- **LO18.1:** Study the characteristics of one Solid State sensor or Fiber Optic sensor.
- **LO18.2:** Analyze the principles of operation and applications of advanced sensors in modern instrumentation.

CO21: Understanding Analog Modulation Techniques.

- **LO21.1:** Study the principles and characteristics of Amplitude Modulation (AM) Amplitude Demodulation techniques.
- **LO21.2:** Study the principles and characteristics of Frequency Modulation (FM) and Frequency Demodulation techniques.
- **LO21.3:** Perform experiments to understand Pulse Amplitude Modulation (PAM) and its applications.

CO22: Practical Implementation of Analog Communication Systems.

- **LO22.1:** Design and analyze AM Transmitter and Receiver circuits.
- **LO22.2:** Design and analyze FM Transmitter and Receiver circuits.
- **LO22.3:** Study and implement Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM) techniques.

CO23: Signal Generation and Manipulation.

- **LO23.1:** Generate continuous-time signals and analyze their properties.
- **LO23.2:** Generate discrete-time signals and understand their representation in discrete systems.
- **LO23.3:** Perform time shifting and time scaling operations on signals to observe their effects.

CO24: Signal Analysis Techniques.

- **LO24.1:** Understand and apply convolution of signals to analyze system responses.
- **LO24.2:** Solve difference equations to model discrete-time systems and understand their solutions.

CO25: Fourier Analysis of Signals.

- **LO25.1:** Represent continuous-time signals using Fourier series and analyze their spectra.
- **LO25.2:** Compute the Fourier transform of continuous-time signals and interpret their frequency content.

CO26: Laplace Transform and System Analysis.

LO26.1: Apply Laplace transform to continuous-time signals for system analysis and stability assessment.

CO27: Introduction to System Simulation.

LO27.1: Utilize Xcos or similar software to simulate systems represented by block diagrams.

LO27.2: Calculate and analyze the output of systems using simulation tools for practical applications.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1, LO2.2, LO12.1, LO13.1, LO14.1, LO15.1, LO17.3	LO1.2, LO5.1, LO6.1, LO16.1 CO1	LO2.1, LO5.2, LO10.2, LO13.2, LO21.1 LO4.2,	LO7.4, LO8.3, LO10.4	LO14.2, LO15.2, LO24.2	
Conceptual		LO1.4, LO3.2, LO6.1, LO10.2, LO21.2	LO7.1, LO8.2	LO9.4, LO22.3		
Procedural		LO2.2, LO3.1, LO4.1, LO6.2, LO10.1, LO22.1 CO2	LO2.1, LO3.1, LO4.3, LO8.2, LO8.4 CO3, CO4, CO5	LO9.1, LO9.3, LO22.2, LO23.3 CO6, CO7, CO8,CO9 CO10, CO11	CO12, CO13, CO14, CO15	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	W	M	S	W	M	W	M	S
CO2	M	S	W	S	M	S	W	M	S	M
CO3	S	W	S	M	S	M	S	W	M	S
CO4	W	M	S	S	W	M	S	S	M	W
CO5	S	W	M	S	M	W	S	M	S	M
CO6	M	S	W	M	S	S	W	M	S	W
CO7	S	W	M	S	M	W	S	S	W	M
CO8	M	S	S	W	M	S	W	M	S	W
CO9	W	M	S	S	W	M	S	S	M	W
CO10	S	W	M	S	M	S	W	M	S	M
CO11	M	S	W	M	S	S	W	M	S	W
CO12	S	W	M	S	M	W	S	S	W	M
CO13	M	S	S	W	M	S	W	M	S	W
CO14	W	M	S	S	W	M	S	S	M	W
CO15	S	W	M	S	M	W	S	M	S	M
CO16	M	S	W	M	S	S	W	M	S	W
CO17	S	W	M	S	M	W	S	S	W	M
CO18	M	S	S	W	M	S	W	M	S	W

CO21	W	M	S	S	W	M	S	S	M	W
CO22	S	W	M	S	M	W	S	M	S	S
CO23	M	S	W	M	S	S	W	M	S	W
CO24	S	W	M	S	M	W	S	S	W	M
CO25	M	S	S	W	M	S	W	M	S	W
CO26	W	M	S	S	W	M	S	S	M	W
CO27	S	W	M	S	M	W	S	M	S	S

S: Strong, M: Medium, W: Weak

List of Experiments:

A. Data Structures, C & C++ Programming Lab:

1. Generate the Fibonacci series up to the given limit N and also print the number of elements in the series.
2. Find minimum and maximum of N numbers.
3. Find the GCD of two integer numbers.
4. Calculate factorial of a given number.
5. Find all the roots of a quadratic equation $Ax^2 + Bx + C = 0$ for non-zero coefficients A, B and C. Else report error.
6. Calculate the value of sin (x) and cos (x) using the series. Also print sin (x) and cos (x) value using library function.
7. Generate and print prime numbers up to an integer N.
8. Sort given N numbers in ascending order.
9. Find the sum & difference of two matrices of order MxN and PxQ.
10. Find the product of two matrices of order MxN and PxQ.
11. Find the transpose of given MxN matrix.
12. Find the sum of principle and secondary diagonal elements of the given MxN matrix.
13. Calculate the subject wise and student wise totals and store them as a part of the structure.
14. Maintain an account of a customer using classes.
15. Implement linear and circular linked lists using single and double pointers.
16. Create a stack and perform Pop, Push, Traverse operations on the stack using Linear Linked list
17. Create circular linked list having information about a college and perform Insertion at front, Deletion at end.
18. Create a Linear Queue using Linked List and implement different operations such as Insert, Delete, and Display the queue elements.
19. Implement polynomial addition and subtraction using linked lists.
20. Implement sparse matrices using arrays and linked lists.
21. Create a Binary Tree to perform Tree traversals (Preorder, Postorder, Inorder) using the concept of recursion.
22. Implement binary search tree using linked lists. Compare its time complexity over that of linear search.

23. Implement Insertion sort, Merge sort, Bubble sort, Selection sort.

B. Digital Electronics Lab:

1. To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. To convert a Boolean expression into logic gate circuit and assemble it using logic gate IC's.
3. Design a Half and Full Adder.
4. Design a Half and Full Subtractor.
5. Design a seven-segment display driver.
6. Design a 4 x 1 Multiplexer using gates.
7. To build a Flip- Flop Circuits using elementary gates. (RS, Clocked RS, D-type).
8. Design a counter using D/T/JK Flip-Flop.
9. Design a shift register and study Serial and parallel shifting of data.
10. Write code to realize basic and derived logic gates.
11. Half adder, Full Adder using basic and derived gates.
12. Half subtractor and Full Subtractor using basic and derived gates.
13. Clocked D FF, T FF and JK FF (with Reset inputs).
14. Multiplexer (4x1, 8x1) and Demultiplexer using logic gates.
15. Decoder (2x4, 3x8), Encoders and Priority Encoders.
16. Design and simulation of a 4-bit Adder.
17. Code converters (Binary to Gray and vice versa).
18. 2-bit Magnitude comparator.
19. 3-bit Ripple counter

C. Electronics Instrumentation Lab:

1. Design of multi range ammeter and voltmeter using galvanometer.
2. Measurement of resistance by Wheatstone bridge and measurement of bridge sensitivity.
3. Measurement of Capacitance by de'Sautys.
4. Measure of low resistance by Kelvin's double bridge.
5. To determine the Characteristics of resistance transducer - Strain Gauge (Measurement of Strain using half and full bridge.)
6. To determine the Characteristics of LVDT.
7. To determine the Characteristics of Thermistors and RTD.
8. Measurement of temperature by Thermocouples and study of transducers like AD590 (two terminal temperature sensor), PT-100, J- type, K-type.
9. To study the Characteristics of LDR, Photodiode, and Phototransistor:
   a) Variable Illumination.
   b) Linear Displacement.
10. Characteristics of one Solid State sensor/ Fiber optic sensor).

D. Analog Communication Lab:

1. Study of Amplitude Modulation
2. Study of Amplitude Demodulation
3. Study of Frequency Modulation

4. Study of Frequency Demodulation
5. Study of Pulse Amplitude Modulation
6. AM Transmitter/Receiver
7. FM Transmitter/Receiver
8. Study of TDM, FDM
9. Study of Pulse Width Modulation
10. Study of Pulse Position Modulation
11. Study of Pulse Code Modulation
12. Study of Amplitude Shift Keying
13. Study of Phase Shift Keying,
14. Study of Frequency Shift Keying.

E. Signal Systems Lab:

1. Generation of Signals: continuous time
2. Generation of Signals: discrete time
3. Time shifting and time scaling of signals.
4. Convolution of Signals
5. Solution of Difference equations.
6. Fourier series representation of continuous time signals.
7. Fourier transform of continuous time signals.
8. Laplace transform of continuous time signals.
9. Introduction to Xcos/similar function and calculation of output of systems represented by block diagrams

(Total Practical Classes 60, Total Contact Hours 120, Total Marks 60)

At least two experiments must be performed from each unit.

Mode of In-semester Assessment:

1. Viva-voce: **(Marks 20)**
2. Attendance / Laboratory performance / Notebook: **(Marks 20)**

Mode of End-semester Assessment:

Examination on Laboratory Experiments: **(Marks 60)**

Two experiments (not more than one from a single unit) from the list to be performed.

Semester VI

Course Title: Advanced Communication Systems
Course code: ELT-C-12
Nature of the Course: Core
Total credits: 4
Distribution of marks: 80 (End sem) **+ 20** (In-sem)

Course Description: This course provides an in-depth exploration of advanced topics in communication systems and networks. It covers fundamental principles and advanced techniques essential for understanding digital modulation. The course covers also optical communication fundamentals, including optical fiber types, guidance, attenuation, dispersion, and optical sources and detectors. Cellular communication concepts are examined, covering cell structures, frequency bands, roaming, handoff, and technologies like GSM and CDMA. Additionally, satellite communication principles are discussed, including orbits, satellite systems, link types, and access methods such as TDMA, FDMA, and CDMA. The course also introduces LAN technologies like Ethernet, mobile IP, and wireless standards such as Bluetooth, Wi-Fi, and WiMAX.

Course Objectives: This course aims to provide students with a comprehensive understanding of modern communication systems. By exploring topics such as digital modulation techniques (ASK, FSK, PSK, QAM), optical communication principles, cellular network architectures (GSM, CDMA, 2G-4G), and satellite communication fundamentals, students will develop proficiency in analyzing, designing, and optimizing communication systems. They will explore optical communication systems, including fiber types, attenuation, and optical sources. Cellular communication networks will be studied, covering cell structures, frequency reuse, and GSM/CDMA technologies. Satellite communication principles and satellite systems, along with LAN technologies like Ethernet and wireless standards such as Bluetooth, Wi-Fi, and WiMAX, will also be examined.

Prerequisites:

- Basic knowledge of analog and digital communication systems.
- Understanding of fundamental concepts in signals and systems.
- Familiarity with basic networking principles and protocols.

Course Outcomes (COs): The students will able to

CO1: Understand Advanced Digital Modulation Techniques.

- **LO1.1:** Demonstrate proficiency in analyzing and applying digital modulation techniques such as ASK, FSK, PSK, BPSK, QPSK, and QAM.
- **LO1.2:** Demonstrate proficiency in analyzing and applying digital modulation techniques such as ASK, FSK, PSK, BPSK, QPSK, and QAM.
- **LO1.3:** Calculate and evaluate information capacity, bit rate, and baud rate for different modulation schemes.

LO1.4: Design and analyze M-ary coding schemes to optimize data transmission efficiency.

CO2: Explore Optical Communication Systems.

LO2.1: Identify different types of optical fibers and their characteristics.

LO2.2: Discuss the propagation phenomena in optical fibers, including attenuation and dispersion.

LO2.3: Describe the components and functioning of optical sources and detectors.

LO2.4: Construct a block diagram of an optical communication system and perform optical power budgeting calculations.

CO3: Analyze Cellular Communication Systems.

LO3.1: Define the concept of cellular mobile communication and explain cell structures and cell splitting.

LO3.2: Discuss frequency bands and allocation methods in cellular networks, including Absolute RF Channel Numbers (ARFCN).

LO3.3: Evaluate the concepts of frequency reuse, roaming, handoff, and authentication in cellular networks.

LO3.4: Compare and contrast GSM and CDMA technologies, including their architectures and deployment in 2G, 3G, and 4G networks.

CO4: Study Satellite Communication Systems.

LO4.1: Explain the need and advantages of satellite communication systems.

LO4.2: Analyze different satellite orbits and their applications.

LO4.3: Describe the components and operations of satellite systems, including uplink, downlink, and transponders.

LO4.4: Evaluate the impact of solar eclipse and path loss on satellite communication. Discuss the primary characteristics of Ethernet and its evolution. Describe the OSI model and its relevance in network communication. Evaluate wireless LAN standards including Bluetooth, Wi-Fi, and WiMAX. Analyze the requirements and applications of LAN technologies in modern communication networks.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual		LO1.3, LO2.1, LO2.2, LO3.1	LO3.2	LO4.1	LO3.3, LO4.3 CO3	
Conceptual	LO1.1, LO2.4	LO1.2, LO3.2, LO1.4, LO3.4,CO1		LO4.2, LO4.4		
Procedural	LO2.3	LO2.1, LO3.1	LO3.3, LO4.3	LO2.4, CO2	LO4.2 CO4	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	W	M	S	W	M	W	W	M
CO2	S	S	M	M	S	M	S	S	M	S
CO3	S	S	M	S	S	W	M	S	W	S
CO4	S	S	M	M	S	W	M	S	W	S

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Advanced Digital Modulation Technique (L 15, H 15, M 15)

Block diagram of digital transmission and reception, Information capacity, Bit Rate, Baud Rate, M-ary coding. Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK), QAM (Modulation and Demodulation)

Unit-II: Optical Communication (L 12, H 12, M 12)

Introduction of Optical Fiber, Types of Fiber, Guidance in Optical Fiber, Attenuation and Dispersion in Fiber, Optical Sources and Detectors, Block Diagram of optical communication system, optical power budgeting

Unit-III: Cellular Communication (L 12, H 12, M 12)

Concept of cellular mobile communication – cell and cell splitting, frequency bands used in cellular communication, absolute RF channel numbers (ARFCN), frequency reuse, roaming and hand off, authentication of the SIM card of the subscribers, IMEI number, concept of data encryption, architecture (block diagram) of cellular mobile communication network, CDMA technology, CDMA overview, simplified block diagram of cellular phone handset, Comparative study of GSM and CDMA, 2G, 3G and 4G concepts.

Unit-IV: Satellite communication (L 18, H 18, M 18)

Introduction, need, satellite orbits, advantages and disadvantages of geostationary satellites. Satellite visibility, satellite system – space segment, block diagrams of satellite sub systems, up link, down link, cross link, transponders (C- Band), effect of solar eclipse, path loss, ground station, simplified block diagram of earth station. Satellite access, TDMA, FDMA, CDMA concepts, comparison of TDMA and FDMA, Satellite antenna (parabolic dish antenna), GPS-services like SPS & PPS.

Local area networks (LAN): Primary characteristics of Ethernet-mobile IP, OSI model, wireless LAN requirements-concept of Bluetooth, Wi-Fi and WiMAX.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**

2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.**(20 Marks)**

Recommended Readings:

1. Electronic Communication Systems: Fundamentals through Advanced, *W. Tomasi*, Pearson Education.
2. Analog & Digital Communication Systems, *Martin S. Roden*, Prentice Hall, Englewood Cliffs.
3. Modern Digital and Analog Communication systems, *B. P. Lathi*, Oxford University press.
4. Telecommunication Switching Systems and Networks, *Thiagarajan Vishwanathan*, Prentice Hall of India.
5. Wireless Communications Principles and Practice, *Theodore S. Rappaport*, Pearson Education Asia.

Course title: Microprocessors and Microcontrollers
Course code: ELT-C-13
Nature of the course: Core
Total credits: 4
Distribution of marks: 80 (End sem) **+ 20** (In-sem)

Course Description: The course on Microprocessor and Microcontroller provides a comprehensive introduction to the fundamental principles, architecture, and programming of microprocessors and microcontrollers. It covers the basics of microprocessor 8085, including its architecture, instruction set, and programming techniques. Additionally, the course delves into the 8051 microcontroller, focusing on its internal structure, memory organization, I/O interfacing, and programming methodologies. Advanced topics include interrupts handling, serial communication, and interfacing with peripherals such as ADC, DAC, and LCD. Furthermore, students will be introduced to the PIC16F887 microcontroller, exploring its features, memory modules, and practical applications.

Course Objectives: The course on Microprocessor and Microcontroller aims to provide students with a thorough understanding of foundational concepts and practical skills in microprocessor and microcontroller systems. Students will learn the architecture, operation, and programming of the 8085 microprocessor, focusing on instruction sets, addressing modes, and interfacing techniques. Additionally, they will gain proficiency in the 8051 microcontroller, covering memory organization, I/O ports, interrupts, and serial communication. By exploring advanced topics like timers, ADC/DAC interfacing, and practical applications of the PIC16F887 microcontroller, students will develop the skills needed to design and implement embedded systems effectively in various engineering applications.

Prerequisites:

- Basic understanding of digital electronics and logic design.
- Familiarity with programming concepts and assembly language basics.
- Knowledge of fundamental electronic components and circuits.

Course Outcomes (COs): The students will able to

CO1: Understand the fundamental concepts and architecture of microprocessors, including the 8085 microprocessor and its operation.

LO1.1: Explain the basic principles of digital computing and the role of microprocessors in modern electronic systems.

LO1.2: Identify and describe the components of the 8085 microprocessor and their functions within the system.

CO2: Demonstrate proficiency in programming using assembly language for the 8085 microprocessor, covering data transfer, arithmetic, logical operations, and control flow.

LO2.1: Write assembly language programs for the 8085 microprocessor to perform arithmetic and logic operations.

LO2.2: Implement control flow structures using assembly language to manage program execution on the 8085 microprocessor.

CO3: Develop skills in interfacing external devices with the 8085 microprocessor, including memory, I/O ports, timers, and interrupts.

LO3.1: Design and implement interfacing circuits to connect memory devices and I/O peripherals to the 8085 microprocessor.

LO3.2: Demonstrate the use of interrupts and timers to manage real-time events in microprocessor-based systems.

CO4: Analyze and compare different types of microcontrollers, focusing on the features, architecture, and applications of the 8051 microcontroller.

LO4.1: Differentiate between microprocessors and microcontrollers in terms of architecture, memory organization, and application domains.

LO4.2: Evaluate the suitability of the 8051 microcontroller for specific embedded systems applications based on its features and capabilities.

CO5: Design and implement practical applications using the 8051 microcontroller, including interfacing with peripherals such as ADC, DAC, LCD, and stepper motors and Gain hands-on experience with the PIC16F887 microcontroller, understanding its features, architecture, and programming for various applications.

LO5.1: Develop assembly language programs for the 8051 microcontroller to interface with analog and digital peripherals.

LO5.2: Utilize C language programming for the 8051 microcontroller to enhance system functionality and user interaction.

LO5.3: Describe the features and internal architecture of the PIC16F887 microcontroller.

LO5.4: Implement advanced features of the PIC16F887 microcontroller, such as PWM, ADC, and serial communication, in embedded systems projects.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1, LO1.2	LO4.1		LO4.3		
Conceptual		LO4.1 CO1		LO4.2 CO4		
Procedural		LO2.1, LO3.1	LO2.1, LO3.2 CO2 CO3	LO5.1, LO5.3, LO5.4	LO5.2 CO5	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	S	M	M	M	M	M	M
CO2	M	S	M	M	M	M	M	M	M	M
CO3	W	M	M	M	M	M	M	M	M	M
CO4	M	M	M	M	M	M	M	M	M	M
CO5	M	M	M	M	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Introduction to Microprocessor (L 14, H 14, M 14)

Introduction, Applications, Basic block diagram, Speed, Word size, Memory capacity, Classification of microprocessors (mention of different microprocessors being used).

Microprocessor 8085: Features, Architecture - block diagram, General purpose registers, register pairs, flags, stack pointer, program counter, types of buses. Multiplexed address and data bus, generation of control signals, pin description of microprocessor 8085. Basic interfacing concepts, Memory mapped I/O and I/O mapped I/O.

Operation code, Operand & Mnemonics. Instruction set of 8085, instruction classification, addressing modes, instruction format. Data transfer instructions, arithmetic instructions, increment & decrement instructions, logical instructions, branch instructions and machine control instructions. Assembly language programming examples.

Overview on: Stack operations, subroutine, call and return instructions. Interrupts 8085 microprocessor, processing of vectored and non-vectored interrupts, latency time and response time; Handling multiple interrupts.

Unit-II: Microcontrollers (L 14, H 14, M 14)

Introduction, Microprocessor vs Microcontroller, Different types of microcontrollers, embedded microcontrollers, processor architectures. Harvard vs Princeton, CISC vs RISC architectures, microcontroller memory types, microcontroller features, clocking, I/O pins, interrupts, timers, peripherals.

8051 Microcontroller: 8051 Architecture - Registers, Pin diagram, I/O ports functions, Internal Memory organization. External Memory (ROM & RAM) interfacing.

8051 Instruction Set: Addressing Modes, Data Transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions. Simple Assembly language program examples (without loops) to use these instructions.

Unit-III: 8051 Stack, I/O Port Interfacing and Programming (L 12, H 12, M 12)

8051 Stack, Stack and Subroutine instructions. Assembly language program examples on subroutine and involving loops, Delay loops and delay calculation. Interfacing simple switch and LED to I/O ports to switch on/off LED with respect to switch status.

8051 Timers and Serial Port: 8051 Timers and Counters – Operation and Assembly language programming to generate a pulse using Mode-1 and a square wave using Mode-2 on a port pin. 8051 Serial Communication- Basics of Serial Data Communication, RS- 232 standard, 9 pin RS232 signals, Simple Serial Port programming in Assembly and C to transmit a message and to receive data serially.

Unit-IV: 8051 Interrupts and Interfacing Applications (L 12, H 12, M 12)

8051 Interrupts. 8051 Assembly language programming to generate an external interrupt using a switch, 8051 C programming to generate a square waveform on a port pin using a Timer interrupt. Interfacing 8051 to Solid State Relay, ADC-0804, DAC, Seven Segment Display, 4x4 Matrix Keyboard, LCD and Stepper motor and their 8051 Assembly language interfacing programming.

Unit-V: Introduction to PIC16F887 Microcontroller (L 8, H 8, M 8)

Core features, Architecture, pin diagram, memory organization - Program and data memory organization, I/O Ports, oscillator module, Timer modules (Timer 0, Timer 1 and Timer 2), comparator module, analog-to-digital converter (ADC) module, data EEPROM, Enhanced capture/compare/PWM module, EUSART, master synchronous serial port (MSSP) module, special features of the CPU, interrupts, addressing modes, instruction set.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.**(20 Marks)**

Recommended Readings:

1. Microprocessor Architecture, Programming and Applications with 8085, *Ramesh S. Gaonkar*, Wiley Eastern Limited.
2. Fundamentals of Microprocessor & Microcomputer, *B. Ram*, Dhanpat Rai Publications.

3. Microchip PIC16F87X datasheet
4. PIC Microcontrollers, *Milan Verle*, Mikro Elektronika.
5. Microprocessors and Microcontrollers, *Muhammad Ali Mazidi*, Pearson.

Course title: Robotics
Course code: ELT-C-14
Nature of the course: Core
Total credits: 4
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: The Robotics course introduces students to the foundational principles and applications of robotics. Starting with an exploration of robot anatomy, configurations, and end effectors, students learn about robot kinematics, dynamics, and trajectory planning techniques. The course covers a variety of sensors used in robotics and their integration into feedback systems for enhanced performance. Programming languages tailored for robotics applications are also studied, alongside real-world applications in industries such as agriculture, automotive, healthcare, and manufacturing. Through hands-on projects and theoretical learning, students develop the skills necessary to design, program, and optimize robotic systems for diverse operational environments.

Course Objectives: The course aims to equip students with a comprehensive understanding of robotics, covering fundamental concepts and advanced topics. Students will learn to analyze and design robotic systems, comprehend robot kinematics and dynamics through mathematical models like D-H notation and Jacobians, and master trajectory planning techniques. They will gain proficiency in integrating various sensors for feedback systems, essential for robot autonomy and precision. Programming languages specific to robotics will be explored, enabling students to implement algorithms and control strategies. By the end, students will be prepared to apply their knowledge in real-world scenarios, enhancing productivity across industrial and service sectors.

Prerequisites:

- Foundational understanding of mechanical engineering principles
- Proficiency in mathematics including linear algebra and calculus
- Knowledge of programming languages for algorithm implementation
- Familiarity with electrical circuits and systems
- Understanding of physics concepts such as mechanics and dynamics

Course Outcomes (COs): The students will able to

CO1: Understand the fundamental concepts and components of robotics, including robot anatomy, configurations, and end effectors.

LO1.1: Define the need for robotics and explain the laws governing robotics.

LO1.2: Classify robots based on their configurations and describe different types of end effectors.

LO1.3: Evaluate design considerations for selecting appropriate end effectors for specific robotic applications.

CO2: Apply kinematic principles to analyze robot motion and trajectory planning techniques.

LO2.1: Utilize homogenous transformation matrices and D-H notation to describe robot position and orientation.

LO2.2: Calculate differential transformations and manipulate Jacobian matrices for robot manipulators.

LO2.3: Design trajectory planning algorithms using Joint Space and Cartesian Space techniques.

CO3: Analyze robot sensors and integrate feedback systems for enhancing robot performance.

LO3.1: Identify types of sensors used in robotics and classify them as analog or digital.

LO3.2: Implement sensor examples such as light sensors, proximity sensors, and temperature sensors in robotic systems.

LO3.3: Construct open and closed-loop feedback systems to improve robot accuracy and responsiveness.

CO4: Explore various robotic programming languages and their applications across different industries.

LO4.1: Compare and contrast different programming languages used in robotics and their software packages.

LO4.2: Evaluate the requirements of an ideal robot programming language for specific applications.

LO4.3: Implement robotic applications in diverse fields such as agriculture, automotive, healthcare, and manufacturing.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	LO1.1, LO1.2, LO3.1	LO1.3, LO3.2 CO1	LO3.2	LO4.1	LO4.2	
Conceptual		LO2.1	LO2.1	LO2.2 CO2		
Procedural		LO2.2, LO3.3	LO2.3	LO3.3 CO3	LO4.3 CO4	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	M	M	M	M	M	M	M	M

CO2	M	S	M	M	M	M	M	M	M	M
CO3	M	M	M	M	M	M	M	M	M	M
CO4	M	M	M	S	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

UNIT-I: Introduction to Robotics. (L 10, H 10, M 10)
Basics of Robot: History of robotics, Need of robot, Laws of robot, Degree of freedom, Anatomy of robot, classification of robots, robot configurations, end effectors classification, Design considerations, general considerations for selection of end effectors. Robot drive and actuation systems.

UNIT-II: Robot mechanics and Trajectory Planning (L 18, H 18, M 18)
Kinematics: Scaling, rotation and homogenous transformation matrix, D-H notation for position and orientation. Differential transformation and manipulators, Jacobians–problems dynamics: Lagrange–Euler and Newton–Euler formulations and problems.
Trajectory planning: definitions and planning tasks, terminology, steps in trajectory planning, Joint space techniques, Cartesian space techniques,

UNIT-III: Robot sensors and Feedback systems (L 17, H 17, M 17)
Robot Sensors: Types - analog and digital, sensor examples - Light sensors, sound sensor, temperature sensor, proximity Sensor, distance Sensor, pressure Sensors, tilt Sensors, navigation / positioning sensors, acceleration sensor, voltage sensors, current sensors, humidity sensors, gas sensors, potentiometers, Magnetic Field Sensors. Feedback systems: Feedback System Block Diagram, open and closed loop feedback systems

UNIT-IV: Robotic Programming languages and Applications (L 15, H 15, M 15)
Programming Languages: Introduction, languages and software packages, requirements of a robot programming language. Applications: Robotics at Agriculture, Automotive, Supply Chain, Healthcare, Warehouses - material Transfer, Material handling, loading and unloading; Processing - spot and continuous arc welding & spray painting - Assembly and Inspection.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:
1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Industrial Robotics, *M. P. Groover*, Pearson Education.
2. Robotics & Control, *R. K. Mittal, I. J. Nagrath*, Tata McGraw & Hills.
3. Introduction to Robotics, *S. K. Saha*, McGraw-Hill Education.

4. Fundamentals of Robotics Analysis and Control, *Robert J. Schilling*, PHI Learning.

Course title: Electronics Lab III
Course code: ELT-C-15
Nature of the course: Core
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course delves deeply into the realm of advanced communication systems, emphasizing digital modulation techniques and their practical applications. Students will explore the fundamental principles of modulation and demodulation, implementing ASK, FSK, PSK, BPSK, QPSK, and QAM modulation schemes through both theoretical study and hands-on simulations. They will analyze the performance of these techniques by calculating signal-to-noise ratio (SNR) and bit error rate (BER), essential for understanding real-world communication system reliability. Practical skills will be honed in setting up and troubleshooting optical communication systems, covering configurations, power budgeting, and loss analysis in fiber optic setups. Additionally, the course includes a thorough introduction to 8085 Assembly Language and PIC microcontroller programming, enabling students to develop and test programs for data manipulation, interfacing with peripherals like LEDs, LCD displays, and stepper motors. Finally, foundational knowledge in robotics components and simulation, focusing on kinematics and dynamics using Denavit-Hartenberg parameters, completes the comprehensive curriculum.

Course Objectives: This course aims to equip students with a robust understanding and practical skills in advanced communication systems. It begins by comprehensively covering digital modulation techniques such as ASK, FSK, PSK, BPSK, QPSK, and QAM, emphasizing their principles, implementation, and application in modern communication scenarios. Students will learn to evaluate the performance of these modulation schemes through calculations of SNR and BER, crucial for assessing reliability in real-world communication environments. Practical proficiency will be developed in setting up and optimizing optical communication systems, including configuring transmitters and receivers, measuring optical power budgets, and troubleshooting fiber optic losses. Additionally, the course focuses on enhancing programming skills through 8085 Assembly Language and PIC microcontroller programming, enabling students to interface with peripherals and control devices effectively. Furthermore, foundational knowledge in robotics components and simulation techniques using Denavit-Hartenberg parameters will be explored, providing students with insights into robot kinematics and dynamics essential for future advancements in robotics technology.

Prerequisites:

- Basic understanding of electromagnetic theory and wave propagation.
- Familiarity with fundamental concepts in electronics and signal processing.
- Proficiency in using mathematical tools such as MATLAB or similar for simulations.
- Prior exposure to communication systems, including modulation techniques and transmission media.

Course Outcomes (COs): The students will able to

CO1: Understand various digital modulation techniques and their applications in advanced communication systems.

- **LO1.1:** Explain the principles of modulation and demodulation in communication systems.
- **LO1.2:** Implement ASK, FSK, and PSK modulation techniques in practical scenarios.
- **LO1.3:** Design and simulate BPSK, QPSK, and QAM modulation schemes using appropriate tools.

CO2: Analyze and evaluate the performance of communication systems using modulation schemes like QAM and DPCM.

- **LO2.1:** Calculate signal-to-noise ratio (SNR) and bit error rate (BER) for QAM modulation.
- **LO2.2:** Implement DPCM encoding and decoding algorithms and assess their efficiency.
- **LO2.3:** Compare the performance of different modulation techniques through practical experiments.

CO3: Demonstrate practical skills in setting up and testing optical communication systems.

- **LO3.1:** Configure optical transmitters and receivers for various communication scenarios.
- **LO3.2:** Measure optical power budgets and analyze losses in fiber optic systems.
- **LO3.3:** Troubleshoot and optimize optical communication setups based on experimental results.

CO4: Proficiency in 8085 Assembly Language Programming.

- **LO4.1:** Write programs to transfer a block of data using 8085 Assembly language and multibyte addition and subtraction programs in 8085 Assembly.
- **LO4.2:** Develop programs to multiply two 8-bit numbers and divide a 16-bit number by an 8-bit number using 8085 Assembly.
- **LO4.3:** Create programs to search for a given number in a list and generate terms of the Fibonacci series.
- **LO4.4:** Implement programs to find minimum, maximum, square root, and sorting algorithms to sort numbers in ascending/descending order using 8085 Assembly.

CO5: Proficiency in PIC Microcontroller Programming.

- **LO5.1:** Write C programs to interface and blink LEDs with a delay of 1 second using PIC microcontroller.
- **LO5.2:** Interface a Solid State Relay (SSR) and control a 2x16 LCD display using PIC microcontroller with PIC microcontroller.
- **LO5.3:** Interface a stepper motor and control its rotation by N steps clockwise/anticlockwise with speed control using PIC microcontroller.
- **LO5.4:** Write a program to test and verify the functionality of all gates of a given IC74XX using PIC microcontroller.

LO5.5: Generate various waveforms (sine, square, sawtooth, triangular, staircase) using Digital-to-Analog Converter (DAC) interface with PIC microcontroller.

LO5.6: Interface and display a 4-digit decimal number using multiplexed 7-segment display interface with PIC microcontroller.

CO6: Understand and analyze the components and performance of real robots.

LO6.1: Identify and explain the functions of major components in real robots.

LO6.2: Analyze performance characteristics such as accuracy, speed, and payload capacity of robots.

CO7: Model and simulate robot joints and manipulators using 3D software.

LO7.1: Utilize 3D modeling software to create and manipulate robot joints and manipulators.

LO7.2: Simulate the movement and interaction of robot manipulators in virtual environments.

CO8: Implement and analyze drives for robotic joints through simulation.

LO8.1: Evaluate different types of drives (electric, hydraulic, pneumatic) for robotic joints.

LO8.2: Analyze the impact of drive selection on robotic system performance.

CO9: Apply Denavit-Hartenberg parameters for robot kinematics and dynamics.

LO9.1: Formulate and apply Denavit-Hartenberg parameters to describe robot configurations.

LO9.2: Use DH parameters to simulate and analyze robot kinematics in software environments.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1		LO2.1, LO3.1	LO2.1, LO3.2		
Conceptual		LO1.1, LO1.3, LO2.2, LO2.3, LO3.2	LO3.1 LO9.1 LO9.2 CO1 CO7 CO9	LO2.3 CO3	LO2.2 LO8.1 LO8.2 CO2 CO8	
Procedural	LO1.2, LO1.3, LO2.2, LO3.1, LO4.1, LO4.4, LO5.1, LO5.5	LO3.3 CO5 CO6		LO4.2, LO4.3 CO4		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	M	M	M	M	M
CO2	M	S	M	M	M	M	M	M	M	M
CO3	M	M	M	M	M	M	M	M	M	M

CO4	M	M	M	S	M	M	M	M	M	M
CO5	M	M	M	M	S	M	M	M	M	M
CO6	M	M	M	M	M	S	M	M	M	M
CO7	M	M	M	M	M	M	S	M	M	M
CO8	M	M	M	M	M	M	M	S	M	M
CO9	M	M	M	M	M	M	M	M	S	M

S: Strong, M: Medium, W: Weak

List of Experiments:

A. Advanced Communication System Lab

1. Modulation of LED and detection through Photo detector.
2. Calculation of the transmission losses in an optical communication system.
3. Study of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK)
4. Study of Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK), QAM
5. Study of architecture of Mobile phone.
6. Study of Satellite Communication System.
7. Study of Optical Fiber Communication System

B. Microprocessors and Microcontroller Lab

8085 Assembly language programs:

1. Program to transfer a block of data.
2. Program for multibyte addition
3. Program for multi byte subtraction
4. Program to multiply two 8-bit numbers.
5. Program to divide a 16-bit number by 8-bit number.
6. Program to search a given number in a given list.
7. Program to generate terms of Fibonacci series.
8. Program to find minimum and maximum among N numbers
9. Program to find the square root of an integer.
10. Program to find GCD of two numbers.
11. Program to sort numbers in ascending/descending order.
12. Program to verify the truth table of logic gates.

PIC Microcontroller Programming:

(Note: Programs to be written using C programming language)

1. LED blinking with a delay of 1 second.
2. Solid State Relay Interface
3. Interfacing of LCD (2x16).
4. Interfacing of stepper motor and Rotating stepper motor by N steps clockwise/anticlockwise with speed control.

5. To test all the gates of a given IC74XX is good or bad.
6. Generate sine, square, saw tooth, triangular and staircase waveform using DAC interface.
7. Display of 4-digit decimal number using the multiplexed 7-segment display interface.

C. Robotics Lab

1. Study of components of real robot and its performance
2. Basics of 3D modeling software
3. Modeling of Robot Joints
4. Assembly of 2DOF/3DOF Robot Manipulator
5. Use of drives for robotic joints and its simulation
6. Roboanalyzer: A learning software of robotics study
7. Formulation of DH parameters of robot configuration
8. Simulation using open-source software of robot kinematics using DH Parameters
9. Forward kinematic analysis of a robot
10. Inverse kinematic analysis of a robot
11. Introduction of MATLAB and Robotic Toolkit introduction.

(Total Practical Classes 60, Total Contact Hours 120, Total Marks 60)

At least four experiments must be performed from each unit.

Mode of In-semester Assessment:
1. Viva-voce: **(Marks 20)**
2. Attendance / Laboratory performance / Notebook: **(Marks 20)**

Mode of End-semester Assessment:
Examination on laboratory experiments: **(Marks 60)**
Two experiments (not more than one from a single unit) from the list to be performed.

Semester VII

Course title: Embedded Systems
Course code: ELT-C-16
Nature of the course: Core
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: The course on Embedded Systems provides a comprehensive exploration of the principles, design methodologies, and practical applications of embedded computing systems. Students will delve into the core concepts of embedded systems, distinguishing them from general-purpose computing systems, and understanding their historical evolution and diverse application domains. The course covers the essential components of embedded systems including processors, memory, sensors, and actuators, emphasizing their integration to meet specific functional requirements. Practical aspects include firmware development using Embedded C, real-time operating systems (RTOS) for task management, synchronization, and communication, and integration techniques for hardware and firmware. Students gain hands-on experience through labs and projects, utilizing development environments, simulators, and debugging tools essential for embedded system design and testing. By the end of the course, students will be equipped with the knowledge and skills necessary to design, develop, and deploy embedded systems across various industries, addressing real-world challenges in technology integration and system optimization.

Course Objectives: This course aims to equip students with a comprehensive understanding of embedded systems, focusing on both theoretical foundations and practical applications. Students will learn the fundamental principles of embedded system design, including hardware components, real-time operating systems, and firmware development using Embedded C. They will gain proficiency in designing, integrating, and testing embedded systems through hands-on projects and laboratory exercises. By the end of the course, students will be capable of analyzing system requirements, selecting appropriate hardware components, developing efficient firmware, and employing debugging tools to ensure reliable operation of embedded systems in diverse application domains.

Prerequisites:

- Basic knowledge of programming concepts (preferably in C or C++)
- Understanding of digital electronics and microprocessors
- Familiarity with operating system fundamentals
- Proficiency in basic mathematics and logic
- Ability to analyze and design simple algorithms
- Prior experience with hardware components and interfacing
- Knowledge of debugging techniques and tools

Course Outcomes (COs): The students will able to

CO1: Understand the fundamental concepts and characteristics of Embedded Systems.

- **LO1.1:** Define Embedded Systems and distinguish them from general computing systems.
- **LO1.2:** Explain the historical development and major application areas of Embedded Systems.
- **LO1.3:** Analyze the purpose and essential features of Embedded Systems in various technological domains.

CO2: Analyze the architecture and components of typical Embedded Systems.

- **LO2.1:** Describe the core components of an Embedded System including processors, memory, sensors, and actuators.
- **LO2.2:** Evaluate different communication interfaces used in Embedded Systems for data exchange.

LO2.3: Illustrate the role and implementation of embedded firmware in system operation and control.

CO3: Apply Real-Time Operating Systems (RTOS) concepts in Embedded System design.

LO3.1: Outline the basics of operating systems and distinguish between different types of OS used in Embedded Systems.

LO3.2: Design tasks, processes, and threads for multitasking and multiprocessing in RTOS environments.

LO3.3: Implement task scheduling, synchronization, and communication mechanisms in RTOS-based Embedded Systems.

CO4: Integrate and test Embedded Hardware and Firmware using appropriate development tools.

LO4.1: Integrate hardware components with firmware and ensure compatibility and functionality.

LO4.2: Utilize Integrated Development Environments (IDEs) and cross-compilation tools for firmware development.

LO4.3: Apply debugging techniques including simulators, emulators, and boundary scan methods for target hardware verification.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1	LO1.2	LO4.2			
Conceptual		LO1.3, CO1		LO2.2	LO4.1, CO4	
Procedural			LO3.3 LO4.2 LO4.3	LO2.1 CO2		
Metacognitive				LO3.1	LO3.2, CO3	

Mapping of Course Outcomes with Program Outcomes:

COs\ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	M	M	M	M	M
CO2	S	M	M	M	M	M	M	M	M	M
CO3	M	S	M	M	M	M	M	M	M	M
CO4	M	S	M	M	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

UNIT-I: Introduction **(L 15, H 15, M 15)**

Introduction to Embedded Systems: History of Embedded Systems, Definition of Embedded System, Embedded Systems Vs General Computing Systems, Classification of Embedded

Systems, Major application areas, Purpose of Embedded Systems, Characteristics and Quality attributes of Embedded Systems.

UNIT-II: Structure and Design of Embedded System **(L 15, H 15, M 15)**
The Typical Embedded System: Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other System components.

Embedded Firmware Design and Development: Embedded Firmware Design, Embedded Firmware Development Languages, Programming in Embedded C.

UNIT-III: RTOS **(L 15, H 15, M 15)**
RTOS Based Embedded System Design: Operating System basics, Types of Operating Systems, Tasks, Process, Threads, Multiprocessing and Multi-tasking, Task Scheduling, Threads-Processes Scheduling putting them together, Task Communication, Task Synchronization, Device Drivers, choice of RTOS.

UNIT-IV: Integration and Testing. **(L 15, H 15, M 15)**
Integration and Testing of Embedded Hardware and Firmware: Integration of Hardware and Firmware, Development Environment: The Integrated Development Environment (IDE), Types of files generated on Cross-Compilation, Disassembler/Decompiler, Simulators, Emulators and Debugging, Target Hardware Debugging, Boundary Scan.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Embedded System-Architecture, Programming, Design, *Raj Kamal*, Mc Graw Hill.
2. Embedded Systems Design: A Unified Hardware/ Software Introduction, *Frank Vahid and Tony Givargis*, John Wiley.
3. Embedded Systems, *Lyla*, Pearson.
4. An Embedded Software Primer, *David E. Simon*, Pearson Education Asia.
5. Embedded system Design, *Peckol*, John Wiley & Sons.
6. Embedded Systems Engineering, *C. R. Sarma*, University Press (India) Pvt. Ltd.
7. Embedded system Design Using C8051, *Han-Way Huang*, Cengage Learning.
8. Real-Time systems Theory and Practice, *Rajib Mall*, Pearson Education.

Course title: Digital Signal Processing
Course code: ELT-C-17
Nature of the course: Core
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course introduces students to the fundamental concepts and techniques of Digital Signal Processing (DSP). It covers the analysis and processing of discrete-time signals and systems, including the Z-transform, Discrete Fourier Transform (DFT), digital filter design, and introduction to Digital Signal Processors (DSPs). Students will learn about classification of systems and signals, sampling, quantization, and spectral analysis. Practical applications include the design and implementation of FIR and IIR filters using various techniques. The course also introduces students to real-world DSP processors and their functionalities.

Course Objectives: This course aims to equip students with a comprehensive understanding of Digital Signal Processing (DSP) principles and applications. By the end of the course, students should be able to analyze discrete-time signals and systems using the Z-transform and understand its properties. They will learn to design and implement digital filters, both Finite Impulse Response (FIR) and Infinite Impulse Response (IIR), using various techniques such as windowing and bilinear transformation. Students will gain proficiency in computing the Discrete Fourier Transform (DFT) using Fast Fourier Transform (FFT) algorithms and interpreting frequency domain representations. Additionally, they will be introduced to the architecture and functionalities of commercial Digital Signal Processors (DSPs).

These objectives prepare students to apply DSP techniques in practical scenarios, including signal analysis, filtering, and real-time processing.

Prerequisites:

- Basic understanding of signals and systems
- Familiarity with continuous-time and discrete-time signals
- Knowledge of linear algebra and complex numbers
- Understanding of Fourier series and Fourier transform
- Proficiency in calculus, including differentiation and integration
- Familiarity with basic programming concepts, preferably in MATLAB or similar tools

Course Outcomes (COs): The students will able to

CO1: Understand the fundamental concepts and classifications of continuous and discrete systems and signals, and their relevance in digital signal processing.

- **LO1.1:** Differentiate between continuous and discrete systems, explaining their characteristics such as linearity, causality, and stability.
- **LO1.2:** Classify signals into energy and power signals, and describe their mathematical representations and spectral density.
- **LO1.3:** Analyze sampling techniques, quantization processes, and the Nyquist rate, and predict aliasing effects in digital signal processing systems.

CO2: Apply Z-transform and inverse Z-transform to analyze and design discrete-time systems, including stability analysis and frequency response.

LO2.1: Apply Z-transform to solve difference equations and analyze system stability through pole-zero analysis.

LO2.2: Evaluate the frequency response of discrete-time systems using Z-transform techniques and interpret system characteristics.

LO2.3: Implement convolution algorithms for discrete-time signals and analyze their frequency domain representations using Discrete Time Fourier Transform (DTFT).

CO3: Understand the theory and implementation of Discrete Fourier Transform (DFT) and its variants for signal analysis and processing.

LO3.1: Explain the properties and applications of Discrete Fourier Transform (DFT) in signal processing.

LO3.2: Implement Fast Fourier Transform (FFT) algorithms such as radix-2 FFT for efficient computation of DFT, understanding the butterfly structure and computational complexity.

LO3.3: Compare different FFT algorithms (DIT vs DIF) and their suitability for various signal processing applications, analyzing their performance metrics.

CO4: Design and implement Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) digital filters for specific signal processing tasks.

LO4.1: Design FIR and IIR digital filters using parallel and cascade forms, considering filter specifications and requirements.

LO4.2: Apply windowing techniques (e.g., Hamming, Kaiser) for FIR filter design, understanding the trade-offs between main lobe width and side lobe level.

LO4.3: Implement digital design techniques for IIR filters using Butterworth and Chebyshev approximations, and analyze their frequency response characteristics.

CO5: Describe the architecture, features, and operational modes of Digital Signal Processors (DSPs), and their role in real-time signal processing applications.

LO5.1: Explain the architecture and functional units of DSPs, including processing elements, memory organization, and instruction sets.

LO5.2: Analyze addressing modes and formats used in DSP programming, and their impact on algorithm implementation and performance.

LO5.3: Evaluate different commercial DSP processors, comparing their specifications, capabilities, and suitability for specific signal processing tasks and applications.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1	LO1.2				
Conceptual		LO1.3, CO1	LO2.2, CO2	LO3.1		
Procedural		LO2.1 LO5.1	LO4.1	LO3.3 LO4.1 LO4.3 LO5.2, CO3	LO4.2, CO4	

Metacognitive					LO5.3, CO5	

Mapping of Course Outcomes with Program Outcomes:

COs\ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	M	M	M
CO2	S	S	M	M	M	M	M	M	M	M
CO3	S	S	M	M	M	M	M	M	M	M
CO4	S	S	M	M	M	M	M	M	M	M
CO5	S	S	M	M	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

UNIT-I: Introduction **(L 10, H 10, M 10)**

Classification of systems: Continuous, discrete, linear, causal, stability, dynamic, recursive, time variant systems; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect.

UNIT-II: Discrete Time System Analysis **(L 15, H 15, M 15)**

Z-transform and its properties, inverse z-transforms; difference equation – Solution by z-transform, application to discrete systems - Stability analysis, frequency response – Convolution – Discrete Time Fourier transform, magnitude and phase representation.

UNIT-III: Discrete Fourier Transform & Computation **(L 12, H 12, M 12)**

Discrete Fourier Transform- properties, magnitude and phase representation - Computation of DFT using FFT algorithm – DIT & DIF using radix 2 FFT – Butterfly structure.

UNIT-IV: Design of Digital Filters **(L 15, H 15, M 15)**

FIR & IIR filter realization – Parallel & cascade forms. FIR design: Windowing Techniques – Need and choice of windows – Linear phase characteristics. Analog filter design – Butterworth and Chebyshev approximations; IIR Filters, digital design using impulse invariant and bilinear transformation, warping and pre warping.

UNIT-V: Digital Signal Processors **(L 8, H 8, M 8)**

Introduction, architecture, features, addressing formats, functional modes, Introduction to commercial DS processors.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Digital Signal Processing Principles, Algorithms and Applications, *J. G. Proakis and D.G. Manolakis*, Pearson Education, New Delhi, PHI.
2. Digital Signal Processing – A Computer Based Approach, *S. K. Mitra*, McGraw Hill Education.
3. Fundamentals of Digital Signal Processing, *Lonnie C. Ludeman*, Wiley.
4. Discrete Time Signal processing, *A. V. Oppenheim, Ronald W. Schafer, John R. Buck*, Pearson Education.
5. Theory and applications of DSP, *L. R. Rabiner and B. Gold*, Prentice Hall of India.

Course title: Power Electronics
Course code: ELT-C-18
Nature of the course: Core
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course introduces fundamental concepts and applications of power electronics. Topics include semiconductor power devices such as diodes, thyristors, and power MOSFETs, their characteristics, and operational principles. Students will study power conversion circuits including inverters, choppers, and their control techniques. Additionally, electromechanical machines like DC and AC motors, and their speed control using power electronic devices will be explored. Practical aspects such as device ratings, protection circuits, and applications in power systems will be emphasized through theoretical learning and hands-on experiments.

Course Objectives: This course aims to provide students with a comprehensive understanding of power electronics principles and applications. Students will learn about semiconductor power devices such as diodes, thyristors, IGBTs, and MOSFETs, focusing on their characteristics, operational modes, and applications in power conversion circuits. The course will cover topics including power inverters, choppers, and their control methods, enabling students to analyze and design efficient power electronic systems. Practical skills in designing, analyzing, and troubleshooting power electronic circuits will be developed, preparing students for careers in industries requiring expertise in energy conversion and control technologies.

Prerequisites:

- Basic knowledge of electrical circuits and electronics principles
- Understanding of semiconductor devices and their operating characteristics
- Familiarity with circuit analysis techniques (Ohm's law, Kirchhoff's laws)
- Knowledge of diodes and transistors
- Understanding of basic power concepts (AC and DC circuits)

- Proficiency in mathematics including algebra and calculus

Course Outcomes (COs): The students will able to

CO1: Understand the operation and characteristics of semiconductor power devices, including Power Diodes and Silicon Controlled Rectifiers (SCRs), and their applications in power electronics.

- **LO1.1:** Describe the need for semiconductor power devices in modern electronic systems and differentiate between power diodes and regular diodes based on their characteristics and applications.
- **LO1.2:** Analyze the structure, I-V characteristics, and operating principles of Silicon Controlled Rectifiers (SCRs), including turn-on and turn-off mechanisms.
- **LO1.3:** Design gate-triggering circuits, control circuits, and protection circuits for SCRs, and apply Snubber circuits to enhance device reliability in practical applications.

CO2: Explain the operation and characteristics of Diac, Triac, Insulated Gate Bipolar Transistors (IGBTs), and Power MOSFETs, and their applications in power electronic circuits.

- **LO2.1:** Describe the structure, working principles, and V-I characteristics of Diac and Triac, and analyze their applications as triggering devices in AC power control circuits.
- **LO2.2:** Explain the basic structure, I-V characteristics, switching behavior, limitations, and safe operating area (SOA) of Insulated Gate Bipolar Transistors (IGBTs).
- **LO2.3:** Compare the operation modes, switching characteristics, and applications of Power MOSFETs and Bipolar Junction Transistors (BJTs) in power electronic circuits, focusing on second breakdown and saturation effects.

CO3: Understand the operation, types, and applications of Power Inverters and Choppers in converting DC to AC and controlling DC power.

- **LO3.1:** Explain the need for commutating circuits in power inverters and analyze various types including DC link inverters, capacitor commutated inverters, and bridge inverters.
- **LO3.2:** Describe the operation and characteristics of different types of choppers (Type A-D), including step-down, step-up, and load-sensitive choppers, using self-commutation and pulse turn-off techniques.
- **LO3.3:** Analyze the limitations and improvements of series inverters, and apply parallel capacitor commutation techniques with reactive feedback in practical power conversion systems.

CO4: Gain knowledge of DC and AC electromechanical machines, including DC Motors and Induction Motors, and their speed control using thyristors.

- **LO4.1:** Describe the principles of operation, construction, and EMF equations of DC Motors, and analyze the factors controlling motor speed and back EMF generation.

LO4.2: Explain the construction, torque-speed characteristics, and operation principles of Induction Motors (AC Motors).

LO4.3: Outline the principles and block diagrams for Thyristor-based speed control of DC Motors and AC Motors, emphasizing practical applications and performance considerations.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1	LO1.2, CO1, LO4.1	LO2.1	LO4.3		
Conceptual	LO3.1	LO2.2	LO3.2, LO4.2	LO2.3, CO2		
Procedural	LO1.3		LO3.3 CO3	CO4		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	M	M	M
CO2	S	S	M	M	M	M	M	M	M	M
CO3	S	S	M	M	M	M	M	M	M	M
CO4	S	S	M	M	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Power Devices **(L 12, H 12, M 12)**

Need for semiconductor power devices, Power diodes, Enhancement of reverse blocking capacity, Introduction to family of thyristors.

Silicon Controlled Rectifier (SCR): Structure, I-V characteristics, Turn-On and Turn-Off characteristics, ratings, Factors affecting the characteristics/ratings of SCR, Gate-triggering circuits, Control circuits design and Protection circuits, Snubber circuit.

Unit-II: Diac and Triac **(L 14, H 14, M 14)**

Basic structure, working and V-I characteristic of, application of a Diac as a triggering device for a Triac.

Insulated Gate Bipolar Transistors (IGBT): Basic structure, I-V Characteristics, switching characteristics, device limitations and safe operating area (SOA) etc.

Application of SCR: SCR as a static switch, phase-controlled rectification, single phase half wave, full wave and bridge rectifiers with inductive & non-inductive loads; AC voltage control using SCR and Triac as a switch.

Power MOSFETs: Operation modes, switching characteristics, power BJT, secondary breakdown, saturation and quasi-saturation state.

Unit-III: Power Inverters **(L 17, H 17, M 17)**

Need for commutating circuits and their various types, DC link inverters, Parallel capacitor commutated inverters with and without reactive feedback and its analysis, Series Inverter, limitations and its improved versions, bridge inverters.

Choppers: Basic chopper circuit, types of choppers (Type A-D), step-down chopper, step-up chopper, operation of DC chopper circuits using self-commutation (A & B - type commutating circuit), cathode pulse turn-off chopper (using class D commutation), load sensitive cathode pulse turn-off chopper (Jones Chopper), Morgan's chopper.

Unit-IV: Electromechanical Machines **(L 17, H 17, M 17)**

DC Motors, Basic understanding of field and armature, Principle of operation, EMF equation, Back EMF, Factors controlling motor speed, Thyristor based speed control of DC motors, AC motor (Induction Motor only), Rotor and stator, torque & speed of induction motor, Thyristor control of AC motors.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.**(20 Marks)**

Recommended Readings:

1. Power Electronics, *P. C. Sen*, TMH.
2. Power Electronics and Controls, *S.K. Dutta*, TMH.
3. Power Electronics, *M.D. Singh and K.B. Khanchandani*, TMH
4. Power Electronics Circuits, Devices and Applications, *M. H. Rashid*, Pearson Education.
5. Power Electronics, Applications and Design, *Ned Mohan*, Tore.
6. Power Electronics, *K. Hari Babu*, Scitech Publication.
7. Power Electronics, *M.S. Jamil Asghar*, PHI.
8. A Textbook of Electrical Technology-Vol-II, *B. L. Thareja, A.K. Thareja*, S. Chand.

Semester VIII

Course title: VLSI Designing
Course code: ELT-C-19
Nature of the course: Core
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: Digital Signal Processing (DSP) is a fundamental area of study focusing on the analysis, manipulation, and synthesis of signals using digital techniques. This course covers theoretical foundations and practical applications essential for understanding and implementing DSP algorithms. Students will explore topics including discrete-time signal analysis, Fourier analysis, digital filter design, real-time signal processing, and advanced DSP applications. Emphasis is placed on hands-on experience through simulations and practical exercises using MATLAB or similar tools. By the end of the course, students will be equipped with the knowledge and skills to design, analyze, and optimize digital signal processing systems for various applications.

Course Objectives: This course aims to provide students with a comprehensive understanding of Digital Signal Processing (DSP), covering both theoretical principles and practical applications. Students will learn fundamental concepts such as discrete-time signals and systems, Fourier analysis, Z-transforms, and digital filter design. The course focuses on developing skills in analyzing, designing, and implementing DSP algorithms using MATLAB or similar tools. By the end of the course, students will be proficient in applying DSP techniques to solve real-world signal processing problems, preparing them for careers in fields ranging from telecommunications and audio processing to biomedical engineering and beyond.

Prerequisites:

- Basic knowledge of signals and systems.
- Understanding of calculus and linear algebra.
- Familiarity with analog and digital electronics.
- Proficiency in programming, preferably in MATLAB or similar environments.
- Ability to analyze and interpret data.
- Knowledge of Fourier transforms and their applications.

Course Outcomes (COs): The students will able to

CO1: Students will demonstrate proficiency in understanding the fundamentals of digital signal processing and applying them to analyze discrete-time signals and systems.
- **LO1.1:** Define discrete-time signals and systems, and differentiate between continuous-time and discrete-time domains.
- **LO1.2:** Explain the concepts of linearity, causality, and time-invariance in discrete-time systems, and analyze their implications.

LO1.3: Apply mathematical representations (difference equations, convolution) to analyze and manipulate discrete-time signals and systems.

CO2: Acquire the ability to analyze signals in the frequency domain using DFT and Z-transform, and design digital filters for practical applications.

LO2.1: Demonstrate knowledge of the properties and applications of Discrete Fourier Transform (DFT) for spectral analysis of discrete-time signals.

LO2.2: Compute and interpret the frequency spectrum of discrete-time signals using DFT and understand the relationship between time-domain and frequency-domain representations.

LO2.3: Design digital filters based on frequency domain specifications using techniques like windowing and understand the trade-offs between filter types (FIR vs IIR).

CO3: Develop skills in designing and implementing digital filters using various design methods and evaluating their performance.

LO3.1: Design Finite Impulse Response (FIR) filters using windowing techniques and understand the characteristics of different window functions.

LO3.2: Implement Infinite Impulse Response (IIR) filters using techniques like Butterworth and Chebyshev approximations, and analyze their frequency response and stability.

LO3.3: Evaluate the performance of digital filters in terms of magnitude and phase response, passband ripple, stopband attenuation, and selectivity.

CO4: Gain practical experience in implementing real-time digital signal processing algorithms and applications.

LO4.1: Implement real-time signal processing algorithms such as digital filtering, convolution, and FFT on hardware platforms or simulation environments.

LO4.2: Analyze the computational complexity and resource utilization of DSP algorithms for real-time applications.

LO4.3: Develop applications of DSP in areas such as audio processing, communications, biomedical signal analysis, and control systems.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	LO1.1	LO1.2		LO2.1, CO2	LO3.3	
Conceptual					LO3.2, CO3	
Procedural	LO1.3	CO1	LO2.2 LO4.1	LO3.1 LO4.2	LO4.3, CO4	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	M	M	M
CO2	S	S	M	M	M	M	M	M	M	M
CO3	S	S	M	M	M	M	M	M	M	M
CO4	S	S	M	M	M	M	M	M	M	M
CO5	S	S	M	M	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

UNIT-I: Introduction to MOS Transistor (L 12, H 12, M 12)
MOS Transistor, CMOS logic, Inverter, Pass Transistor, Transmission gate, Layout Design Rules, Gate Layouts, Stick Diagrams, Long-Channel I-V Characteristics, C-V Characteristics, Nonideal I-V Effects, DC Transfer characteristics, RC Delay Model, Elmore Delay, Linear Delay Model, Logical effort, Parasitic Delay, Delay in Logic Gate, Scaling.

UNIT-II: Combinational MOS Logic Circuits (L 12, H 12, M 12)
Circuit Families: Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits, Pass Transistor Logic, Transmission Gates, Domino, Dual Rail Domino, CPL, DCVSPG, DPL, Circuit Pitfalls. Power: Dynamic Power, Static Power, Low Power Architecture.

UNIT-III: Sequential Circuit Design (L 12, H 12, M 12)
Static latches and Registers, Dynamic latches and Registers, Pulse Registers, Sense Amplifier Based Register, Pipelining, Schmitt Trigger, Monostable Sequential Circuits, Astable Sequential Circuits. Timing Issues: Timing Classification of Digital System, Synchronous Design.

UNIT-IV: Design of Arithmetic Building Blocks and Subsystem (L 12, H 12, M 12)
Arithmetic Building Blocks: Data Paths, Adders, Multipliers, Shifters, ALUs, power and speed trade-offs, Case Study: Design as a trade-off. Designing Memory and Array structures: Memory Architectures and Building Blocks, Memory Core, Memory Peripheral Circuitry.

UNIT-V: Implementation Strategies and Testing (L 12, H 12, M 12)
FPGA Building Block Architectures, FPGA Interconnect Routing Procedures. Design for Testability: Ad Hoc Testing, Scan Design, BIST, IDDQ Testing, Design for Manufacturability, Boundary Scan.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**

2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

- CMOS VLSI Design: A Circuits and Systems Perspective, *Neil H. E. Weste*, *David Money Harris*, Pearson.
- Digital Integrated Circuits: A Design perspective, *Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic*, Pearson.

Course title: Digital Image Processing
Course code: ELT-C-20
Nature of the course: Core
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides a comprehensive introduction to Digital Image Processing (DIP), covering fundamental concepts, techniques, and algorithms used in manipulating and analyzing digital images. Topics include image fundamentals, enhancement, restoration, segmentation, compression, and recognition. Practical applications of DIP in various fields such as medical imaging, remote sensing, and multimedia are also explored through case studies and projects.

Course Objectives: This course aims to provide students with a comprehensive understanding of Digital Image Processing (DIP), focusing on fundamental theories, techniques, and practical applications. Students will learn the steps involved in image acquisition, sampling, quantization, and transformation. They will explore methods for enhancing image quality in both spatial and frequency domains, and techniques for restoring images affected by noise and degradation. The course also covers image segmentation methods, compression algorithms, and recognition techniques, preparing students to apply DIP in fields such as medical imaging, remote sensing, and multimedia with proficiency in implementing various image processing algorithms.

Prerequisites:

- Understanding of basic mathematics including calculus, linear algebra, and probability theory.
- Familiarity with fundamental programming concepts and proficiency in a programming language (e.g., Python, MATLAB).
- Knowledge of basic signal processing concepts such as Fourier transforms and filters.
- Understanding of basic concepts in computer vision and image representation.
- Knowledge of basic electronics and digital systems may be advantageous but not mandatory.

Course Outcomes (COs): The students will able to

CO1: Understand the fundamental components and mathematical preliminaries of digital images.

- **LO1.1:** Describe the steps involved in digital image processing.
- **LO1.2:** Explain the principles of image sensing, acquisition, and quantization.
- **LO1.3:** Apply 2D transforms such as DFT and DCT to analyze digital images.

CO2: Enhance digital images using spatial and frequency domain techniques.

- **LO2.1:** Implement gray level transformations and histogram processing.
- **LO2.2:** Apply spatial filtering techniques for image smoothing and sharpening.
- **LO2.3:** Utilize frequency domain filters (ideal, Butterworth, Gaussian) for image enhancement.

CO3: Restore degraded images using various restoration techniques.

- **LO3.1:** Understand image degradation models and noise characteristics.
- **LO3.2:** Apply mean filters, adaptive filters, and frequency domain filters for image restoration.
- **LO3.3:** Implement Wiener filtering and inverse filtering for image restoration.

CO4: Segment images into meaningful regions using edge detection and region-based techniques.

- **LO4.1:** Perform edge detection and linking using Hough transform.
- **LO4.2:** Implement thresholding and region growing for image segmentation.
- **LO4.3:** Apply morphological operations (erosion, dilation) and watershed algorithms for segmentation.

CO5: Compress images efficiently and recognize patterns using advanced techniques.

- **LO5.1:** Understand the principles of image compression and various encoding techniques.
- **LO5.2:** Implement JPEG and MPEG standards for image and video compression.
- **LO5.3:** Describe pattern recognition methods based on boundary, regional, topological, and texture features.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	LO1.1	LO1.2		LO3.1		
Conceptual		LO5.1	LO2.1 LO5.3	LO4.1	LO5.2, LO4.2 CO4 CO5	
Procedural	LO1.3	LO2.2, CO1	LO2.3, CO2	LO4.3	LO3.3, CO3	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	M	M	M
CO2	S	S	M	M	M	M	M	M	M	M
CO3	S	S	M	M	M	M	M	M	M	M
CO4	S	S	M	M	M	M	M	M	M	M
CO5	S	S	M	M	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Digital Image Fundamentals **(L 12, H 12, M 12)**

Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels - Color image fundamentals - RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT.

Unit-II: Image Enhancement **(L 12, H 12, M 12)**

Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.

Unit-III: Image Restoration **(L 12, H 12, M 12)**

Image Restoration - degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters, Band pass Filters, Band reject Filters, Notch Filters, Optimum Notch Filtering, Inverse Filtering, Wiener filtering.

Unit-IV: Image Segmentation **(L 12, H 12, M 12)**

Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm.

Unit-V: Image Compression and Recognition **(L 12, H 12, M 12)**

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Digital Image Processing, *Rafael C. Gonzalez, Richard E. Woods*, Pearson.
2. Fundamentals of Digital Image Processing, *Anil K. Jain*, Pearson.
3. Digital Image Processing, *Kenneth R. Castleman*, Pearson.
4. Digital Image Processing using MATLAB, *Rafael C. Gonzalez*, *Richard E. Woods, Steven Eddins*, Pearson Education.
5. Multidimensional Digital Signal Processing, *D. E. Dudgeon and RM. Mersereau*, Prentice Hall Professional Technical Reference.
6. Digital Image Processing, *William K. Prat*t, John Wiley.
7. Image processing, analysis and machine vision, *Milan Sonka et al,* Brookes/Cole, Vikas Publishing House.

DETAILED SYLLABUS OF DISCIPLINE SPECIFIC ELECTIVE COURSES

Semester VIII

Group I (in lieu of dissertation)
(choose any one from this group)

Course title: Transmission Lines, Antenna and Wave Propagation
Course code: ELT-DSE-1A
Nature of the course: DSE
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course explores the fundamental principles and applications of electromagnetic wave propagation, transmission lines, waveguides, waveguide devices, and antenna theory. Students will delve into the behavior of electromagnetic waves in different media, including conductors and dispersive materials. The study of transmission lines covers various types and their parameters, such as impedance and standing wave ratio, alongside practical applications. Waveguides are examined for their modes of propagation and applications in microwave systems. Antenna theory encompasses radiation mechanisms, antenna parameters, types of antennas, and their characteristics. Practical applications in communication and radar systems are emphasized throughout the course.

Course Objectives: This course aims to equip students with a comprehensive understanding of electromagnetic wave propagation, transmission lines, waveguides, waveguide devices, and antenna theory. By the end of the course, students will be able to analyze and describe the behavior of electromagnetic waves in different media, apply transmission line theory to analyze impedance and signal propagation characteristics, understand the modes of wave propagation in waveguides, and evaluate the design and performance parameters of various antenna types. Practical applications in communication systems and radar technology will also be explored, enhancing students' skills in electromagnetic field analysis and antenna design.

Prerequisites:

- Understanding of basic physics concepts (electricity and magnetism)
- Familiarity with calculus (especially differential equations)
- Knowledge of linear algebra
- Proficiency in circuit theory and analysis
- Basic understanding of signals and systems
- Familiarity with complex numbers and phasors

Course Outcomes (COs): The students will able to

CO1: Understand the fundamentals of electromagnetic wave propagation in different media.

LO1.1: Explain the propagation characteristics of electromagnetic waves in good conductors.

LO1.2: Analyze the reflection of uniform plane waves at normal and oblique incidences.

LO1.3: Define and differentiate between phase velocity and group velocity in dispersive media.

CO2: Comprehend the theory and applications of various types of transmission lines.

LO2.1: Describe the characteristics and parameters of typical transmission lines like co-axial, microstrip, and coplanar lines.

LO2.2: Solve transmission line equations and analyze wave propagation in different types of lines.

LO2.3: Utilize Smith Charts for impedance matching and understand transmission line applications in practice.

CO3: Gain proficiency in waveguide theory and application of waveguide devices.

LO3.1: Explain the propagation modes (TEM, TM, TE) in waveguides, including rectangular and circular waveguides.

LO3.2: Analyze power transmission and attenuation characteristics in waveguides.

LO3.3: Describe the operation and applications of waveguide devices like directional couplers and circulators.

CO4: Understand the principles of radiation and characteristics of various types of antennas.

LO4.1: Calculate antenna parameters such as radiation pattern, directivity, and gain.

LO4.2: Explain the concept of antenna efficiency, polarization, and impedance.

LO4.3: Identify and classify different types of antennas including dipole antennas, microstrip antennas, and antenna arrays.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	LO1.1	LO2.1				
Conceptual	LO1.3, CO1	LO2.2, CO2	LO3.1, CO3	LO4.3 LO4.2 CO4		
Procedural		LO2.3	LO3.3 LO4.1			
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	M	M	M	M	M	M	M	M
CO2	M	M	M	M	M	M	M	M	M	M
CO3	M	M	M	M	M	M	M	M	M	M

CO4	S	M	M	M	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

.

Course Contents:

Unit-I: Electromagnetic Wave Propagation (L 15, H 15, M 15)
Propagation in Good Conductors, Skin Effect, Reflection of uniform Plane Waves at normal incidence, Plane Wave reflection at Oblique Incidence, Wave propagation in dispersive media, concept of phase velocity and group velocity.

Unit-II: Transmission Lines (L 15, H 15, M 15)
Typical Transmission lines: Co-axial, Two Wire, Microstrip, Co-planar and Slot Lines, Transmission Line Parameters, Transmission Line Equations, Wave propagation in Transmission lines, low loss, lossless line, Distortion less line, Input Impedance, Standing Wave Ratio, Power. and lossy lines, Shorted Line, Open-Circuited Line, Matched Line, Smith Chart, Transmission Line Applications.

Unit-III: Waveguides and Waveguide Devices (L 15, H 15, M 15)
Wave propagation in waveguides, Parallel plate waveguides, TEM, TM and TE modes, rectangular waveguides, circular waveguides, Power transmission and attenuation, rectangular cavity resonators, directional couplers, isolator, circulator.

Unit-IV: Radiation of Electromagnetic Waves (L 15, H 15, M 15)
Concept of retarded potentials, Antenna Parameters: Radiation Mechanism, Current Distribution on a Thin Wire Antenna, Radiation Pattern, Radiation Power Density, Radiation Intensity, Beamwidth, Directivity, Antenna Efficiency, Gain, Beam Efficiency, Bandwidth, Polarization, Input Impedance Antenna Radiation Efficiency, Effective Length and Equivalent Areas, Maximum Directivity and Maximum Effective Area, Friis Transmission Equation and Radar Range Equation.

Types of Antenna: Hertzian dipole, Half wave dipole, Quarter-wave dipole, Yagi-Uda, Parabolic antenna, Helical antenna, Antenna array, microstrip antenna.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Principles of Electromagnetics, *M. N. O. Sadiku*, Oxford University Press.
2. Fundamentals of Electromagnetics with MATLAB, *Karl E. Longren, Sava V. Savov, Randy J. Jost,* PHI.

3. Engineering Electromagnetics, *W. H. Hayt and J. A. Buck*, Tata McGraw Hill.
4. Field and Wave Electromagnetics, *D. C. Cheng*, Pearson Education.
5. Electromagnetics, *J. A. Edminster*, Schaum Series, Tata McGraw Hill.
6. Elements of Engineering Electromagnetics, *N. Narayan Rao*, Pearson Education.
7. Antennas and Propagation, *G. S. N. Raju*, Pearson Education.

Course title: Control Systems
Course code: ELT-DSE-1B
Nature of the course: DSE
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course introduces fundamental concepts in control systems, focusing on mathematical modeling, analysis, and design techniques. Topics include the modeling of electrical, mechanical, and electromechanical systems using Laplace transforms and transfer functions. It covers state-space representation, block diagrams, and signal flow graphs. Emphasis is placed on feedback control systems, stability analysis using Routh-Hurwitz and Lyapunov methods, frequency domain analysis with Bode and Nyquist plots, and root-locus techniques for controller design. The course also explores various types of controllers (P, PI, PD, PID) and their applications in practical control system design.

Course Objectives: This course aims to equip students with a comprehensive understanding of control systems by covering key theoretical foundations and practical applications. Students will learn to model various electrical, mechanical, and electromechanical systems using Laplace transforms and state-space methods. They will analyze system stability using Routh-Hurwitz, Lyapunov techniques, and frequency domain tools like Bode and Nyquist plots. The course emphasizes controller design (P, PI, PD, PID) using root-locus and frequency response methods to achieve desired performance criteria. Through hands-on exercises, students will evaluate transient and steady-state responses, ensuring proficiency in system analysis and design.

Prerequisites:

- Basic knowledge of calculus and differential equations.
- Understanding of linear algebra and matrix operations.
- Familiarity with basic electrical and mechanical systems.
- Proficiency in system analysis and transfer functions.
- Prior exposure to Laplace transforms and their applications.

Course Outcomes (COs): The students will able to

CO1: Understand the necessity and applications of control systems, including feedback control principles.

LO1.1: Define the concept of control systems and distinguish between open-loop and closed-loop systems.

LO1.2: Analyze and model electrical, mechanical, and electromechanical systems using Laplace transforms and transfer functions.

LO1.3: Apply state-space modeling techniques to describe the dynamics of physical systems and reduce block diagrams using Mason's gain formula.

CO2: Analyze and interpret mathematical models to predict system behavior and performance metrics.

LO2.1: Solve differential equations to obtain system response, including transient and steady-state characteristics.

LO2.2: Evaluate the influence of poles, zeros, and transfer functions on system stability and performance.

LO2.3: Calculate and interpret time-domain specifications such as rise time, overshoot, and settling time from unit step responses.

CO3: Design and evaluate feedback control systems using stability criteria and root-locus techniques.

LO3.1: Analyze system stability using Routh-Hurwitz and Nyquist stability criteria.

LO3.2: Construct Bode and Nyquist plots to determine system stability margins and robustness.

LO3.3: Design controllers using root-locus methods and assess system performance through error analysis.

CO4: Design and implement Proportional, Integral, Derivative (PID) controllers and analyze their performance.

LO4.1: Compare and contrast different types of controllers (P, PI, PD, PID) based on their control characteristics and applications.

LO4.2: Implement pole placement techniques for state feedback and output feedback control systems.

LO4.3: Design lead-lag compensators and evaluate their impact on closed-loop system performance and stability.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	LO1.1	LO1.3				
Conceptual	LO2.2	LO3.1, CO1	LO3.2	LO4.2 CO4		
Procedural	LO1.2	LO2.1 CO2		LO2.3	LO3.3 CO3	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S	M	S	M	M	S	S

CO2	M	S	S	S	M	S	M	M	S	S
CO3	M	S	S	S	M	S	M	M	S	S
CO4	M	S	S	S	M	S	M	M	S	S

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Introduction to Control Systems (L 15, H 15, M 15)
Necessity and examples of control systems, feedback control systems. Mathematical modeling of: electrical systems, mechanical systems, electromechanical systems. Laplace transforms, transfer functions, electrical analogues of other dynamical systems. State-space modelling of dynamical systems, Block diagrams, block diagram reductions. Signal flow graph, Mason's gain formula. Linearity, Time-invariance versus nonlinearity and time-variance Linearization, Distributed parameter systems

Unit-II: Mathematical Models (L 15, H 15, M 15)
Obtaining solutions from mathematical models, Poles and zeros and their effects on solutions, Transient response of second order system, Time domain specifications for unit step response, Steady state error-linear continuous data control system. Generalized error coefficient and its evaluation, Correlation between static and dynamic error coefficients.

Unit-III: Feedback Control Systems (L 15, H 15, M 15)
Basic idea of feedback control systems, Definition of stability. Routh-Hurwitz test. Lyapunov theory. Bode plot, Nyquist plot, Nyquist stability criterion, gain and phase margins, and robustness. The root-locus technique, steps in obtaining a root-locus. Design of controllers using root-locus, Error analysis,

Unit-IV: P, PI, PD and PID Controllers (L 15, H 15, M 15)
Proportional (P), Proportional Integrator (PI), Proportional Derivative (PD), Proportional Integrator Derivative (PID) controllers, Pole placement with state feedback, controllability. Pole placement with output feedback, observability, Luenberger observer LQR control Lead compensator, lag compensator, lead-lag/lag-lead compensators, and their design.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:
1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Modern Control Engineering, *Katsuhiko Ogata*, Prentice Hall of India.
2. Automatic Control Systems, *Benjamin C. Kuo* Wiley Publisher.
3. Control Systems, *S. Hasan Saeed*, Katson Books.

4. Control Systems Engineering, *I. J. Nagrath and M. Gopal*, New Age International.
5. Control Systems, *N. K. Sinha*, New Age International.

Course title: Internet of Things
Course code: ELT-DSE-1C
Nature of the course: DSE
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course introduces the Internet of Things (IoT), exploring its core concepts, architecture, and enabling technologies. Students will learn about IoT protocols, communication models, and functional blocks, as well as the differences between IoT and Machine-to-Machine (M2M) communication. Hands-on projects include programming IoT devices like Raspberry Pi and using Python for system design. The course also covers cloud storage, data analytics with Hadoop and Spark, and ethical considerations in IoT deployment. By the end, students will be proficient in developing and implementing IoT solutions for various applications.

Course Objectives: This course aims to equip students with a comprehensive understanding of IoT concepts, architecture, and enabling technologies. Students will learn to design and implement IoT systems using Python, understand IoT communication models and protocols, and explore the differences between IoT and M2M communication. The course includes hands-on experience with IoT devices like Raspberry Pi, cloud storage models, and data analytics using Hadoop and Spark. By the end of the course, students will be able to develop, analyze, and deploy IoT solutions, addressing real-world challenges and leveraging emerging technologies effectively.

Prerequisites:

- Basic knowledge of computer programming (preferably in Python)
- Understanding of basic electronics and circuit design
- Familiarity with networking concepts and protocols
- Introductory knowledge of cloud computing and data storage
- Experience with Linux operating systems and command-line interfaces

Course Outcomes (COs): The students will able to

CO1: Understand the foundational concepts of IoT, including its definitions, characteristics, and physical design.

LO1.1: Define IoT and describe its key characteristics and components.

LO1.2: Explain the physical design of IoT systems and the role of Things in IoT.

LO1.3: Identify and analyze IoT protocols, communication models, and enabling technologies such as Wireless Sensor Networks and Cloud Computing.

CO2: Learn about Machine-to-Machine (M2M) communication, differences between IoT and M2M, and the role of SDN and NFV in IoT.

LO2.1: Compare and contrast IoT and M2M, understanding their respective roles and technologies.

LO2.2: Describe Software Defined Networking (SDN) and Network Function Virtualization (NFV) in the context of IoT.

LO2.3: Demonstrate practical skills in IoT platform design using Python, covering data types, control flow, functions, and interaction with IoT devices.

CO3: Understand IoT physical devices, endpoints, and their integration with cloud services.

LO3.1: Describe IoT devices, focusing on Raspberry Pi as an exemplary device, including programming with Python.

LO3.2: Explain IoT physical servers, cloud storage models, and communication networks.

LO3.3: Implement IoT applications using frameworks like Django for designing RESTful web APIs and utilizing cloud services like Xively.

CO4: Understand data analytics for IoT applications, including batch and real-time data analysis using technologies like Apache Hadoop, Spark, and Storm.

LO4.1: Describe Apache Hadoop and its use in batch data analysis with MapReduce.

LO4.2: Discuss Apache Storm for real-time data analysis in IoT applications.

LO4.3: Analyze the implications of IoT on privacy, control, and environmental aspects, and understand IoT as part of comprehensive solutions.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1, LO3.1	LO2.1				
Conceptual		CO1, LO1.2, LO2.2, LO3.2, LO4.2				
Procedural		CO2, CO3, LO1.3, LO2.3, LO3.3, LO4.3		CO4, LO4.1		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	M	S	S
CO2	M	S	S	S	S	M	S	M	S	S
CO3	M	S	S	S	S	S	M	S	S	S
CO4	W	M	W	W	W	W	W	W	W	W

Course Contents:

UNIT-I: Introduction (L 15, H 15, M 15)

Definitions and Characteristics of IoT, Physical Design of IoT, Things in IoT, IoT Protocols, Logical Design of IoT, IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies, Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, IoT levels and Development Templates, IoT Level-1, IoT Level2, IoT Level-3, IoT Level-4, IoT Level-5, IoT Level-6.

UNIT-II: M2M, Networking and Data Types (L 15, H 15, M 15)

M2M, Difference between IoT and M2M, SDN and NFV for IoT, Software Defined Networking, Network Function Virtualization, Platform Design Methodology, Logical Design Using Python, Python Data Types and Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date Time applications, Classes.

UNIT-III: IoT Physical Devices and End Points (L 15, H 15, M 15)

Raspberry Pi, Linux on Raspberry Pi, Raspberry pi interfaces, programming raspberry pi with python, other IoT devices, physical servers and cloud-based server, introduction to cloud storage and communication networks, wamp-autobahn for IoT, xively cloud for IoT, python web application frame work-django, designing a RESTful web API.

UNIT-IV: Data Analytics for IoT (L 15, H 15, M 15)

Introduction to Apache Hadoop, using Hadoop Map Reduce for Batch Data Analysis, Apache oozie, Apache Spark, Apache Storm, using Apache Storm for Real-time Data Analysis.
Characterizing the IoT, Privacy, Control, Distributing Control and Crowd Sourcing, different environments, Physical Thing, Internet Service, Solutions, IoT as Part of Solution, Cautious Optimizing, The definition of Open IoT.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Internet of Things - A Hands-on Approach, *Arshdeep Bahga and Vijay Madisetti*, University of Penn.
2. Designing the Internet of Things, *Adrian McEwen and Hakim Cassimally*, Wiley Publication.
3. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, *Ovidiu Vermesan and Peter Friess*, River Publishers Series in Communication.
4. Internet of Things Principles and Paradigms, *Rajkumar Buyya*, *Amir Vahid Dastjerdi*, MK.
5. Learning Python, *Mark Lutz,* O'Reilly Media.

6. Programming in Python 3, A Complete Introduction to the Python Language, *Mark Summerfield*, Pearson.

Course title: Computer Networks
Course code: ELT-DSE-1D
Nature of the course: DSE
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course covers the fundamental concepts of data communication and networking, including network architecture, protocols, and standards. Students will learn about digital and analog transmission methods, error detection and correction, and the various layers of network protocols. The course includes practical sessions on implementing protocols, configuring network devices, and managing data communication systems.

Course Objectives: The course aims to provide a comprehensive understanding of data communication and networking fundamentals. Students will learn about network architectures, protocols, and standards essential for efficient data transmission. The curriculum covers digital and analog transmission techniques, error detection and correction methods, and the functionality of various network layers. Emphasis is placed on practical skills for configuring network devices and implementing protocols. By the end of the course, students will be proficient in managing network systems, addressing and routing in the network layer, and understanding transport and application layer protocols, preparing them for advanced studies and professional roles in networking.

Prerequisites:

- Basic knowledge of computer programming (preferably in Python)
- Understanding of basic electronics and circuit design
- Familiarity with networking concepts and protocols
- Introductory knowledge of cloud computing and data storage
- Experience with Linux operating systems and command-line interfaces

Course Outcomes (COs): The students will able to

CO1: Understand the fundamentals of data communications, including components, protocols, standards, and network architectures.

LO1.1: Describe the components, protocols, and standards involved in data communications.

LO1.2: Explain the ISO-OSI and TCP/IP reference models, transmission modes, and digital signal encoding.

LO1.3: Analyze various switching techniques such as circuit switching (space-division, time-division, space-time division) and packet switching (virtual circuit and Datagram approach).

CO2: Gain insights into data link layer protocols, including design issues, flow control, and error control mechanisms.

LO2.1: Evaluate design issues in the data link layer and the role of Data Link Control.

LO2.2: Compare and contrast ARQ protocols like Stop-and-wait, Go-Back-N, and Selective Repeat.

LO2.3: Understand medium access control methods, including multiple access protocols and IEEE standards for LANs and WLANs.

CO3: Understand network layer design, including routing algorithms, congestion control, and internetworking concepts.

LO3.1: Analyze routing algorithms and congestion control mechanisms at the network layer.

LO3.2: Describe IP addressing, subnetting, and network layer protocols like ARP, ICMP, IPv4, and IPv6.

LO3.3: Understand the concept of internetworking and host-to-host delivery in network layer protocols.

CO4: Understand the process-to-process delivery in the transport layer, including UDP and TCP protocols, congestion control, and Quality of Service (QoS).

LO4.1: Compare UDP and TCP protocols for process-to-process delivery and analyze their congestion control mechanisms.

LO4.2: Explain the client-server model, socket interface, and Domain Name System (DNS) in the application layer.

LO4.3: Discuss application layer protocols like SMTP, FTP, HTTP, and their roles in electronic mail, file transfer, and web services.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1, LO2.2, LO3.2, LO4.3	CO1, LO1.2, LO3.3, LO4.2				
Conceptual		LO1.3, LO2.1, LO3.1	CO2, LO2.3	LO4.1		
Procedural			CO3, LO3.2		CO4, LO4.1	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	M	S	M	S	S

CO2	S	S	M	M	S	M	S	M	S	S
CO3	S	S	M	M	S	M	S	M	S	S
CO4	S	S	M	M	S	M	S	M	S	S

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Data Communications (L 15, H 15, M 15)

Components, protocols and standards, Network and Protocol Architecture, Reference Model ISO-OSI, TCP/IP-Overview, topology, transmission mode, digital signals, digital to digital encoding, digital data transmission, DTE-DCE interface, interface standards, modems, cable modem, transmission media- guided and unguided, transmission impairment, Performance, wavelength and Shannon capacity. Review of Error Detection and Correction codes. Switching: Circuit switching (space-division, time division and space-time division), packet switching (virtual circuit and Datagram approach), message switching.

Unit-II: Data Link Layer (L 15, H 15, M 15)

Design issues, Data Link Control and Protocols: Flow and Error Control, Stop-and-wait ARQ. Sliding window protocol, Go-Back-N ARQ, Selective Repeat ARQ, HDLC, Point-to –Point Access: PPP Point –to- Point Protocol, PPP Stack, Medium Access Sub layer: Channel allocation problem, Controlled Access, Channelization, multiple access protocols, IEEE standard 802.3 & 802.11 for LANS and WLAN, high-speed LANs, Token ring, Token Bus, FDDI based LAN, Network Devices-repeaters, hubs, switches bridges.

Unit-III: Network Layer (L 15, H 15, M 15)

Design issues, Routing algorithms, Congestion control algorithms, Host to Host Delivery: Internetworking, addressing and routing, IP addressing (class full & Classless), Subnet, Network Layer Protocols: ARP, IPV4, ICMP, IPV6, ICMPV6.

Unit-IV: Transport Layer (L 15, H 15, M 15)

Process to Process Delivery: UDP; TCP, congestion control and Quality of service. Application Layer: Client Server Model, Socket Interface, Domain Name System (DNS): Electronic Mail (SMTP), file transfer (FTP), HTTP and WWW.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc. **(20 Marks)**

Recommended Readings:

1. Computer Networks, *S. Tannenbum, D. Wetherall*, Prentice Hall, Pearson.

2. Data Communications and Networking, *Behrouz A. Forouzan*, Tata McGraw-Hill.
3. Data Communications, Computer Networks and Open Systems, *Halsall Fred*, Addison Wesley.

Group II (in lieu of dissertation)
(choose any one from this group)

Course title: Fundamentals of Applied Physics
Course code: ELT-DSE-2A
Nature of the course: DSE
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides a comprehensive exploration of fundamental concepts in quantum physics, mechanical properties of materials, thermal properties, and electric and magnetic properties. Students delve into the inadequacies of classical physics, wave-particle duality, and the Schrodinger wave equation's application in various scenarios. Mechanical properties cover elastic and plastic deformations, while thermal properties include thermodynamics laws, entropy, and thermal conductivity. Electric and magnetic properties address conductivity, Ohm's Law, superconductivity, and magnetic materials' classifications. The course emphasizes theoretical foundations alongside practical applications, preparing students to understand and analyze material behaviors, thermodynamic processes, and electromagnetic phenomena crucial to modern physics and engineering applications.

Course Objectives: The course aims to equip students with a deep understanding of foundational principles in quantum physics, mechanical properties of materials, thermal properties, and electric and magnetic properties. Students will develop proficiency in analyzing quantum phenomena such as wave-particle duality and the Schrodinger wave equation, applying them to real-world scenarios. They will explore mechanical behaviors including elasticity, plasticity, and material strength, alongside thermal concepts like entropy, heat capacity, and thermoelectric effects. Additionally, the course covers electrical conductivity, magnetic behaviors, and superconductivity, fostering skills in applying theoretical knowledge to practical situations, preparing them for careers in physics, materials science, and engineering fields.

Prerequisites:

- Basic understanding of classical physics
- Familiarity with calculus and differential equations
- Proficiency in algebra and trigonometry
- Knowledge of basic principles of mechanics and thermodynamics

Course Outcomes (COs): The students will able to

CO1: Understand the foundational principles and mathematical formalism of quantum mechanics.

- **LO1.1:** Explain the inadequacies of classical physics and key experimental observations that led to the development of quantum theory.
- **LO1.2:** Describe the wave-particle duality of matter and light, including Compton's effect and the photoelectric effect.
- **LO1.3:** Apply the Schrödinger wave equation to solve problems involving free particles, particles in a potential well, and potential barriers.

CO2: Gain insights into the mechanical behavior and properties of materials under stress and deformation.

- **LO2.1:** Define elastic and plastic deformations, Hooke's Law, and the various elastic moduli.
- **LO2.2:** Analyze the tensile strength, brittleness, and ductility of materials, along with mechanisms like hardness, creep, fatigue, and fracture.
- **LO2.3:** Discuss the theoretical and critical shear stress of crystals and the factors influencing strengthening mechanisms in materials.

CO3: Understand the fundamental principles and concepts related to thermal properties and thermodynamics.

- **LO3.1:** Explain the laws of thermodynamics, entropy, and the concept of phonons in solids.
- **LO3.2:** Describe heat capacity, Debye's law, and specific heat capacities for different materials like silicon (Si) and gallium arsenide (GaAs).
- **LO3.3:** Discuss thermal conductivity, thermoelectric effects (Seebeck, Thomson, Peltier effects), and their applications in materials science and engineering.

CO4: Explore the electrical and magnetic properties of materials, including conductivity and magnetism.

- **LO4.1:** Define conductivity, Ohm's Law, and factors affecting resistivity in metals, including electron scattering and relaxation times.
- **LO4.2:** Classify magnetic materials and explain the origin of magnetic moments and different types of magnetism (dia, para, ferro, antiferro).
- **LO4.3:** Analyze superconductivity, magnetic domains, Giant Magnetoresistance (GMR), and magnetic recording technologies.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1, LO2.1, LO3.1, LO4.1	CO1, LO1.2, LO2.2, LO3.				
Conceptual		CO2, LO1.3, LO2.3, LO4.3				

Procedural			CO3, LO3.2, LO3.3, LO4.2	CO4, LO4.3		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	W	S	W	M	W	M	M	M	W	S
CO2	W	S	W	M	W	M	M	M	W	S
CO3	W	S	W	M	W	M	M	M	W	S
CO4	W	S	W	M	W	M	M	M	W	S

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Quantum Physics (L 20, H 20, M 20)

Inadequacies of Classical physics, Compton's effect, Photo-electric Effect, Wave-particle duality, de Broglie waves. Basic postulates and formalism of quantum mechanics: probabilistic interpretation of waves, conditions for physical acceptability of wave functions. Schrodinger wave equation for a free particle and in a force field (1 dimension), Boundary and continuity conditions, Operators in Quantum Mechanics, Conservation of probability, Time-dependent form, Linearity and superposition, Operators, Time-independent one-dimensional Schrodinger wave equation, Stationary states, Eigen-values and Eigen functions. Particle in a one-dimensional box, Extension to a three-dimensional box, Potential barrier problems, phenomenon of tunnelling, Kronig Penney Model and development of band structure. Spherically symmetric potentials, the Hydrogen-like atom problem.

Unit-II: Mechanical Properties of Materials (L 10, H 10, M 10)

Elastic and Plastic Deformations, Hooke's Law, Elastic Moduli, Brittle and Ductile Materials, Tensile Strength, Theoretical and Critical Shear Stress of Crystals, Strengthening Mechanisms, Hardness, Creep, Fatigue, Fracture.

Unit-III: Thermal Properties (L 15, H 15, M 15)

Brief Introduction to Laws of Thermodynamics, Concept of Entropy, Concept of Phonons, Heat Capacity, Debye's Law, Lattice Specific Heat, Electronic Specific Heat, Specific Heat Capacity for Si and GaAs, Thermal Conductivity, Thermoelectricity, Seebeck Effect, Thomson Effect, Peltier Effect.

Unit-IV: Electric and Magnetic Properties (L 15, H 15, M 15)

Conductivity of metals, Ohm's Law, relaxation time, collision time and mean free path, electron scattering and resistivity of metals, heat developed in current carrying conductor, Superconductivity.

Classification of Magnetic Materials, Origin of Magnetic moment, Origin of dia, para, ferro and anti-ferro magnetism and their comparison, Ferrimagnetic materials, Saturation Magnetisation and Curie temperature, Magnetic domains, Concepts of Giant Magnetic Resistance (GMR), Magnetic recording.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Material Science, *S. Vijaya and G. Rangarajan*, Tata Mcgraw Hill.
2. Material Science and Engineering: An Introduction, *W. E. Callister*, Wiley India.
3. Concepts of Modern Physics, *Beiser*, McGraw-Hill Book Company.
4. Quantum Mechanics: Theory and Applications, *A. Ghatak and S. Lokanathan*, Macmillan India.

Course title: Electromagnetics
Course code: ELT-DSE-2B
Nature of the course: DSE
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course in Electromagnetic Theory covers foundational principles and applications of electromagnetism. Unit-I begins with Vector Analysis, exploring scalar and vector fields, along with electrostatic fields and their mathematical descriptions. Unit-II delves into Poisson's and Laplace's equations, Magnetostatics, and the fundamentals of magnetic fields and potentials. Unit-III extends into time-varying fields, Maxwell's equations, and electromagnetic induction. Unit-IV concludes with electromagnetic wave propagation, including concepts of polarization, reflection, and standing waves. Emphasis is placed on mathematical rigor and practical applications in engineering contexts, preparing students to analyze and solve complex electromagnetic problems in various domains.

Course Objectives: The course aims to equip students with a deep understanding of Electromagnetic Theory and its applications. By the end of the course, students will proficiently apply vector analysis to describe electromagnetic fields and solve related problems. They will grasp the intricacies of electrostatic and magnetostatic phenomena, including field distributions and potential formulations. Furthermore, students will master Maxwell's equations in both differential and integral forms, comprehend electromagnetic wave propagation, polarization, and reflection phenomena. Practical skills will be honed in analyzing and designing electromagnetic systems, preparing students for careers where knowledge of electromagnetic theory is essential, such as telecommunications, electronics, and power systems engineering.

Prerequisites:

- Understanding of calculus, including differential and integral calculus
- Proficiency in vector algebra and vector calculus
- Familiarity with basic physics principles, especially in electricity and magnetism
- Knowledge of differential equations
- Understanding of basic circuit theory and analysis

Course Outcomes (COs): The students will able to

CO1: Understand vector analysis and its applications in electrostatics.

LO1.1: Define scalars and vectors, and perform vector algebra operations in Cartesian, cylindrical, and spherical coordinate systems.

LO1.2: Apply Gauss's law and the divergence theorem to solve electrostatic problems involving charge distributions and electric fields.

LO1.3: Analyze the behavior of electric fields in conductors, dielectric materials, and capacitors, including the calculation of capacitance and electrostatic energy.

CO2: Understand Poisson's and Laplace's equations and their solutions, and principles of magnetostatics.

LO2.1: Derive Poisson's and Laplace's equations and apply them to solve boundary value problems in different coordinate systems.

LO2.2: Explain Biot-Savart's law, Ampere's circuital law, and the principles of magnetization in materials.

LO2.3: Analyze magnetic fields, magnetic boundary conditions, inductors, and magnetic energy in magnetic circuits.

CO3: Understand Maxwell's equations and their applications in time-varying electromagnetic fields.

LO3.1: Describe Faraday's law of electromagnetic induction, displacement current, and Maxwell's equations in both differential and integral forms.

LO3.2: Discuss the concept of electromagnetic potentials, Lorentz gauge, and the wave equation for potentials.

LO3.3: Analyze time-harmonic electromagnetic fields, use of phasors, and electromagnetic boundary conditions in practical applications.

CO4: Understand the principles of electromagnetic wave propagation and its characteristics.

LO4.1: Describe the properties of uniform plane waves in lossless and lossy media, including wave polarization and velocity.

LO4.2: Explain the concept of reflection, standing waves, and the flow of electromagnetic power using the Poynting vector.

LO4.3: Analyze the interaction of electromagnetic waves with boundaries and their propagation in various media, including the electromagnetic spectrum.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual	LO1.1					
Conceptual	LO1.3	LO2.1		CO1, LO1.2 CO2, LO2.3		
Procedural		LO3.1 LO4.2		LO2.2 LO4.1 CO3, LO3.2 CO4, LO4.3		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	M	M	M
CO2	S	S	M	M	M	M	M	M	M	M
CO3	S	S	M	M	M	M	M	M	M	M
CO4	S	S	M	M	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Vector Analysis and Electrostatic Fields (L 15, H 15, M 15)

Scalars and Vectors, Vector Algebra, Rectangular (Cartesian) Coordinate System, Vector Components and Unit Vector, Vector Field, Products, Cylindrical Coordinates, Spherical Coordinates, Differential Length, Area and Volume, Line Surface and Volume integrals, Del Operator, Gradient of a Scalar, Divergence and Curl of a Vector, the Laplacian.

Coulomb's Law and Electric Field, Field due to Discrete and Continuous Charge Distributions, Electric Flux Density, Gauss's Law and Applications, Divergence Theorem and Maxwell's First Equation. Electric Potential, Potential due to a Charge and Charge distribution, Electric dipole. Electric Fields in Conductors, Current and Current Density, Continuity of Current, Metallic Conductor Properties and Boundary Conditions, Method of Images. Dielectric materials, Polarization, Dielectric Constant, Isotropic and Anisotropic dielectrics, Boundary conditions, Capacitance and Capacitors. Electrostatic Energy and Forces.

Unit-II: Poisson's and Laplace's Equations (L 15, H 15, M 15)

Derivation of Poisson's and Laplace's equation, Uniqueness Theorem, Examples of Solution of Laplace's Equation: Cartesian, Cylindrical and Spherical Coordinates.

Magnetostatics: Biot Savert's law and Applications, Magnetic dipole, Ampere's Circuital Law, Curl and Stoke's Theorem, Maxwell's Equation, Magnetic Flux and Magnetic Flux

Density, Scalar and Vector Magnetic Potentials. Magnetization in Materials and Permeability, Anisotropic materials, Magnetic Boundary Conditions, Inductors and Inductances, Magnetic Energy, Magnetic Circuits. Inductances and Inductors, Magnetic Energy, Forces and Torques.

Unit-III: Time-Varying Fields and Maxwell's Equations. (L 15, H 15, M 15)

Faraday's Law of Electromagnetic Induction, Stationary Circuit in Time-Varying Magnetic Field, Transformer and Motional EMF, Displacement Current, Maxwell's Equations in differential and integral form and Constitutive Relations. Potential Functions, Lorentz gauge and the Wave Equation for Potentials, Concept of Retarded Potentials. Electromagnetic Boundary Conditions. Time-Harmonic Electromagnetic Fields and use of Phasors

Unit-IV: Electromagnetic Wave Propagation (L 15, H 15, M 15)

Time- Harmonic Electromagnetic Fields and use of Phasors, the Electromagnetic Spectrum, Wave Equation in a source free isotropic homogeneous media, Uniform Plane Waves in Lossless and Lossy unbounded homogeneous media, Wave Polarization, Phase and Group velocity, Flow of Electromagnetic Power and Poynting Vector. Uniform Plane wave incident on a Plane conductor boundary, concept of reflection and standing wave.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Vector Analysis, *Murray. R. Spiegel*, Schaum series, Tata McGraw Hill.
2. Elements of Electromagnetics, *M. N. O. Sadiku*, Oxford University Press.
3. Engineering Electromagnetics, *W. H. Hayt and J. A. Buck*, Tata McGraw Hill.
4. Field and Wave Electromagnetics, *D. C. Cheng*, Pearson Education.
5. Electromagnetics, *J. A. Edminster*, Schaum Series, Tata McGraw Hill.
6. Elements of Engineering Electromagnetics, *N. Narayan Rao*, Pearson Education.
7. Introduction to Electrodynamics, *D. J. Griffiths*, Pearson Education.
8. Electromagnetic Wave and Radiating System, *Jordan and Balmain*, Prentice Hall.

Course title: Photonics
Course code: ELT-DSE-2C
Nature of the course: DSE
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course delves into the principles of wave optics and the interaction of light with matter. Topics include the propagation of light as electromagnetic waves, interference and diffraction phenomena, polarization, and the operation of optical devices such as LEDs, lasers, and photodetectors. The course also covers advanced topics like holography, the behavior of guided waves, and the characteristics of optical fibers. Emphasis is placed on both theoretical foundations and practical applications, providing students with a comprehensive understanding of optical physics and its technological implications.

Course Objectives: The objective of this course is to provide students with a thorough understanding of wave optics and the physical principles governing the interaction of light with various media. Students will explore the concepts of interference, diffraction, and polarization, as well as gain insight into the operation of light-emitting devices, lasers, and photodetectors. The course aims to equip students with the knowledge necessary to understand and analyze the behavior of guided optical waves and the properties of optical fibers, preparing them for advanced studies and practical applications in optical physics and engineering.

Prerequisites:

- Understanding of calculus, including differential and integral calculus.
- Proficiency in vector algebra and vector calculus.
- Familiarity with basic physics principles, especially in electricity and magnetism.
- Knowledge of differential equations.
- Basic understanding of circuit theory and analysis.

Course Outcomes (COs): The students will able to

CO1: Understand light as an electromagnetic wave and its interactions with matter.

- **LO1.1:** Explain plane waves, spherical waves, and their propagation in homogeneous media.
- **LO1.2:** Analyze reflection, transmission at interfaces, total internal reflection, and Brewster's Law.
- **LO1.3:** Describe interference phenomena including Young's double slit experiment, thin film interference, Newton's rings, and applications like holography.

CO2: Understand polarization of light and its properties in various media.

- **LO2.1:** Define linear, circular, and elliptical polarization and analyze polarization phenomena using polarizers and analyzers.
- **LO2.2:** Explain double refraction in crystals, wave propagation in uniaxial media, and the effects of half wave and quarter wave plates.
- **LO2.3:** Discuss Faraday rotation, electro-optic effect, and their applications in optical devices.

CO3: Understand the principles and applications of light-emitting devices and optical detectors.

- **LO3.1:** Describe the construction, materials, and operation of Light Emitting Diodes (LEDs).
- **LO3.2:** Explain the principles of laser operation, including Einstein coefficients, laser cavity, and conditions for amplification.
- **LO3.3:** Discuss photodetectors such as photomultiplier tubes, photodiodes, their quantum efficiency, and responsivity, as well as the principles and applications of Liquid Crystal Displays (LCDs).

CO4: Understand guided wave propagation in optical fibers and its characteristics.

- **LO4.1:** Describe TE and TM modes in symmetric slab waveguides, effective index, and field distributions.
- **LO4.2:** Explain total internal reflection, step index optical fibers, and concepts related to single mode and multimode fibers.
- **LO4.3:** Analyze attenuation, dispersion, and the principles of linearly polarized waves in optical fibers, including practical applications in telecommunications.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual	LO1.1	LO1.2	LO2.1		LO3.1	
Conceptual		CO1, LO1.1, LO1.3	CO2, LO2.2, LO2.3	LO4.1	CO3, LO3.2, LO3.3	
Procedural				CO4, LO4.2 LO4.3	-	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	M	M	M
CO2	S	S	S	M	M	M	M	M	M	M
CO3	S	S	M	M	M	M	M	M	M	M
CO4	S	S	M	M	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Light as an Electromagnetic Wave **(L 20, H 20, M 20)**

Plane waves in homogeneous media, concept of spherical waves. Reflection and transmission at an interface, total internal reflection, Brewster's Law. Interaction of electromagnetic waves with dielectrics: origin of refractive index, dispersion.

Interference: Superposition of waves of same frequency, Concept of coherence, Interference by division of wavefront, Young's double slit, Division of Amplitude, thin film interference, anti-reflecting films, Newton's rings; Michelson interferometer. Holography.

Diffraction: Huygen Fresnel Principle, Diffraction Integral, Fresnel and Fraunhoffer approximations. Fraunhoffer Diffraction by a single slit, rectangular aperture, double slit, resolving power of microscopes and telescopes; Diffraction grating: Resolving power and Dispersive power

Unit-II: Polarization **(L 10, H 10, M 10)**

Linear, circular and elliptical polarization, polarizer-analyzer and Malus' law; Double refraction by crystals, Interference of polarized light, Wave propagation in uniaxial media. Half wave and quarter wave plates. Faraday rotation and electro-optic effect.

Unit-III Light Emitting Diodes **(L 15, H 15, M 15)**

Construction, materials and operation.

Lasers: Interaction of radiation and matter, Einstein coefficients, Condition for amplification, laser cavity, threshold for laser oscillation, line shape function. Examples of common lasers. The semiconductor injection laser diode.

Photodetectors: Bolometer, Photomultiplier tube, Charge Coupled Device. Photo transistors and Photodiodes (p-i-n, avalanche), quantum efficiency and responsivity.

LCD Displays: Types of liquid crystals, Principle of Liquid Crystal Displays, applications, advantages over LED displays.

Unit-IV: Guided Waves and the Optical Fiber **(L 15, H 15, M 15)**

TE and TM modes in symmetric slab waveguides, effective index, field distributions, Dispersion relation and Group Velocity. Step index optical fiber, total internal reflection, concept of linearly polarized waves in the step index circular dielectric waveguides, single mode and multimode fibers, attenuation and dispersion in optical fiber.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Optics, *Ajoy Ghatak*, Tata McGraw Hill.
2. Optics, *E. Hecht*, Pearson Education Ltd.
3. Optoelectronics: An Introduction, *J. Wilson and J. F. B. Hawkes*, Prentice Hall India.
4. Optoelectronics and Photonics: Principles and Practices, *S. O. Kasap*, Pearson Education.
5. Introduction to fiber optics, *A. K. Ghatak and K. Thyagarajan*, Cambridge University Press.

Course title: Nano Electronics
Course code: ELT-DSE-2D
Nature of the course: DSE
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course introduces students to the fundamentals and applications of nanoscience and nanotechnology. Topics include the unique properties of nanoscale materials, quantum theory relevant to nanomaterials, and the preparation and characterization of quantum nanostructures. Students will explore various growth techniques for nanomaterials, including bottom-up and top-down approaches, and advanced methods for measuring and characterizing nanomaterials. The course also covers specialized topics such as carbon nanotubes, graphene, and the application of nanoparticles in biology, emphasizing the impact of nanotechnology on the environment and its potential for innovation in various fields.

Course Objectives: The objective of this course is to provide students with a comprehensive understanding of nanoscience and nanotechnology, focusing on the unique properties and behaviors of materials at the nanoscale. Students will learn about quantum theory applications, synthesis methods, and characterization techniques essential for nanomaterials. The course aims to equip students with the knowledge to innovate and apply nanotechnology in diverse fields such as electronics, materials science, and biotechnology, while also considering environmental impacts. Through theoretical and practical insights, students will be prepared for advanced research and development in nanotechnology.

Prerequisites:

- Basic understanding of solid-state physics.
- Fundamental knowledge of quantum mechanics.
- Familiarity with materials science concepts.
- General background in chemistry and physics.
- Proficiency in mathematical concepts such as calculus and linear algebra.

Course Outcomes (COs): The students will able to

CO1: Understand the fundamental concepts of nano-science and nano-technology.
- **LO1.1:** Define nano-science and nano-technology, and discuss their applications in various fields.
- **LO1.2:** Explain size dependence of properties in nano-materials, bonding in atoms, and electronic conduction in solids.
- **LO1.3:** Analyze quantum mechanical principles such as the Schrodinger wave equation, particle in a box, potential step, and quantum confinement effects in nano-materials.

CO2: Understand various techniques for synthesizing nanomaterials.
- **LO2.1:** Describe bottom-up and top-down approaches to nanomaterial synthesis, including lithographic and non-lithographic techniques.

LO2.2: Explain specific growth techniques such as sputtering, evaporation methods (thermal and e-beam), chemical vapor deposition (CVD), and sol-gel techniques.

LO2.3: Discuss advanced methods like molecular beam epitaxy (MBE), pulsed laser deposition, and synthesis of nanowires using VLS method and electrochemical deposition.

CO3: Understand advanced microscopy and spectroscopy techniques for nano-material characterization.

LO3.1: Explain scanning probe microscopy (SPM), atomic force microscopy (AFM), and electron microscopy techniques (SEM, TEM) including their applications in nano-material analysis.

LO3.2: Discuss spectroscopic techniques such as infrared, Raman, X-ray, magnetic resonance, optical, and vibrational spectroscopy for nano-material characterization.

LO3.3: Analyze the role of these characterization techniques in biopolymer tagging, semiconductor quantum dots, and other nano-material applications.

CO4: Understand the properties, fabrication methods, and applications of carbon-based nanostructures.

LO4.1: Describe the fabrication techniques and structural properties of carbon nanotubes, graphene, nano cuboids, and carbon quantum dots.

LO4.2: Explain the electrical, mechanical, and vibrational properties of these nanostructures and their applications in various fields.

LO4.3: Discuss the use of nano-particles in biological applications such as drug delivery and bio-imaging, and assess the environmental impacts of nanotechnology.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1, LO2.1, LO3.1, LO4.1	LO1.2, LO2.2, LO3.2, LO4.2	LO1.3, LO2.3, LO3.3, LO4.3			
Conceptual		CO1, LO1.2	CO2, LO2.1	CO3, LO3.2	CO4, LO4.2	
Procedural		LO1.3	LO2.2	LO3.3	LO4.3	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	W	M	W	W	W	W	W	W
CO2	M	S	W	W	W	W	W	W	W	W
CO3	W	W	M	W	W	W	W	W	W	W

CO4	M	W	W	W	W	W	W	W	W	W

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Introductory Concepts (L 15, H 15, M 15)

Definition of Nano-Science and Nano Technology, Applications of Nano-Technology.

Introduction to Physics of Solid State: Size dependence of properties, bonding in atoms and giant molecular solids, Electronic conduction, Systems confined to one, two or three dimension and their effect on property

Quantum Theory for Nano Science: Time dependent and time independent Schrodinger wave equations. Particle in a box, Potential step: Reflection and tunneling. Penetration of Barrier, Electron trapped in 2D plane (Nano sheet), Quantum confinement effect in nano materials.

Quantum Wells, Wires and Dots: Preparation of Quantum Nanostructure; Size and Dimensionality effect, Fermi gas; Potential wells; Partial confinement; Excitons; Single electron Tunneling, Infrared detectors; Quantum dot laser Superconductivity.

Unit-II: Growth Techniques of Nanomaterials (L 17, H 17, M 17)

Synthetic aspects: bottom up and top-down approaches, Lithographic and Nanolithographic techniques, Sputtering and film deposition in glow discharge, DC sputtering technique (p-CuAlO2 deposition). Thermal evaporation technique, E-beam evaporation, Chemical Vapour deposition (CVD), Synthesis of carbon nano-fibres and multi-walled carbon nanotubes, Pulsed Laser Deposition, Molecular beam Epitaxy, Sol-Gel Technique, Synthesis of nanowires/rods, Electro deposition, Chemical bath deposition, Ion beam deposition system, Vapor-Liquid – Solid (VLS) method of nanowire

Unit-III: Methods of Measuring Properties and Characterization Techniques (L 18, H 18, M 18)

Microscopy: Scanning Probe Microscopy (SPM), Atomic Force Microscopy (AFM), Field Ion Microscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) including energy dispersive X-ray (EDX) analysis, low energy electron diffraction (LEED), reflection high energy electron diffraction (RHEED)

Spectroscopy: Infra-red and Raman Spectroscopy, X-ray Spectroscopy, Magnetic resonance, Optical and Vibrational Spectroscopy.

Characterization and application like biopolymer tagging and light emitting semiconductor quantum dots.

Unit-IV: Carbon Nanos (L 10, H 10, M 10)

Carbon nanotubes, nano cuboids, graphene, carbon quantum dots: Fabrication, structure. electrical, mechanical, and vibrational properties and applications. Use of nano particles for biological application, drug delivery and bio-imaging, Impact of nanotechnology on the environment.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Nanoscale Science and Technology, *Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan*, John Wiley & Sons, Ltd.
2. Nanomaterials: synthesis, properties and applications, Institute of Physics.
3. Introduction to Nanotechnology, *Charles P. Poole Jr and Frank J. Owens*, Wiley Interscience.
4. Electron Microscopy and analysis, Taylor and Francis.
5. Bio-Inspired Nanomaterials and Nanotechnology, *Edited by Yong Zhou*, Nova Publishers.
6. Quantum dot heterostructures, Wiley.
7. Modern magnetic materials: principles and applications, John Wiley & Sons.
8. Nano: The Essentials: Understanding Nanoscience and Nano technology, *T. Pradeep*, Tata McGraw-Hill.
9. Nanobiotechnology, concepts, applications and perspectives, Wiley-VCH.

DETAILED SYLLABUS OF SKILL ENHANCEMENT COURSES

Course title: Electrical Wiring and Maintenance
Course code: ELT-SEC-1
Nature of the course: Skill Enhancement Course
Total credits: 3
Distribution of credits: Theory – 1, Practical - 2
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides a comprehensive overview of electrical circuits, focusing on both theoretical principles and practical applications. Students will learn about electric current, resistance, potential difference, and various voltage sources. The course covers different types of wiring, electrical symbols, and schematic drawings, emphasizing the design and implementation of domestic electrical systems. It also includes important safety protocols and protective devices. Through hands-on experience with tools and wiring accessories, students will develop practical skills essential for electrical installations and maintenance in residential and commercial environments.

Course Objectives: The primary objectives of this course are to equip students with a solid understanding of fundamental electrical concepts and practical wiring techniques. Students will learn to identify and use various electrical components and wiring systems, design and interpret electrical schematics, and implement safe and efficient electrical installations. The course aims to develop proficiency in handling tools and wiring accessories, understanding electrical protection devices, and adhering to safety standards. By the end of the course, students will be able to design, install, and maintain domestic and small-scale electrical systems, ensuring reliability and safety in all their electrical projects.

Prerequisites:

- Basic understanding of physics and mathematics, particularly concepts related to electricity and magnetism.
- Familiarity with fundamental electronic components and their functions.
- Ability to read and interpret simple electrical schematics.
- Basic hands-on experience with electrical tools and safety practices.
- Awareness of different types of electrical circuits and their applications.

Course Outcomes (COs): The students will able to

CO1: Gain foundational knowledge of electric circuits and components.

- **LO1.1:** Understand the concept of electric current, its unit, and different types of conductors and insulators.
- **LO1.2:** Explain resistance, potential difference, and different types of voltage sources (AC and DC).
- **LO1.3:** Apply Ohm's law to analyze series, parallel, and combination circuits.
- **LO1.4:** Describe AC current and voltage, single-phase and three-phase alternating

current sources, and transformers.

LO1.5: Understand units of power and energy (kWh, KVA) and their significance.

LO1.6: Identify and differentiate between different types of light sources, switches, fan regulators, dimmers, and domestic electrical appliances.

CO2: Understand various types of wiring systems and accessories.

LO2.1: Identify various tools and wiring accessories used in electrical installations.

LO2.2: Compare casing-capping, PVC conduit wiring, and concealed wiring (PVC/MS).

LO2.3: Select appropriate wiring schemes for domestic situations.

LO2.4: Evaluate and select wires, cables, and wiring accessories based on current carrying capacity and safety standards.

LO2.5: Understand the role of protective devices such as MCBs, ELCBs, fuses, switches, and sockets.

CO3: Develop skills in reading and creating electrical drawings and schematics.

LO3.1: Interpret electrical symbols used in domestic installations and power systems as per BIS code.

LO3.2: Read and understand circuit schematics and wiring diagrams.

LO3.4: Design wiring diagrams for various electrical installations like light circuits, fan circuits, and alarm circuits.

LO3.5: Create schematic diagrams for lighting systems in different environments (small room, hall, conference room).

LO3.6: Design distribution boards and panels using MCBs, ELCBs, main switches, and changeover switches.

LO3.7: Estimate electrical materials required for domestic wiring projects.

CO4: Understand the importance of electrical protection and safety measures.

LO4.1: Explain the concept and purpose of earthing and describe different types and procedures of earthing (plate and pipe).

LO4.2: Conduct tests and estimate costs for earthing materials.

LO4.3: Describe the effects of electric shock on the human body and administer first aid for electric shock.

LO4.4: Apply rules and standards in house wiring for ensuring safety.

LO4.5: Introduce lightning arresters and describe their types and applications.

LO4.6: Identify electrical hazards, their effects, and basic safety measures.

LO4.7: Understand personal protection equipment (PPE) and basic injury prevention measures.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1, LO1.4, LO1.5, LO2.1	CO1, CO2LO1.2, LO1.6, LO2.4, LO3.1	LO1.3, LO2.2, LO2.5, LO3.2	LO3.6, LO4.1	LO4.5, LO4.6	
Conceptual		LO1.2, LO3.1	LO2.3, LO3.2	CO3, LO3.6, LO4.6	LO4.5, LO4.7 CO4	
Procedural			LO2.3, LO3.4	LO3.5		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	W	M	W	W	M	S
CO2	M	S	S	S	S	M	M	W	M	S
CO3	S	S	S	M	M	W	M	W	M	S
CO4	M	S	W	S	S	S	W	S	S	M

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Basics of Electrical Circuits (L 4, H 4, M 4)

Introductory concepts and basic circuit elements: Concept of Electric current and its unit, Conductors, Insulators, Resistance, potential and potential difference, different voltage sources (AC and DC), Ohm's law, electric power, electric energy, Series circuit, parallel circuit, combination circuit, AC current and voltage, single-phase and three-phase alternating current sources, Transformers, Unit of power and energy, kWh, KVA. Different types of light sources like filament bulb, tube (fluorescent) light, CFL, LED and Neon light, Different types of switches, two-way, three-way, four-way switches, fan regulators, dimmer, different types of domestic electrical appliances and their power.

Unit-II: Types of wiring (L 3, H 3, M 4)

Various types of tools and wiring accessories, Basics of wiring: casing-capping, PVC conduit wiring, concealed wiring (PVC/MS), comparison of different wire joint (flat and straight), types of wiring systems; selection and design of wiring schemes for particular situation (domestic), selection of wire, cables, wiring accessories and use of protective devices i.e., MCB, ELCB etc.; rating and current carrying capacity of wires, cables, fuse, switches, socket, MCBs, ELCBs and other electrical accessories.

Unit-III: Electrical Drawing and Symbols (L 4, H 4, M 6)

Different types of electrical symbols used in domestic installation and power systems as per BIS code. Electrical Schematics. Reading of circuit schematics. Understanding the connections of elements and identifying current flow and voltage drop. Wiring diagram of light, fan, bell and alarm circuit, staircase wiring, schematic diagram of lighting system of small room, hall and conference room, circuit breakers, inverter connections, Design and drawing of panels, distribution board using MCB, ELCB, main switches and change over switches for domestic installations, Estimation of electrical materials for domestic wiring.

Unit-IV: Electrical Protection and Safety (L 4, H 4, M 6)

Earthing: Concept and purpose of earthing, different types and procedure of earthing, drawing of plate and pipe earthing, test material and costing and estimating. Safety precautions: Effect of electric shock on human body, first aid for electric shock, rules and standards in house wiring, Introduction to Lightning Arresters–Types, Electrical Hazards and its effects- Basic, safety introduction-Personal protection and PPE, Basic injury prevention, Basic first aid.

(Total Lectures 15, Total Contact Hours 15, Total Marks 20)

2-credits practical

Demonstration and Laboratory:

1. Safety use in electricity, shock treatment methods, safety precautions.
2. To study & find the specifications of various types of wires and cables.
3. To measure the gauge of a given wire with the help of a wire gauge.
4. Prepare a chart of wattage of different electrical items/ appliances like CFL bulb, LED bulb, Tube light, Ceiling Fan, Table Fan, Gyger, Mixer-grinder, Refrigerator, Water pump, Iron, Xerox Machine, Inverter, TV, Hanging/ pendant Light, Microwave oven etc.
5. Measurements of ac voltage with multimeter.
6. To connect the wires with different electrical accessories.
8. Skinning the cable and joint practice on single and multi-strand wire.
9. To make a main switch board for house wiring
10. Installation of common electrical accessories such as switch, holder, plug on board
11. Installation and wiring connection of ceiling fan, exhaust fan, geyser, and water purifier.
12. Preparation of extension board with switches, sockets and indicator.
13. Demonstrate electrical circuit diagrams related to electrical house hold appliances.
14. Carry out the earthing of the installed electrical circuit as per standard practice
15. Practice on different types of House Wiring installation and testing
16. House wiring circuits using fuse, switches, sockets, ceiling fan etc.in P. V. C. casing-capping.
17. Prepare one estimate of materials required for CTS wiring for small domestic installation of one room and one verandah within 25 m^2 with given light, fan & plug points.

(Total Practical Classes 30, Total Contact Hours 60, Total Marks 40)

Mode of In-semester Assessment:

1. Internal exam / Viva-voce:	(Marks 20)
2. Attendance / Laboratory performance / Notebook:	(Marks 20)

Mode of End-semester Assessment:

1. Examination for 1 credit theory	(Marks 20)
2. Examination for 2 credit practical	(Marks 40)

Recommended Readings:

- Elementary Electrical Engineering, *M. L. Gupta*, New Heights.
- Electrical Installation and Estimating, *Surjit Singh*, Dhanpat Rai and Sons.

- A Course in Electrical Installation, Estimating and Costing, *J B Gupta*, S K Kataria and Sons.
- A Text Book in Electrical Technology, *B. L. Theraja*, S Chand & Co.
- A Text Book of Electrical Technology, *A K Theraja,* S Chand & Co.

Course Title: Design and Fabrication of Printed Circuit Boards
Course Code: ELT-SEC-2A
Nature of the Course: Skill Enhancement Course
Credit assigned: 3
Distribution of credits: Theory – 1, Practical -2
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: The course provides an in-depth understanding of the principles and practices involved in the design, fabrication, and application of Printed Circuit Boards (PCBs). This course covers the classification, components, and manufacturing processes of PCBs, emphasizing both theoretical concepts and practical skills. Students will learn about the schematic and layout design of PCBs, including component placement, conductor routing, and design considerations. Additionally, the course explores the technology of PCB fabrication, including design automation, materials used, soldering techniques, and quality control. Environmental concerns and recent advancements in the PCB industry will also be discussed.

Course Objectives: The primary objective of the course is to provide students with a comprehensive understanding of the principles and practices involved in the design, fabrication, and application of Printed Circuit Boards (PCBs). This course aims to equip students with the knowledge and technical skills necessary to effectively design and produce PCBs. Students will explore the basic concepts and classifications of PCBs, including single, double, multilayer, and flexible boards. They will gain proficiency in schematic and layout design, focusing on component placement, conductor routing, and essential design considerations. The course will delve into the materials and processes used in PCB fabrication, such as design automation, copper clad laminates, soldering techniques, and various printing and etching methods. Furthermore, students will develop the ability to perform quality control and testing to ensure PCB reliability and adherence to industry standards. By staying informed about the latest trends and environmental concerns in the PCB industry, students will be well-prepared to tackle real-world challenges in electronics design and manufacturing, enhancing their technical competence and employability in the field.

Prerequisites:

- Basic understanding of electrical and electronic principles.
- Familiarity with electronic components and their functions.
- Introductory knowledge of circuit theory and electrical circuits.
- Basic skills in using electronic measurement tools such as multimeters and oscilloscopes.

- Experience with basic soldering techniques.
- Familiarity with schematic diagrams and electronic design automation (EDA) tools is helpful but not mandatory.

Course Outcomes (COs): The students will able to

CO1: Understand the fundamental concepts of electric circuits and components.

LO1.1: Describe the concept of electric current, conductors, and insulators.

LO1.2: Apply Ohm's law to calculate voltage, current, and resistance in circuits.

LO1.3: Analyze series, parallel, and combination circuits.

LO1.4: Explain the differences between AC and DC circuits.

LO1.5: Discuss the operation and application of different types of light sources and switches.

CO2: Gain proficiency in various types of wiring techniques and materials.

LO2.1: Identify and compare tools and wiring accessories used in electrical installations.

LO2.2: Select appropriate wiring systems and accessories for different applications.

LO2.3: Determine the current carrying capacity and rating of wires, cables, and protective devices.

CO3: Develop skills in reading electrical schematics and drawings.

LO3.1: Interpret electrical symbols as per BIS code.

LO3.2: Create wiring diagrams and schematics for domestic electrical installations.

LO3.3: Design panels and distribution boards using MCB, ELCB, and switches.

LO3.4: Estimate electrical materials required for wiring projects.

CO4: Understand safety measures and procedures in electrical installations.

LO4.1: Explain the concept and purpose of earthing.

LO4.2: Demonstrate safety precautions to prevent electric shock.

LO4.3: Identify different types of lightning arresters and their applications.

LO4.4: Describe basic first aid procedures for electrical accidents.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1, LO1.4, LO1.5	CO1, LO1.2, LO2.1,	LO1.3, LO2.2, LO2.3, LO4.3	LO3.1, CO3, LO3.3	CO4, LO4.4	
Conceptual		LO4.1	CO2			
Procedural		LO3.2	LO3.2, LO3.4		LO4.2	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	M	W	W	M	W	S

CO2	M	S	S	S	S	M	M	W	W	M
CO3	S	S	S	S	M	W	M	M	M	S
CO4	S	S	M	S	M	S	W	S	S	M

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: PCB Fundamentals (L 4, H 4, M 5)

Advantages of PCB, Electronic components, Surface Mount Devices (SMD).
Classification of PCB - single, double, multilayer and flexible boards, Manufacturing of PCB, PCB standards.

Unit-II: Schematic and Layout Design (L 5, H 5, M 7)

Schematic diagram, General, Mechanical and Electrical design considerations, Placing and Mounting of components, Conductor spacing, routing guidelines, heat sinks and package density, Net list, creating components for library, Tracks, Pads, Vias, power plane, grounding.

Unit-III: Technology OF PCB (L 6, H 6, M 8)

Design automation, Design Rule Checking, copper clad laminates materials of copper clad laminates, properties of laminates (electrical & physical), types of laminates, soldering techniques. Film master preparation, Image transfer, photo printing, Screen Printing, Plating techniques etching techniques, Mechanical Machining operations, Lead cutting and Soldering Techniques, Testing and quality controls, Recent Trends and advances, Environmental concerns in PCB industry.

(Total Lectures 15, Total Contact Hours 15, Total Marks 20)

2-credits practical

Demonstration and Laboratory:

Hands on Tutorials/Demonstrations by using freeware version of Diptrace software/other open source equivalents:

a) Draw schematic circuit of RC band pass filter circuit and design its single sided PCB layout
b) Draw schematic circuit of Regulated DC power supply and design its single sided/double sided PCB layout
c) Draw schematic circuit of 741 Operational amplifier-based differentiator circuit and design its single sided/double sided PCB layout

PCB fabrication & etching:
Use screen printing / toner paper / CNC tools to convert the Diptrace PCB layout design above into actual PCB

Drilling and soldering:
Drilling should be done on the fabricated PCBs and components should be soldered during the demonstration session.

(Total Practical Classes 30, Total Contact Hours 60, Total Marks 40)

Mode of In-semester assessment:

1. Internal exam / Viva-voce: **(Marks 20)**
2. Attendance / Laboratory performance / Notebook: **(Marks 20)**

Mode of End-semester assessment:

1. Examination for 1 credit theory: **(Marks 20)**
2. Examination for 2 credit practical: **(Marks 40)**

Recommended Readings:

1. Printed circuit Board – Design & Technology, *Walter C. Bosshart*, Tata McGraw Hill.
2. Printed Circuit Board – Design, Fabrication, Assembly & Testing, *R.S. Khandpur*, Tata McGraw Hill.

Course title: Basic Instrumentation Skills
Course code: ELT-SEC-2B
Nature of the course: Skill Enhancement Course
Total credits: 3
Distribution of credits: Practical -3
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: The Basic Circuit Theory and Network Analysis lab course and Semiconductor Devices lab course are foundational components of the electronics curriculum, offering students essential hands-on experience and practical skills. In Basic Circuit Theory, students study the behavior of resistors, capacitors, and inductors in various configurations such as series, parallel, and series-parallel. They learn to apply voltage and current divider rules for circuit analysis and develop proficiency in using multimeters and Cathode Ray Oscilloscopes (CROs) to measure and interpret signal characteristics like amplitude, frequency, and phase. Practical experiments validate fundamental laws and theorems including Kirchhoff's laws, Norton's and Thevenin's theorems, and explore the design and analysis of RC circuits, filters, and LCR circuits. In Semiconductor Devices, students delve into the characteristics and operational principles of diodes (ordinary and Zener), Bipolar Junction Transistors (BJTs), and other semiconductor devices like Unijunction Transistors (UJTs), Silicon Controlled Rectifiers (SCRs), Junction Field Effect Transistors (JFETs), and Metal-Oxide-Semiconductor Field-Effect Transistors (MOSFETs). They conduct experiments to analyze and interpret I-V characteristics, gaining insights into device behavior and applications in modern electronics. These courses collectively equip students with foundational knowledge and practical skills essential for careers in electronics, semiconductor technology, and beyond.

Course Objectives: The courses in Basic Circuit Theory and Network Analysis Lab and Semiconductor Devices Lab aim to equip students with essential practical skills and theoretical knowledge in electronics and electrical engineering. Students will gain proficiency in analyzing and designing electrical circuits, understanding the behavior of fundamental components like resistors, capacitors, and inductors, and applying circuit laws and theorems in practical scenarios. Through hands-on experiments with equipment such as multimeters, oscilloscopes, and semiconductor testing devices, students will develop critical thinking and problem-solving abilities. The courses prepare students for careers in electronics, semiconductor technology, and related fields by providing a strong foundation in circuit analysis, device characterization, and experimental methodologies essential for modern engineering practice.

Prerequisites:

- Understanding of basic electrical principles including Ohm's law and Kirchhoff's laws.
- Proficiency in algebra and calculus for circuit analysis.
- Familiarity with electronic components such as resistors, capacitors, and diodes.
- Ability to use basic laboratory equipment like multimeters and oscilloscopes.

Course Outcomes (COs): The students will able to

CO1: Understanding of Basic Circuit Configurations and Component Characteristics.

- **LO1.1:** Describe the characteristics and behaviors of resistors, capacitors, and inductors in series, parallel, and series-parallel configurations.
- **LO1.2:** Apply voltage and current divider rules effectively in circuit analysis.
- **LO1.3:** Demonstrate proficiency in using a multimeter to measure and test components accurately.

CO2: Proficiency in Measurement Techniques Using CRO.

- **LO2.1:** Measure amplitude, frequency, and phase difference accurately using a Cathode Ray Oscilloscope (CRO).
- **LO2.2:** Interpret and analyze CRO waveforms to determine amplitude, frequency, and phase characteristics of signals.

CO3: Application of Fundamental Circuit Laws and Theorems.

- **LO3.1:** Verify Kirchhoff's Law (KCL and KVL) through practical experiments and calculations.
- **LO3.2:** Apply Norton's and Thevenin's theorems to simplify and analyze complex circuits.
- **LO3.3:** Apply the Superposition theorem to predict and analyze circuit behaviors.
- **LO3.4:** Validate the Maximum Power Transfer theorem through practical experiments.

CO4: Analysis and Design of RC Circuits, Filters, and LCR Circuits.

- **LO4.1:** Calculate and verify the time constant of RC circuits, and design differentiator and integrator circuits.
- **LO4.2:** Design and analyze Low Pass and High Pass RC Filters, and study their frequency response characteristics.
- **LO4.3:** Analyze the frequency response of Series LCR Circuits, determine resonant frequency, impedance at resonance, quality factor (Q), and bandwidth.

CO5: Understanding of Semiconductor Device Characteristics.

- **LO5.1:** Analyze and interpret the I-V characteristics of diodes (ordinary and Zener) under various biasing conditions.
- **LO5.2:** Measure and analyze I-V characteristics of Bipolar Junction Transistors (BJTs) in Common Emitter, Common Base, and Common Collector configurations.
- **LO5.3:** Study the I-V characteristics of other semiconductor devices such as Unijunction Transistors (UJTs), Silicon Controlled Rectifiers (SCRs), Junction Field Effect Transistors (JFETs), and Metal-Oxide-Semiconductor Field-Effect Transistors (MOSFETs).
- **LO5.4:** Study the characteristics of solar cells and demonstrate understanding of the Hall effect phenomenon.

CO6: Experimental Analysis and Measurement of Semiconductor Devices

- **LO6.1:** Conduct experiments to measure and plot I-V characteristics of semiconductor devices accurately.
- **LO6.2:** Utilize lab equipment effectively to perform experiments on semiconductor devices and obtain reliable data.
- **LO6.3:** Analyze and interpret experimental data to draw conclusions about semiconductor device behaviors and applications.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1, LO1.2, LO1.3	LO5.1	CO2, LO1.2	LO4.1	CO3, LO3.4	
Conceptual		LO5.2	CO5, LO5.3, CO5.4	CO4, LO4.1, LO4.2, LO4.3	LO3.1	
Procedural		LO1.3, CO1,	LO2.1 LO6.1 CO6, LO6.2, LO6.3		LO3.2	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10

CO1	S	M	M	S	M	S	M	S	M	S
CO2	M	S	M	S	M	S	M	S	S	S
CO3	S	S	S	S	M	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	M	S	S	S	M	S	M	S	M
CO6	S	M	S	S	M	S	M	M	M	M

S: Strong, M: Medium, W: Weak

List of Experiments:

A. Basic Circuit Theory and Network Analysis Lab

1. Familiarization with
   a) Resistance in series, parallel and series – parallel.
   b) Capacitors & inductors in series & parallel.
   c) Multimeter – testing of components.
   d) Voltage sources in series, parallel and series – parallel.
   e) Voltage and current dividers.
2. Measurement of Amplitude, Frequency & Phase difference using CRO.
3. Verification of Kirchhoff's Law.
4. Verification of Norton's theorem.
5. Verification of Thevenin's theorem.
6. Verification of Superposition theorem.
7. Verification of the Maximum Power Transfer theorem.
8. RC Circuits: Time Constant, Differentiator, Integrator.
9. Designing of a Low Pass RC Filter and study of its Frequency Response.
10. Designing of a High Pass RC Filter and study of its Frequency Response.
11. Study of the Frequency Response of a Series LCR Circuit and determination of its (a) Resonant Frequency, (b) Impedance at Resonance, (c) Quality Factor Q, and (d) Band Width.

B. Semiconductor Devices Lab

1. Study of the I-V Characteristics of Diode – Ordinary and Zener Diode.
2. Study of the I-V Characteristics of the CE configuration of BJT and obtain r_i, r_o, β.
3. Study of the I-V Characteristics of the Common Base Configuration of BJT and obtain r_i, r_o, α.
4. Study of the I-V Characteristics of the Common Collector Configuration of BJT and obtain voltage gain, r_i, r_o,.
5. Study of the I-V Characteristics of the UJT.
6. Study of the I-V Characteristics of the SCR.
7. Study of the I-V Characteristics of JFET.
8. Study of the I-V Characteristics of MOSFET.
9. Study of Characteristics of Solar Cell

10. Study of Hall Effect.

(Total Practical Classes 60, Total Contact Hours 120, Total Marks 60)

At least 30% of the experiments must be performed from each unit.

Mode of In-semester Assessment:

1. Viva-voce: (**Marks 20)**
2. Attendance / Laboratory performance / Notebook: (**Marks 20)**

Mode of End-semester Assessment:

Examination on laboratory experiments: (**Marks 60)**
Two experiments (not more than one from a single unit) from the list to be performed.

Course Title: Domestic Equipment Maintenance
Course Code: ELT-SEC-3
Nature of the Course: Skill Enhancement Course
Credit assigned: 3
Distribution of credits: Theory – 1, Practical - 2
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides comprehensive knowledge on electrical safety, components, and maintenance of various electrical and motorized appliances. It covers essential safety practices, identification, and working principles of general electrical components and testing instruments. The curriculum includes detailed study and hands-on troubleshooting of common heating appliances like room heaters, electric irons, stoves, and geysers, as well as motorized appliances such as fans, pump motors, mixers, washing machines, vacuum cleaners, air conditioners, and refrigerators. Students will learn to identify parts, understand electrical diagrams, and perform routine maintenance and repairs, ensuring proper functionality and safety of household electrical devices.

Course Objectives: The objective of this course is to equip students with the fundamental skills and knowledge required for the safe operation, maintenance, and troubleshooting of various electrical and motorized appliances. Emphasis is placed on understanding and implementing safety practices, identifying and working with different electrical components, and using testing instruments effectively. The course aims to develop students' proficiency in diagnosing and repairing common faults in household heating and motorized appliances, fostering practical skills essential for ensuring the reliable and efficient functioning of these devices. This comprehensive training prepares students for real-world electrical maintenance and safety challenges.

Prerequisites:

- Basic understanding of electrical principles and concepts
- Familiarity with electrical circuit components and their functions
- Knowledge of safety practices and procedures related to electricity
- Ability to read and interpret simple electrical diagrams
- Basic skills in using hand tools and electrical testing instruments

Course Outcomes (COs): The students will able to

CO1: Gain knowledge and skills in electrical safety practices and identification of electrical components.

- **LO1.1:** Demonstrate safety practices and precautions in handling electrical circuits.
- **LO1.2:** Identify and use different types of fire extinguishers effectively.
- **LO1.3:** Recognize various electrical components such as switches, fuses, thermostats, and conductors.
- **LO1.4:** Perform basic tests using electrical testing instruments.
- **LO1.5:** Explain procedures for rescuing a person in contact with a live wire and administering first aid for electric shock.

CO2: Develop proficiency in maintaining and troubleshooting heating appliances.

- **LO2.1:** Identify components and understand the working principles of room heaters, electric irons, stoves, kettles, toasters, immersion heaters, and microwave ovens.
- **LO2.2:** Analyze common faults in heating appliances and perform troubleshooting.
- **LO2.3:** Repair and replace components such as coils, insulators, and thermostats in heating appliances.

CO3: Acquire skills in maintaining and repairing motorised appliances.

- **LO3.1:** Understand the construction and electrical diagrams of ceiling fans, table fans, and domestic pump motors.
- **LO3.2:** Perform connection wiring and maintenance tasks for fans and domestic pumps.
- **LO3.3:** Conduct routine checks and perform repairs like overhauling and resolving common faults in fan motors and domestic pumps.
- **LO3.4:** Identify parts and troubleshoot issues in domestic appliances like mixer grinders, food processors, washing machines, vacuum cleaners, air conditioners, and refrigerators.
- **LO3.5:** Replace and repair components such as motors, switches, valves, timers, and compressors in motorised appliances.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	LO1.3	LO1.5,	LO1.4,	LO3.1, CO3	LO1.2, CO1	
Conceptual		LO2.1	LO3.3,	LO2.2, CO2		
Procedural	LO1.1,		LO2.3,	LO3.2,		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	S	M	S	S	S	M	S
CO2	M	S	S	M	S	M	S	M	S	M
CO3	S	S	S	M	S	S	M	S	M	S

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: General (L 4, H 4, M 5)

Safety: Safety Practices; Fires in electrical Circuits & Precautions, Fire Extinguishers & its Types, General Safety of Tools & equipment, Rescue of person who is in contact with live wire, Treat a person for electric shock/ injury.

General idea on Various Components: Different types of switches, fuse, thermostat, heating elements, conductors, insulators, capacitors, wires and cables (for up to 15 amp) symbol of various components. Different types of electrical testing instruments.

Unit-II: Maintenance of Heating Appliances. (L 5, H 5, M 5)

Identification, Working, raw material and manufacturing process, electrical wiring diagram, types. Common Faults and their troubleshooting working and specification of each part. Repairing for some common problems, replacement of coil, insulators, thermostat etc. for

a) Room Heater (with/ without variable thermostat)
b) Electric iron (with/without variable thermostat)
c) Electric stove, electric kettle, electric rice cocker, electric toaster
d) Electric immersion heater
e) Microwave oven
f) Geyser.

Unit-III: Maintenance of Motorised Appliances (L 6, H 6, M 10)

Maintenance of Ceiling and Table fan: Construction, Identification of various parts, electrical diagram, regulator. Connection Wiring of a fan with switch and regulator, maintenance of fan (overhauling), repair of some common problems like low speed, fan not starting, fan rotating in reverse direction, any other as suggested by concerned teacher.

Maintenance of Domestic Pump motor: Identification of pump motor, type & specification, electrical connection, of switch, cable etc. Routine check-up of motor (e. g. meggar test, checking of winding resistance.) repairing of some common fault like starting problem, tripping of motor or any other as suggested by concerned teacher.

Maintenance of domestic Mixer grinder, food processor: Identification of various parts, identification of motor used, its type and specification. Study of selector switch and its repairing, thermostat connection and its replacement and operation, repairing for some common fault (e. g. motor not starting, motor abnormal noise etc).

Maintenance of washing machine: Identification of various parts of a semi-automatic washing machine like (a) motor, (b) water valve, (f) timer, (g) Brake arrangement, working of all parts for various mode of operation, replacement of various parts of a washing machine. Troubleshooting for various faults.

Vacuum Cleaner: Identification of various constructional parts, motor specification, type, electrical connection. Common faults, repair and maintenance of vacuum cleaner.

Air Conditioner: Working, raw material and manufacturing process, electrical wiring diagram, types. Common Faults and their troubleshooting: Faults in following parts of AC: Filter, thermostat, refrigerant leaks, breakers, capacitors, compressor, evaporator coils, condenser coils, warm contactor. General faults: AC UNIT has an odour, shuts ON and OFF repeatedly, does not blow cold air, repeatedly tripping a circuit breaker, indoor UNIT is leaking water inside the room, outdoor UNIT is making an unusually loud sound, room is not getting cold enough, AC not turning ON.

Refrigerator: Working, raw material and manufacturing process, electrical wiring diagram, types of refrigerators. Common faults and their troubleshooting: fridge not cooling, fridge not defrosting, leaking water, freezing food light not working, freezer is cooled but fridge stays warm, dead refrigerator, not enough cooling, keeps running, leakage, makes noise. Replacement procedure for: seal (gasket), evaporator fan motor, PTC relay, thermostat, compressor, bulb.

(Total Lectures 15, Total Contact Hours 15, Total Marks 20)

2-credits practical

Demonstration and Laboratory:

1. Safety use in electricity, shock treatment methods, safety precautions.
2. To study & find the specifications of various types of wires and cables.
3. Prepare a chart of wattage of different electrical items/ appliances like CFL bulb, LED bulb, Tube light, Ceiling Fan, Table Fan, Gyger, Mixer-grinder, Refrigerator, Water pump, Iron, Xerox Machine, Inverter, TV, Hanging/ pendant Light, Microwave oven etc.
4. Measurements of ac voltage with multimeter.
5. Installation of common electrical accessories such as switch, holder, plug on board
6. Installation and wiring connection of ceiling fan, exhaust fan, geyser, and water purifier, water pump, air conditioner etc. as mentioned in the Unit 1 to 3.
7. Detection and rectification of common fault of the electrical appliances.

(Total Practical Classes 30, Total Contact Hours 60, Total Marks 40)

Mode of In-semester Assessment:

1. Internal exam / Viva-voce: **(Marks 20)**
2. Attendance / Laboratory performance / Notebook: **(Marks 20)**

Mode of End-semester Assessment:

1. Examination for 1 credit theory: **(Marks 20)**
2. Examination for 2 credit practical: **(Marks 40)**

Recommended readings:

- Electronic Instruments and Systems: Principles, Maintenance and Troubleshooting, *R. G. Gupta,* TMH.
- Modern Electronic Equipment: Troubleshooting, Repair and Maintenance, *R S Khandpur*, TMH.
- Electronic fault diagnosis, *G. C. Loveday,* A. H. Longman.

DETAILED SYLLABUS OF GENERIC ELECTIVE COURSES

Course title: Circuit Theory
Course code: ELT-GEC-1
Nature of the course: Generic Elective Course
Total credits: 3
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides a comprehensive introduction to basic circuit analysis, covering both DC and AC circuits. Topics include resistive elements, Kirchhoff's laws, mesh current and node voltage analysis, network theorems, and transient response analysis using Laplace transforms. Students will explore AC circuits, phasor diagrams, power factor, and three-phase circuit analysis. The course also delves into resonance and coupled circuits, examining their frequency response, quality factor, and bandwidth. Emphasis is placed on practical applications and problem-solving techniques to prepare students for more advanced studies in electrical engineering.

Course Objectives: This course aims to equip students with the fundamental principles and analytical techniques needed to understand and analyze electrical circuits. Students will learn to apply Ohm's Law, Kirchhoff's laws, and various network theorems to both DC and AC circuits. They will develop skills in transient response analysis and explore the behavior of resonant and coupled circuits. The course prepares students to tackle complex electrical engineering problems and provides a solid foundation for future studies in the field, emphasizing practical applications and critical thinking.

Prerequisites:

- Basic understanding of physics and mathematics.
- Familiarity with algebra and trigonometry.
- Introductory knowledge of calculus.
- General background in electrical concepts.

Course Outcomes (COs): The students will able to

CO1: Understand fundamental concepts and laws governing resistive circuits.

- **LO1.1:** Apply Ohm's Law to calculate voltage, current, and resistance in resistive elements.
- **LO1.2:** Analyze resistors in series and parallel circuits using Kirchhoff's laws.
- **LO1.3:** Use mesh current and node voltage methods to solve complex circuits.

CO2: Learn techniques to simplify and analyze complex networks.

- **LO2.1:** Perform network reduction using voltage and current division, and source transformation.
- **LO2.2:** Apply Thevenin's and Norton's theorems to simplify and analyze circuits.

LO2.3: Utilize Superposition, Maximum Power Transfer, Reciprocity, and Millman's theorems in circuit analysis.

CO3: Understand the behavior of circuits during transient conditions.

LO3.1: Analyze transient responses of RL, RC, and RLC circuits using Laplace transform for DC and AC inputs.

CO4: Study alternating current circuits and their characteristics.

LO4.1: Calculate average and RMS values of AC signals.

LO4.2: Construct phasor diagrams and analyze power, power factor, and energy in AC circuits.

LO4.3: Analyze three-phase circuits including star and delta configurations, balanced and unbalanced loads.

CO5: Explore resonance phenomena and coupled circuits.

LO5.1: Analyze series and parallel resonance, understanding frequency response, quality factor, and bandwidth.

LO5.2: Study self and mutual inductance, coefficient of coupling, and tuned circuits.

LO5.3: Analyze single tuned circuits and their applications.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	LO4.1, LO5.1		LO1.1, LO4.2			
Conceptual		CO2, LO1.2, LO1.3, LO2.1 LO2.2,	CO1,	CO3, LO3.1		
Procedural			LO2.3, LO4.3, LO5.3	CO4, LO4.2	CO5, LO5.2	
Metacognitive						

Mapping of course Outcomes (COs) to Programme Outcomes (POs)

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	M	M	M	S	S	S	M
CO2	S	S	S	M	S	M	S	M	S	M
CO3	M	S	M	M	M	M	M	M	M	M
CO4	M	M	M	S	S	M	M	M	S	M
CO5	M	M	M	M	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Basic Circuits Analysis **(L 6, H 6, M 10)**

Resistive elements, Ohm's Law, Resistors in series and parallel circuits, Kirchhoff's laws, Mesh current and node voltage - methods of analysis, Star-Delta Conversion.

Unit-II: Network Theorems **(L 10, H 10, M 13)**

Thevenin's and Norton Theorems, Superposition Theorem, Maximum power transfer theorem, Reciprocity Theorem, Millman's theorem.

Unit-III: Transient Response Analysis **(L 10, H 10, M 12)**

RC Circuit- Charging and discharging, Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. sinusoidal input.

Unit-IV: AC Circuits Analysis **(L 10, H 10, M 13)**

Sinusoidal Voltage and Current, Definition of Instantaneous, Peak, Peak to Peak, Root Mean Square and Average Values. Voltage-Current relationship in Resistor, Inductor and Capacitor, Phasor diagram, Complex Impedance, Power in AC Circuits: Instantaneous Power, Average Power, Reactive Power, Power Factor.

Unit-V: Resonance and Coupled Circuits **(L 9, H 9, M 12)**

Series and parallel resonance, their frequency response, Quality factor and Bandwidth, Self and mutual inductance, Coefficient of coupling, Tuned circuits, Single tuned circuits.

(Total Lectures 45, Total Contact Hours 45, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations: **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Engineering Circuits Analysis, *William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin*, McGraw Hill.
2. Fundamentals of Electric Circuits, Charles *K. Alexander, Mathew N. O. Sadiku*, McGraw Hill.

Course title: Electronic Devices and Circuits
Course code: ELT-GEC-2
Nature of the course: Generic Elective Course
Total credits: 3
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course offers an in-depth study of electronic devices and circuits, focusing on PN junction devices, transistors, thyristors, and various amplifier configurations. Students will explore the structure, operation, and characteristics of diodes, BJTs, JFETs, MOSFETs, and other semiconductor devices. The course covers amplifier analysis, including small signal models and frequency response. Additionally, students will learn about multistage and differential amplifiers, power amplifiers, and feedback principles. The course also includes a comprehensive study of oscillators, their conditions for oscillation, and different types such as phase shift, Wien bridge, Hartley, Colpitts, and crystal oscillators.

Course Objectives: This course aims to provide students with a thorough understanding of electronic devices and circuit principles. Students will learn to analyze and design rectifiers, amplifiers, and oscillators. The course will enhance their knowledge of the operational characteristics and applications of PN junction diodes, transistors, and thyristors. Emphasis is placed on developing the ability to perform frequency response analysis and understand the impact of feedback in amplifier circuits. By the end of the course, students will be equipped with the skills needed to design and analyze complex electronic circuits.

Prerequisites:

- Basic understanding of physics and mathematics
- Familiarity with semiconductor physics
- Introductory knowledge of electrical circuits and components
- General background in electronics concepts

Course Outcomes (COs): The students will able to

CO1: Understand the principles and characteristics of PN junction devices.

LO1.1: Explain the structure, operation, and V-I characteristics of PN junction diodes.
LO1.2: Analyze diffusion and transition capacitance in PN junctions.
LO1.3: Design and analyze half-wave and full-wave rectifiers using diodes.
LO1.4: Describe the characteristics and applications of LED, laser diodes, and Zener diodes.

CO2: Study the structure, operation, and characteristics of transistors and thyristors.

LO2.1: Explain the structure and operation of BJT, JFET, and MOSFET transistors.
LO2.2: Analyze biasing techniques for BJT, JFET, and MOSFET.
LO2.3: Describe the structure and characteristics of UJT, thyristors, and IGBT.

CO3: Analyze small-signal models and frequency response of amplifiers.

LO3.1: Analyze CE, CB, and CC configurations of BJT amplifiers.
LO3.2: Evaluate gain and frequency response of MOSFET amplifiers (CS and source follower).
LO3.3: Perform high-frequency analysis of amplifiers.

CO4: Study multistage amplifiers, differential amplifiers, and power amplifiers.

LO4.1: Design and analyze BIMOS cascade amplifiers and differential amplifiers.
LO4.2: Analyze gain and frequency response of single-tuned amplifiers.
LO4.3: Describe neutralization methods in amplifiers and classify power amplifier types qualitatively.

CO5: Understand feedback amplifiers and oscillator circuits.

LO5.1: Explain the advantages of negative feedback and analyze its types (voltage/current, series/shunt).
LO5.2: Describe the conditions for oscillations and analyze phase shift in oscillators.
LO5.3: Design and analyze Wien bridge, Hartley, Colpitts, and crystal oscillators.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1, LO2.1		CO5, LO4.3, LO5.1			
Conceptual		LO1.2, LO2.2, LO5.2		CO2, CO1, LO1.3, LO2.3		
Procedural			LO3.1, LO4.1, LO5.3	LO3.2, LO4.2 CO4	CO3, LO3.3	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	S	S	S	M
CO2	S	S	S	M	S	M	S	M	S	M
CO3	M	S	M	M	M	M	M	M	M	M
CO4	M	M	M	S	S	M	M	M	S	M
CO5	M	M	M	M	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: PN Junction Devices **(L 9, H 9, M 12)**

PN junction diode, structure, operation and V-I characteristics, diffusion and transition capacitance, Rectifiers – Half Wave and Full Wave Rectifier, Display devices- LED, Laser diodes, Zener diode characteristics, Zener and Avalanche Breakdown Mechanism, Zener as regulator.

Unit-II: Transistors and Thyristors **(L 9, H 9, M 12)**

BJT, JFET, MOSFET- structure, operation, characteristics and Biasing UJT, Thyristors and IGBT - Structure and characteristics.

Unit-III: Amplifiers **(L 9, H 9, M 12)**

BJT small signal model, Analysis of CE, CB, CC amplifiers, Gain and frequency response, MOSFET, Biasing of MOSFETs, Small Signal Parameters, Common Source amplifier circuit analysis, Source follower, Gain and frequency response, High frequency analysis.

Unit-IV: Differential Amplifier **(L 9, H 9, M 12)**

Differential amplifier, Common mode and Difference mode analysis, parameters of operational amplifier, Open and closed loop configuration, Inverting, Non-inverting, Summing and difference amplifier, Integrator, Differentiator.

Unit-V: Feedback Amplifiers and Oscillators **(L 9, H 9, M 12)**

Advantages of negative feedback – voltage / current, series, Shunt feedback –positive feedback – Condition for oscillations, phase shift, Wien bridge, Hartley, Colpitts and Crystal oscillators.

(Total Lectures 45, Total Contact Hours 45, Total Marks 60)

Mode of In-semester assessment:

1. Two internal examinations: **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Electronic devices and circuits, *David A. Bell*, Oxford University Higher Education.
2. Microelectronic circuits, *Sedra and Smith*, Oxford University Press.
3. Electronic devices and circuits, Balbir Kumar, *Shail. B. Jain*, PHI learning private Ltd.
4. Electronic devices, *Thomas L. Floyd*, Pearson Prentice Hall.
5. Electronic Circuit Analysis and Design, *Donald A. Neamen*, Tata McGraw Hill.
6. Electronic devices and circuit theory, *Robert L. Boylestad*.
7. Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation *Robert B. Northrop*, CRC Press.

Course title: Digital Logic Circuits
Course code: ELT-GEC-3
Nature of the course: Generic Elective Course
Total credits: 3
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course delves into the fundamentals of digital electronics, encompassing number systems, digital logic families, combinational and sequential circuits, and programmable logic devices. Students will learn about binary codes, error detection and correction, and various digital logic families such as RTL, DTL, TTL, ECL, and MOS. The course covers the design and implementation of combinational circuits using K-maps and explores synchronous and asynchronous sequential circuits. Additionally, it introduces programmable logic devices like PROM, PLA, PAL and CPLD.

Course Objectives: This course aims to provide a comprehensive understanding of digital electronics, focusing on the design and analysis of digital circuits. Students will gain proficiency in number systems, binary codes, and digital logic families. They will learn to design combinational and sequential circuits, including counters and shift registers, and understand the principles of programmable logic devices. By the end of the course, students will be equipped with the skills necessary to design, analyze, and implement complex digital systems.

Prerequisites:

- Basic understanding of binary and decimal number systems.
- Familiarity with basic logic gates (AND, OR, NOT).
- Introductory knowledge of electrical circuits.
- General background in electronics concepts.

Course Outcomes (COs): The students will able to

CO1: Understand number systems, binary codes, and digital logic families.

LO1.1: Review different number systems and their conversions, including binary, octal, decimal, and hexadecimal.

LO1.2: Analyze binary codes and error detection/correction codes such as Parity and Hamming codes.

LO1.3: Compare and evaluate RTL, DTL, TTL, ECL, and MOS digital logic families in terms of operation and characteristics.

CO2: Design and analyze combinational logic circuits.

LO2.1: Represent logic functions using SOP (Sum of Products) and POS (Product of Sums) forms.

LO2.2: Use Karnaugh maps (K-maps) for minimization and simplification of logic functions.

LO2.3: Design and implement combinational circuits including multiplexers, demultiplexers, code converters, adders, subtractors, encoders, and decoders.

CO3: Understand and design synchronous sequential circuits.

LO3.1: Explain SR, JK, D, and T flip-flops, their characteristics, and applications.

LO3.2: Design synchronous counters including modulo counters and shift registers.

LO3.3: Design synchronous sequential circuits using Moore and Mealy models, and analyze state diagrams, state reduction, and state assignment.

CO4: Analyze and design asynchronous sequential circuits and programmable logic devices.

LO4.1: Analyze transition and flow stability in asynchronous sequential circuits, and identify race conditions and hazards.

LO4.2: Understand Programmable Logic Devices (PLDs) such as PROM, PLA, PAL, CPLD, and FPGA, and their applications.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	LO1.1	CO1, LO1.2				
Conceptual				CO4, LO4.1	CO3, LO3.1	
Procedural		LO4.2	LO2.1	CO2, LO2.2, LO2.3 LO1.3		

Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	W	S	W	M	M	S	V	S
CO2	S	S	M	S	M	S	S	S	M	S
CO3	M	M	W	S	W	S	S	M	M	M
CO4	M	M	M	M	W	S	M	S	M	S
CO5	M	M	M	S	W	S	S	S	M	S

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Number Systems and Digital Logic Families **(L 9, H 9, M 15)**
Number systems, Binary, Octal and Hexadecimal arithmetic, binary codes, error detection and correction codes (Parity and Hamming code), Digital Logic Families - comparison of RTL, DTL, TTL, ECL and MOS families.

Unit-II: Combinational Circuits **(L 9, H 9, M 15)**
Combinational logic, representation of logic functions, SOP and POS forms, K-map representations, minimization using K maps, simplification and implementation of combinational logic, multiplexers and de multiplexers, Encoders and Decoders, binary Adder, half and full adder, binary subtractor.

Unit-III: Synchronous Sequential Circuits **(L 9, H 9, M 15)**
Latches and Flip flops, S-R Flip flop, J-K Flip flop, T and D type Flip flop, Clocked and edge triggered Flip flops, Registers, Counters (synchronous and asynchronous and modulo-N), Ripple counter, up and down counter State Table, State Diagrams, Ring counter and Johnson counter.

UNIT-IV: Asynchronous Sequential Circuits and Programmability Logic Devices
(L 9, H 9, M 15)
Asynchronous sequential logic circuits- Transition stability, flow stability- race conditions, hazards & errors in digital circuits, analysis of asynchronous sequential logic circuits introduction to Programmable Logic Devices: PROM, PLA, PAL, CPLD.

(Total Lectures 45, Total Contact Hours 45, Total Marks 60)

Mode of In-semester Assessment:
1. Two internal examinations: **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

- Digital Electronics, James *W. Bignel*, Cengage learning.
- Digital Design with an introduction to the VHDL, *M. Morris Mano*, Pearson Education.
- Digital Logic & State Machine Design, *Comer*, Oxford.
- Digital Electronics Principles & Application, *Mandal*, McGraw Hill.
- Digital Electronics - A Practical Approach with VHDL, *William Keitz*, Pearson.
- Digital Fundamentals, *Thomas L. Floyd*, Pearson Education.
- Digital System Design using VHDL, *Charles H. Roth, Jr, Lizy Lizy Kurian John*, Cengage.
- Digital circuits and Design, *D. P. Kothari, J. S. Dhillon*, Pearson Education.

DETAILED SYLLABUS OF MINOR COURSES

Course title: Basic Circuit Theory and Network Analysis
Course code: ELT-MIN-1
Nature of the course: Minor
Total credits: 4
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides an in-depth study of fundamental circuit concepts, including voltage and current sources, resistors, inductors, and capacitors, along with their construction, characteristics, and applications. It covers essential circuit analysis techniques using Kirchhoff's laws, node and mesh analysis, and introduces transient and AC circuit analysis. Students will explore resonance in RLC circuits, passive filters, and network theorems for both DC and AC circuits. Additionally, the course delves into two-port networks and their parameters, equipping students with the analytical skills needed to understand and design complex electrical circuits.

Course Objectives: This course aims to impart a solid understanding of basic circuit elements and their behaviors. Students will learn to analyze and solve complex electrical circuits using various methods and theorems. The objectives include mastering transient and AC circuit analysis, understanding the principles of resonance and passive filtering, and applying network theorems for circuit simplification. By the end of the course, students will be proficient in analyzing electrical networks and designing circuits that meet specific requirements, laying a strong foundation for advanced studies in electrical engineering.

Prerequisites:

- Basic knowledge of physics, particularly electromagnetism
- Familiarity with algebra and trigonometry
- Understanding of basic electrical concepts such as current, voltage, and resistance
- Prior exposure to simple electrical circuits and components

Course Outcomes (COs): The students will able to

CO1: Understand fundamental concepts of voltage, current, resistors, inductors, and capacitors.

- **LO1.1:** Explain the characteristics and color coding of resistors, and analyze resistors in series and parallel configurations.
- **LO1.2:** Describe the principles of inductance, including self and mutual inductance, Faraday's law, and energy stored in an inductor.
- **LO1.3:** Define capacitance, analyze different types of capacitors, and discuss their construction, characteristics, and applications.

CO2: Analyze DC circuits using Kirchhoff's laws, node analysis, and mesh analysis.

LO2.1: Apply Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL) to solve DC circuit problems.

LO2.2: Perform star-delta transformations and analyze DC transient responses in RC and RL circuits.

CO3: Understand sinusoidal circuits and analyze AC circuits.

LO3.1: Define sinusoidal voltage and current parameters (instantaneous, peak, RMS, average) and analyze their relationships in resistive, inductive, and capacitive elements.

LO3.2: Analyze phasors, complex impedance, power in AC circuits (instantaneous, average, reactive power, power factor), and perform sinusoidal analysis for RL, RC, and RLC circuits.

LO3.3: Study resonance in series and parallel RLC circuits, frequency response, quality factor (Q), bandwidth, and passive filters (low pass, high pass, band pass, band stop).

CO4: Apply network theorems and analyze two-port networks.

LO4.1: Apply network theorems such as Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, and Maximum Power Transfer Theorem to analyze AC circuits.

LO4.2: Analyze two-port networks using impedance (Z) parameters, admittance (Y) parameters, and transmission (ABCD) parameters.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1	LO1.2				
Conceptual		CO1, LO1.3		CO4, LO4.2		
Procedural		LO2.1 LO3.1	CO3, LO3.2	CO2, LO2.2, LO4.1		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	M	M	M
CO2	S	S	M	M	M	M	M	M	M	M
CO3	S	S	S	S	M	M	M	M	M	M
CO4	S	S	M	M	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Basic Circuit Concepts (L 14, H 14, M 14)

Voltage and Current Sources, Resistors: Fixed and Variable resistors, Construction and Characteristics, Colour coding of resistors, resistors in series and parallel.

Inductors: Fixed and Variable inductors, Self and mutual inductance, Faraday's law and Lenz's law of electromagnetic induction, Energy stored in an inductor, Inductance in series and parallel, testing of resistance and inductance using multimeter.

Capacitors: Principles of capacitance, Parallel plate capacitor, Permittivity, Definition of Dielectric Constant, Dielectric strength, Energy stored in a capacitor, Air, Paper, Mica, Teflon, Ceramic, Plastic and Electrolytic capacitor, Construction and application, capacitors in series and parallel, factors governing the value of capacitors, testing of capacitors using multimeter.

Unit-II: Circuit Analysis (L 14, H 14, M 14)

Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis, Star-Delta Conversion.

DC Transient Analysis: RC Circuit- Charging and discharging with initial charge, RL Circuit with Initial Current, Time Constant, RL and RC Circuits with Sources, DC Response of Series RLC Circuits.

Unit-III: AC Circuit Analysis. (L 16, H 16, M 16)

Sinusoidal Voltage and Current, Definition of Instantaneous, Peak, Peak to Peak, Root Mean Square and Average Values. Voltage-Current relationship in Resistor, Inductor and Capacitor, Phasor, Complex Impedance, Power in AC Circuits: Instantaneous Power, Average Power, Reactive Power, Power Factor. Sinusoidal Circuit Analysis for RL, RC and RLC Circuits.

Resonance in Series and Parallel RLC Circuits, Frequency Response of Series and Parallel RLC Circuits, Quality (Q) Factor and Bandwidth. Passive Filters: Low Pass, High Pass, Band Pass and Band Stop.

Unit-IV: Network Theorems

Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem. AC circuit analysis using Network theorems.

Two Port Networks: Impedance (Z) Parameters, Admittance (Y) Parameters, Transmission (ABCD) Parameters.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester assessment:

1. Two internal examinations: **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

- Electric Circuits, *S. A. Nasar*, Schaum's outline series, Tata McGraw Hill.
- Electrical Circuits, *M. Nahvi and J. Edminister*, Schaum's Outline Series, Tata McGraw-Hill.
- Essentials of Circuit Analysis, *Robert L. Boylestad*, Pearson Education.
- Engineering Circuit Analysis, *W. H. Hayt, J. E. Kemmerly, S. M. Durbin*, Tata McGraw Hill.
- Fundamentals of Electric Circuits, *Alexander and M. Sadiku*, McGraw Hill.

Course title: Semiconductor Devices
Course code: ELT-MIN-2
Nature of the course: Minor
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides a comprehensive introduction to semiconductor devices and their underlying principles. It covers semiconductor basics, including crystal structures, energy bands, and carrier concentration. Students will learn about carrier transport phenomena, p-n junction diodes, and various types of transistors such as BJTs and FETs. The course also delves into special semiconductor devices like tunnel diodes, varactor diodes, solar cells, and power devices including UJTs, SCRs, and IGBTs. Through this course, students will gain a deep understanding of the theoretical and practical aspects of semiconductor devices used in modern electronic systems.

Course Objectives: The objective of this course is to provide students with a solid foundation in semiconductor physics and device operation. Students will understand the behavior of carriers in semiconductors and learn to analyze the performance of p-n junctions, bipolar junction transistors, and field-effect transistors. The course also aims to familiarize students with various special semiconductor devices and their applications. By the end of the course, students will be equipped with the knowledge to analyze, design, and implement semiconductor-based circuits and systems.

Prerequisites:

- Basic knowledge of physics, especially electromagnetism and solid-state physics
- Understanding of basic electrical concepts such as current, voltage, and resistance
- Familiarity with algebra and trigonometry
- Prior exposure to simple electrical circuits and components

Course Outcomes (COs): The students will able to

CO1: Understand the fundamental principles of semiconductor materials and carrier transport phenomena.

LO1.1: Explain semiconductor crystal structure, energy band theory, and carrier concentration in intrinsic and extrinsic semiconductors.
LO1.2: Analyze carrier transport mechanisms including carrier drift, mobility, resistivity, Hall effect, diffusion, and generation-recombination processes.

CO2: Analyze the characteristics and applications of P-N junction diodes and related devices.
LO2.1: Describe the formation of depletion layer, depletion capacitance, and diode equation derivation.
LO2.2: Analyze the breakdown mechanisms in diodes (Zener and avalanche), and understand tunnel diodes, varactor diodes, and solar cells.

CO3: Understand the operation and characteristics of bipolar junction transistors.
LO3.1: Explain the basic structure and operation of PNP and NPN transistors, and analyze their energy band diagrams.
LO3.2: Analyze BJT static characteristics, including current gain, base-width modulation, and operating modes (CB, CE, CC configurations).

CO4: Understand the operation and characteristics of field-effect transistors.
LO4.1: Describe the construction, operation, and characteristics of JFETs and MOSFETs (depletion type and enhancement type).
LO4.2: Analyze the working principles and applications CMOS devices.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	CO1, LO1.1					
Conceptual		LO1.2, LO3.1				
Procedural		CO4, LO2.1, LO4.1, LO4.2		CO2, CO3, LO2.2, LO3.2		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	M	M	M
CO2	S	S	M	M	M	M	M	M	M	M
CO3	S	S	M	M	M	M	M	M	M	M
CO4	S	S	M	M	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Semiconductor Basics (L 12, H 12, M 12)
Introduction to Semiconductor Materials, Crystal Structure, Planes and Miller Indices, Energy Band in Solids, Concept of Effective Mass, Density of States, Carrier Concentration at Normal Equilibrium in Intrinsic Semiconductors, Derivation of Fermi Level for Intrinsic & Extrinsic

Semiconductors, Donors, Acceptors, Dependence of Fermi Level on Temperature and Doping Concentration, Temperature Dependence of Carrier Concentrations.

Carrier Transport Phenomena: Carrier Drift, Mobility, Resistivity, Hall Effect, Diffusion Process, Einstein Relation, Current Density Equation, Carrier Injection, Generation and Recombination Processes, Continuity Equation.

Unit-II: P-N Junction Diode (L 15, H 15, M 15)

Formation of Depletion Layer, Space Charge at a Junction, Derivation of Electrostatic Potential Difference at Thermal Equilibrium, Depletion Width and Depletion Capacitance of an Abrupt Junction. Concept of Linearly Graded Junction, Derivation of Diode Equation and I-V Characteristics. Zener and Avalanche Junction Breakdown Mechanism.

Tunnel diode, varactor diode, solar cell: circuit symbol, characteristics, applications.

Unit-III: Bipolar Junction Transistors (BJT) (L 15, H 15, M 15)

PNP and NPN Transistors, Basic Transistor Action, Emitter Efficiency, Base Transport Factor, Current Gain, Energy Band Diagram of Transistor in Thermal Equilibrium, Quantitative Analysis of Static Characteristics (Minority Carrier Distribution and Terminal Currents), Base-Width Modulation, Modes of operation, Input and Output Characteristics of CB, CE and CC Configurations. Metal Semiconductor Junctions: Ohmic and Rectifying Contacts.

Unit-IV: Field Effect Transistors (L 18, H 18, M 18)

JFET, Construction, Idea of Channel Formation, Pinch-Off and Saturation Voltage, Current-Voltage Output Characteristics. MOSFET, types of MOSFETs, Circuit symbols, Working and Characteristic curves of Depletion type MOSFET (both N channel and P Channel) and Enhancement type MOSFET (both N channel and P channel). Complimentary MOS (CMOS).

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

- Semiconductor Devices: Physics and Technology, *S. M. Sze*, Wiley India.
- Solid State Electronic Devices, *Ben G. Streetman and S. Banerjee*, Pearson Education.
- Transistors, *Dennis Le Croissette*, Pearson Education.
- Semiconductor Devices: Basic Principles, *Jasprit Singh*, John Wiley and Sons.
- Semiconductor Devices, *Kanaan Kano*, Pearson Education.
- Semiconductor Device Fundamentals, *Robert F. Pierret*, Pearson Education.

Course title: Electronic Circuits
Course code: ELT-MIN-3
Nature of the course: Minor
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course focuses on the analysis and application of semiconductor devices in electronic circuits. It begins with an exploration of diode circuits, including rectifiers, clippers, clampers, and Zener diode regulators. The course progresses to an in-depth study of bipolar junction transistors (BJTs), covering their characteristics, biasing techniques, and applications in amplifiers and switches. Students will also learn about feedback amplifiers, including the concepts and benefits of negative feedback and various types of oscillators. The course concludes with an examination of MOSFET circuits and power amplifiers, emphasizing their operation, biasing, and applications in modern electronics.

Course Objectives: The objective of this course is to provide students with a comprehensive understanding of semiconductor devices and their applications in electronic circuits. Students will learn to analyze and design various diode circuits, including rectifiers, clippers, and clampers, as well as Zener diode regulators. The course covers the operation and characteristics of bipolar junction transistors (BJTs), focusing on their use in amplifiers and switching circuits. Additionally, students will explore feedback amplifiers and oscillators, understand MOSFET circuits and their small signal analysis, and study power amplifiers, including their classification, operation, and efficiency. This knowledge will equip students with the skills needed for practical electronic circuit design and analysis.

Prerequisites:

- Basic understanding of electrical circuits and components.
- Familiarity with semiconductor physics.
- Knowledge of algebra and basic calculus.

Course Outcomes (COs): The students will able to

CO1: Understand the operation and characteristics of diodes in various circuit configurations.

- **LO1.1:** Analyze ideal diode characteristics, piecewise linear equivalent circuit, and perform DC load line analysis.
- **LO1.2:** Explain the operation, circuit diagrams, and characteristics of rectifiers (HWR, FWR), including waveforms, ripple factor, and efficiency.
- **LO1.3:** Describe different types of filters, focusing on the shunt capacitor filter, and analyze its circuit diagram and waveforms.
- **LO1.4:** Evaluate Zener diode regulator circuits, including load and line regulation, and discuss their disadvantages.

CO2: Analyze the characteristics and applications of BJT in amplifier and switching circuits.

- **LO2.1:** Review CE and CB characteristics, operating regions, and hybrid parameters.
- **LO2.2:** Discuss transistor biasing techniques (fixed bias, voltage divider bias, emitter bias) and analyze DC load lines, thermal runaway, stability, and stability factor.

LO2.3: Explain the operation and applications of transistors as switches, Darlington pairs, and CE amplifiers.

LO2.4: Quantitatively study the frequency response of CE amplifiers and cascaded CE amplifiers.

CO3: Understand the principles and applications of feedback in amplifier circuits.

LO3.1: Explain the concepts of negative and positive feedback, and analyze their advantages and disadvantages.

LO3.2: Analyze voltage and current feedback amplifiers, and calculate gain, input, and output impedances.

LO3.3: Discuss the conditions for oscillations according to Barkhausen criteria and study phase shift, Colpitts, and Hartley oscillators.

CO4: Analyze MOSFET circuits and various types of power amplifiers.

LO4.1: Review the operation, biasing, and small signal parameters of depletion and enhancement MOSFETs.

LO4.2: Analyze Common Source amplifier circuits and CMOS circuits.

LO4.3: Compare voltage and power amplifiers, and classify Class A, Class B, and Class C power amplifiers.

LO4.4: Explain the operation of Class A single-ended and Class B push-pull power amplifiers, including crossover distortion, efficiency, and the use of heat sinks.

LO4.5: Discuss the circuit operation, limitations, and applications of single tuned amplifiers in communication circuits.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	CO1, LO1.1					
Conceptual		CO3, LO1.2, LO3.1, LO4.1, LO4.3		CO2, LO2.1		
Procedural	LO2.4, LO4.2	LO1.3, LO2.2, LO2.3, LO3.2, LO3.3	LO1.4, LO2.2, LO4.2	CO4, LO4.4		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	M	M	M
CO2	S	S	M	M	M	M	M	M	M	M
CO3	S	S	M	M	M	M	M	M	M	M
CO4	S	S	M	M	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Diode Circuits **(L 14, H 14, M 14)**

Ideal diode, piecewise linear equivalent circuit, dc load line analysis, Quiescent (Q) point. Clipping and clamping circuits. Rectifiers: HWR, FWR (center tapped and bridge). Circuit diagrams, working and waveforms, ripple factor & efficiency, comparison. Filters: types, circuit diagram and explanation of shunt capacitor filter with waveforms.

Zener diode regulator circuit diagram and explanation for load and line regulation, disadvantages of Zener diode regulator.

Unit-II: Bipolar Junction Transistor **(L 14, H 14, M 14)**

Review of CE, CB Characteristics and regions of operation. Hybrid parameters. Transistor biasing, DC load line, operating point, thermal runaway, stability and stability factor, Fixed bias without and with RE, collector to base bias, voltage divider bias and emitter bias (+VCC and –VEE bias), circuit diagrams and their working.

Transistor as a switch, circuit and working**,** Darlington pair and its applications.

BJT amplifier (CE), dc and ac load line analysis, hybrid model of CE configuration, Quantitative study of the frequency response of a CE amplifier, Effect on gain and bandwidth for Cascaded CE amplifiers (RC coupled).

Unit-III: Feedback Amplifiers **(L 12, H 12, M 12)**

Concept of feedback, negative and positive feedback, advantages and disadvantages of negative feedback, voltage (series and shunt), current (series and shunt) feedback amplifiers, gain, input and output impedances. Barkhausen criteria for oscillations, Study of phase shift oscillator, Colpitts oscillator and Hartley oscillator.

Unit-IV: MOSFET Circuits **(L 20, H 20, M 20)**

Review of Depletion and Enhancement MOSFET, Biasing of MOSFETs, Small Signal Parameters, Common Source amplifier circuit analysis, CMOS circuits.

Power Amplifiers: Difference between voltage and power amplifier, classification of power amplifiers, Class A, Class B, Class C and their comparisons. Operation of a Class A single ended power amplifier. Operation of Transformer coupled Class A power amplifier, overall efficiency. Circuit operation of complementary symmetry Class B push pull power amplifier, crossover distortion, heat sinks.

Single Tuned Amplifiers: Circuit diagram, Working and Frequency Response for each, Limitations of single tuned amplifier, Applications of tuned amplifiers in communication circuits

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Electronic Devices and circuit theory, *Robert Boylstead and Louis Nashelsky*, PHI.
2. Electronic devices, *David A Bell*, Reston Publishing Company
3. Electronic Circuits: Discrete and Integrated, *D. L. Schilling and C. Belove*, Tata McGraw Hill.
4. Electronic Circuit Analysis and Design, *Donald A. Neamen*, Tata McGraw Hill.
5. Integrated Electronics, *J. Millman and C. C. Halkias*, Tata McGraw Hill.
6. Microelectronic Circuit Design, *J. R. C. Jaegar and T. N. Blalock*, Tata McGraw Hill.
7. 2000 Solved Problems in Electronics, *J. J. Cathey*, Schaum's outline Series, Tata McGraw Hill.
8. Electronic Devices and Circuits, *Allen Mottershed*, Goodyear Publishing Corporation.

Course title: Electronics LAB-I
Course code: ELT-MIN-4
Nature of the course: Minor
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This lab-focused course offers practical experience in understanding and analyzing basic circuit theory, semiconductor devices, and electronic circuits. Students will engage in hands-on activities to familiarize themselves with fundamental circuit components and configurations, verify essential electrical theorems, and design and analyze various types of filters and amplifiers. The course covers detailed experiments with semiconductor devices like diodes, transistors, and MOSFETs, along with rectifiers, power supplies, and oscillators, enhancing students' ability to apply theoretical concepts in real-world scenarios.

Course Objectives: The objective of this course is to provide students with practical skills and knowledge in basic circuit theory, semiconductor devices, and electronic circuits. Students will learn to use various electrical measurement tools and instruments, analyze the behavior of circuit components in different configurations, and apply fundamental theorems in circuit analysis. Through this course, students will also gain experience in designing and testing filters, amplifiers, and oscillators, preparing them for more advanced studies and applications in electronics and electrical engineering.

Prerequisites:

- Basic understanding of electrical principles and concepts.
- Familiarity with electrical circuit components and their functions.
- Knowledge of safety practices and procedures related to electricity.
- Ability to read and interpret simple electrical diagrams.
- Basic skills in using hand tools and electrical testing instruments.

Course Outcomes (COs): The students will able to

CO1: Understanding Basic Circuit Components.

- **LO1.1:** Identify and apply principles of resistances in series, parallel, and series-parallel configurations.
- **LO1.2:** Explain the behavior and applications of capacitors and inductors in series and parallel circuits.

CO2: Measurement and Instrumentation Skills.

- **LO2.1:** Demonstrate proficiency in using multimeters to measure and verify electrical components.
- **LO2.2:** Measure and analyze amplitude, frequency, and phase difference using a Cathode Ray Oscilloscope (CRO).

CO3: Theoretical Verification of Circuit Laws and Theorems.

- **LO3.1:** Conduct experiments to verify Kirchhoff's laws (KCL and KVL) and analyze their implications.
- **LO3.2:** Experimentally verify Norton's and Thevenin's theorems and interpret the results.

CO4: Analysis and Design of RC and LCR Circuits.

- **LO4.1:** Analyze RC circuits including time constants, differentiators, and integrators.
- **LO4.2:** Design and analyze low pass and high pass RC filters, and interpret their frequency response characteristics.
- **LO4.3:** Determine resonant frequency, impedance at resonance, quality factor (Q), and bandwidth of series LCR circuits.

CO5: Understanding Semiconductor Device Characteristics.

- **LO5.1:** Analyze and interpret the I-V characteristics of ordinary and Zener diodes.
- **LO5.2:** Evaluate the performance parameters (r_i, r_o, β) of the CE configuration of a BJT.
- **LO5.3:** Determine the performance parameters (r_i, r_o, α) of the Common Base configuration of a BJT.
- **LO5.4:** Calculate the voltage gain and performance parameters (r_i, r_o,) of the Common Collector configuration of a BJT.

CO6: Study of Specialized Semiconductor Devices.

- **LO6.1:** Examine the operational characteristics and applications of a Solar Cell.
- **LO6.2:** Study the Hall Effect and its significance in semiconductor materials.

CO7: Experimental Techniques and Data Analysis.

- **LO7.1:** Apply experimental techniques to measure and plot I-V characteristics accurately.
- **LO7.2:** Analyze experimental data to draw conclusions about device behavior and performance.

CO8: Practical Applications and Circuit Design.

- **LO8.1:** Design basic circuits using semiconductor devices based on their characteristics.
- **LO8.2:** Demonstrate practical skills in circuit construction, testing, and troubleshooting.

CO9: Understanding Rectification and Power Supply.

- **LO9.1:** Analyze and compare the performance of half wave and full wave rectifiers.

LO9.2: Evaluate the operation of power supplies using C filter and Zener diode for voltage regulation.

LO9.3: Design and test a 5V/9V DC regulated power supply, assessing its load-regulation capabilities.

CO10: Study of Clipping, Clamping, and Biasing Circuits.

LO10.1: Investigate the behavior and applications of clipping and clamping circuits.

LO10.2: Analyze the characteristics and functionality of fixed bias, voltage divider, and collector-to-base bias configurations for transistors.

CO11: Design and Analysis of Amplifiers.

LO11.1: Design a single stage CE amplifier, considering gain, bandwidth, and stability.

LO11.2: Study the characteristics and applications of Class A, B, and C power amplifiers.

CO12: Oscillator Circuits.

LO12.1: Explore the operation and frequency stability of Colpitt's, Hartley's, and Phase Shift oscillators.

CO13: Frequency Response of FET Amplifier.

LO13.1: Investigate the frequency response characteristics of a Common Source FET amplifier, including gain and bandwidth.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	CO1, CO2, CO3 LO1.1, LO2.1, LO3.1	LO1.2, LO5.1, LO7.1	LO2.2, LO4.1	CO4, CO6, CO9, LO4.2, LO6.1, LO9.1 LO9.3	LO8.1, CO10, LO10.1, LO11.2	
Conceptual	LO1.3, LO3.2, LO4.2	CO5, LO5.2, LO6.2, CO8, LO8.2	LO1.4, LO10.2	LO2.3, LO5.4, CO11, LO11.1	CO7, LO3.3, LO7.2,	
Procedural			LO2.3, LO4.3	LO3.3, LO6.2	LO1.4	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	W	M	M	W	W	W	W	M
CO2	S	S	W	M	S	W	M	W	W	S
CO3	S	S	W	S	M	W	M	W	W	S
CO4	S	S	W	S	M	W	L	W	W	S
CO5	S	M	W	M	S	W	M	W	W	S
CO6	S	M	W	M	S	W	M	W	W	S

CO7	S	S	W	S	S	W	M	W	W	S
CO8	S	S	W	M	S	W	M	W	W	S
CO9	S	S	W	M	S	W	W	W	W	S
CO10	S	S	W	S	S	W	W	W	W	S
CO11	S	S	W	S	S	W	W	W	W	S
CO12	S	M	W	S	M	W	W	W	W	S
CO13	S	S	W	S	M	W	W	W	W	S

S: Strong, M: Medium, W: Weak

List of Experiments:

A. Basic Circuit Theory and Network Analysis Lab:

1. Familiarization with
   a. Resistance in series, parallel and series – parallel.
   b. Capacitors & inductors in series & parallel.
   c. Multimeter – Checking of components.
   d. Voltage sources in series, parallel and series – parallel.
   e. Voltage and current dividers.
2. Measurement of Amplitude, Frequency & Phase difference using CRO.
3. Verification of Kirchoff's Law.
4. Verification of Norton's theorem.
5. Verification of Thevenin's theorem.
6. Verification of Superposition theorem.
7. Verification of the Maximum Power Transfer theorem.
8. RC Circuits: Time Constant, Differentiator, Integrator.
9. Designing of a Low Pass RC Filter and study of its Frequency Response.
10. Designing of a High Pass RC Filter and study of its Frequency Response.
11. Study of the Frequency Response of a Series LCR Circuit and determination of its (a) Resonant Frequency (b) Impedance at Resonance (c) Quality Factor Q (d) Band Width.

B. Semiconductor Devices Lab:

1. Study of the I-V Characteristics of Diode – Ordinary and Zener Diode.
2. Study of the I-V Characteristics of the CE configuration of BJT and obtain r_i, r_o, β.
3. Study of the I-V Characteristics of the Common Base Configuration of BJT and obtain r_i, r_o, α.
4. Study of the I-V Characteristics of the Common Collector Configuration of BJT and obtain voltage gain, r_i, r_o.
5. Study of the I-V Characteristics of the UJT.
6. Study of the I-V Characteristics of the SCR.
7. Study of the I-V Characteristics of JFET.
8. Study of the I-V Characteristics of MOSFET.
9. Study of Characteristics of Solar Cell

10. Study of Hall Effect.

C. Electronics Circuits Lab:

1. Study of the half wave rectifier and Full wave rectifier.
2. Study of power supply using C filter and Zener diode.
3. Designing and testing of 5V/9 V DC regulated power supply and find its load-regulation.
4. Study of clipping and clamping circuits.
5. Study of Fixed Bias, Voltage divider and Collector-to-Base bias Feedback configuration for transistors.
6. Designing of a Single Stage CE amplifier.
7. Study of Class A, B and C Power Amplifier.
8. Study of the Colpitt's Oscillator.
9. Study of the Hartley's Oscillator.
10. Study of the Phase Shift Oscillator
11. Study of the frequency response of Common Source FET amplifier.

(Total Practical Classes 60, Total Contact Hours 120, Total Marks 60)

At least five experiments must be performed from each unit.

Mode of In-semester Assessment:
1. Viva-voce: **(20 Marks)**
2. Attendance / Laboratory performance / Notebook: **(20 Marks)**

Mode of End-semester Assessment:
1. Laboratory experiments: **(60 Marks)**
2. Two experiments (not more than one from a single unit) from the list to be performed.

Course title: Communication Electronics
Course code: ELT-MIN-5
Nature of the course: Minor
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides a comprehensive overview of electronic communication systems, emphasizing both theoretical and practical aspects. Students will study the fundamental principles of electronic communication, including modulation techniques, noise analysis, and signal processing. The curriculum covers amplitude and angle modulation, pulse analog modulation, and pulse code modulation, along with an in-depth exploration of digital carrier modulation techniques. By examining the block diagrams of transmitters and receivers, students will gain insights into the operational frameworks of communication systems. The course aims to prepare students for advanced studies and practical applications in the field of communication technology.

Course Objectives: This course aims to equip students with a robust understanding of electronic communication systems, including both analog and digital modulation techniques. Students will explore the principles of electronic communication, such as the need for modulation, noise concepts, and the functioning of transmitters and receivers. The course delves into amplitude and angle modulation, highlighting their generation and detection methods, and comparing different modulation techniques. Additionally, students will learn about pulse analog modulation and pulse code modulation, focusing on the need for digital transmission and related techniques. The course also covers digital carrier modulation techniques, preparing students for advanced studies and practical applications in communication systems.

Prerequisites:

- Basic understanding of electronics and electrical circuits.
- Knowledge of semiconductor devices (diodes, transistors, etc.).
- Familiarity with fundamental concepts of physics, especially electromagnetism.
- Proficiency in basic mathematics, including algebra and calculus.
- Introduction to signal processing principles.
- Prior coursework or experience in digital and analog circuit design.

Course Outcomes (COs): The students will able to

CO1: Understand the fundamental concepts of electronic communication systems and noise.

- **LO1.1:** Explain the block diagram of an electronic communication system and the electromagnetic spectrum.
- **LO1.2:** Define modulation and discuss the need for modulation, channels, and base-band signals.
- **LO1.3:** Identify different types of noise, calculate signal-to-noise ratio, understand noise figure, noise temperature, and the Friis formula.

CO2: Analyze the principles and applications of amplitude and angle modulation techniques.

- **LO2.1:** Describe amplitude modulation (AM), modulation index, and frequency spectrum.
- **LO2.2:** Discuss the generation of AM, demodulation techniques (diode detector), and various forms of AM (DSB-SC, SSB-SC, Pilot Carrier Modulation, Vestigial Side Band Modulation, Independent Side Band Modulation).
- **LO2.3:** Explain frequency modulation (FM), phase modulation (PM), modulation index, frequency spectrum, generation methods, and demodulation techniques (PLL).
- **LO2.4:** Compare AM, FM, and PM modulation techniques, and analyze their block diagrams for both transmitters and receivers.

CO3: Understand pulse analog modulation techniques and pulse code modulation (PCM) principles.

- **LO3.1:** Discuss pulse amplitude modulation (PAM), pulse duration modulation (PDM), pulse position modulation (PPM), their modulation and detection techniques.
- **LO3.2:** Explain the concepts of channel capacity, sampling theorem, time division multiplexing (TDM), and frequency division multiplexing (FDM).
- **LO3.3:** Describe pulse code modulation (PCM), including quantization, quantization noise, companding, coding, decoding, and regeneration.

CO4: Analyze digital transmission and reception techniques using carrier modulation.

- **LO4.1:** Describe digital transmission block diagrams, information capacity, bit rate, baud rate, and M-ary coding.
- **LO4.2:** Explain amplitude shift keying (ASK), frequency shift keying (FSK), phase shift keying (PSK), binary phase shift keying (BPSK), and quadrature phase shift keying (QPSK) modulation techniques.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	CO1, LO1.1, LO1.2, LO1.3	LO2.1, LO2.4, LO4.1	CO2, LO2.3, LO4.2	CO3, CO4, LO1.3, LO2.4, LO3.2, LO4.2, LO3.3		
Conceptual		LO2.2, LO3.1, LO4.2		LO1.1, LO2.4, LO3.3, LO4.1		
Procedural			LO2.2, LO3.2	LO3.1		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	M	S	S	S	S
CO2	M	S	S	M	S	S	M	S	S	M
CO3	S	S	M	M	M	M	S	M	S	M
CO4	S	M	M	S	M	S	S	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Electronic communication **(L 10, H 10, M 10)**

Block diagram of an electronic communication system, electromagnetic spectrum-band designations and applications, need for modulation, concept of channels and base-band signals.

Concept of Noise, Types of Noise, Signal to noise ratio, Noise Figure, Noise Temperature, Friss formula.

Unit-II: Amplitude and Angle Modulations **(L 20, H 20, M 20)**

Amplitude Modulation, modulation index and frequency spectrum. Generation of AM, Amplitude Demodulation (diode detector), Concept of Double side band suppressed carrier, Single side band suppressed carrier, other forms of AM (Pilot Carrier Modulation, Vestigial Side Band modulation, Independent Side Band Modulation). Block diagram of AM Transmitter and Receiver.

Frequency and Phase modulation, modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM (direct and indirect methods), FM detector (PLL). Block diagram of FM Transmitter and Receiver Comparison between AM, FM and PM.

Unit-III: Pulse Analog and Code Modulations **(L 15, H 15, M 15)**

Channel capacity, Sampling theorem, PAM, PDM, PPM modulation and detection techniques, Multiplexing, TDM and FDM.

Need for digital transmission, Quantizing, Uniform and Non-uniform Quantization, Quantization Noise, Companding, Coding, Decoding, Regeneration.

Unit-IV: Digital Carrier Modulation Techniques **(L 15, H 15, M 15)**

Block diagram of digital transmission and reception, Information capacity, Bit Rate, Baud Rate and M-ary coding. Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK).

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Electronic communication systems, *Kennedy*, McGraw International Publications.
2. Principles of Electronic communication systems, *Frenzel*, McGraw Hill.
3. Communication Systems, *S. Haykin*, Wiley India.
4. Advanced electronic communications systems, *Tomasi,* PHI.

Course Title: Digital Electronics
Course code: ELT-MIN-6
Nature of the course: Minor
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course delves into the foundational principles of digital electronics, focusing on number systems, Boolean algebra, logic gates, flip-flops, counters, shift registers, arithmetic circuits, and memory devices. Students will explore conversion techniques between different number systems, simplifying Boolean expressions, and implementing various digital logic circuits. The course also covers combinational and sequential logic circuits, including the design and application of flip-flops and counters. Additionally, it introduces memory types and digital-to-analog (DAC) and analog-to-digital converters (ADC). Through theoretical and practical approaches, students will gain a comprehensive understanding of digital electronics, essential for advanced studies and applications in electronics and computer engineering.

Course Objectives: The course aims to provide a comprehensive understanding of digital electronics fundamentals, focusing on the principles of number systems, Boolean algebra, and logic gate operations. Students will learn to simplify complex digital circuits using Karnaugh maps and Boolean postulates, design and implement various combinational and sequential logic circuits, and explore the workings of flip-flops, counters, and shift registers. Additionally, the course covers memory devices, digital-to-analog, and analog-to-digital converters, equipping students with the necessary skills to analyze, design, and troubleshoot digital systems. Through a blend of theoretical knowledge and practical applications, the course prepares students for advanced studies and professional practice in electronics and computer engineering.

Prerequisites:

- Basic understanding of electronics and electrical circuits
- Knowledge of semiconductor devices (diodes, transistors, etc.)
- Familiarity with fundamental concepts of physics, especially electromagnetism
- Proficiency in basic mathematics, including algebra and calculus
- Introduction to signal processing principles
- Prior coursework or experience in digital and analog circuit design

Course Outcomes (COs): The students will able to

CO1: Understand and apply concepts related to number systems, Boolean algebra, and various codes.

- **LO1.1:** Perform decimal-binary conversion, octal, and hexadecimal conversions to decimal, and understand BCD and floating-point number systems.
- **LO1.2:** Apply Boolean postulates, De Morgan's theorems, and properties of Boolean algebra to simplify compound expressions.
- **LO1.3:** Minimize Boolean functions using Karnaugh maps for 2, 3, 4, 5, and 6 variables.

LO1.4: Explain different codes including weighted codes (BCD), Excess-3 code, Gray code, and alphanumeric codes (ASCII, EBCDIC).

LO1.5: Design and implement decimal to binary and octal to binary encoders.

CO2: Analyze and design logic circuits using basic gates and flip-flops.

LO2.1: Describe basic logic operations and characteristics of logic gates (AND, OR, NOT, NAND, NOR, XOR) and universal gates.

LO2.2: Analyze noise immunity, propagation delay, and voltage transfer characteristics of logic families (DTL, RTL, TTL, ECL).

LO2.3: Explain the operation and applications of flip-flops including NAND, SR, D, JK, and master-slave flip-flops.

LO2.4: Compare and contrast bipolar logic families (DTL, RTL, TTL), Schottky TTL, and Emitter Coupled Logic (ECL).

CO3: Understand the design and operation of counters and shift registers.

LO3.1: Design asynchronous, synchronous, up/down counters, including decade and self-stopping counters.

LO3.2: Explain the operation and applications of serial-in, parallel-in, and universal shift registers, including 3-bit CMOS shift registers.

CO4: Analyze and design arithmetic circuits, memory systems, and ADC/DAC converters.

LO4.1: Design and implement basic arithmetic circuits such as half adders, full adders, half subtractors, and full subtractors.

LO4.2: Describe the principles and operation of memory systems including RAM, ROM, PROM, EPROM, EEPROM, and secondary storage.

LO4.3: Explain the principles and operation of Digital to Analog Converters (DAC) and Analog to Digital Converters (ADC) including successive approximation ADC, parallel ADC, and dual slope ADC.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	CO1, LO1.1, LO1.4, LO1.5	CO2, LO2.1, LO2.4, LO3.2	CO3, LO3.1, LO4.1			
Conceptual		LO2.2,	LO4.2			
Procedural		LO2.4,	CO4, LO3.1, LO4.3			
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	M	M	L	M	M	M	M
CO2	S	S	M	M	M	M	M	M	M	M
CO3	S	S	M	M	M	M	M	M	M	M

CO4	S	S	M	M	M	M	M	M	M	M

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Number System **(L 15, H 15, M 15)**

Decimal-Binary conversion, Octal and Hexadecimal number system and their conversion to Decimal, BCD number, compliment Technique, Floating point number. Boolean Algebra: Boolean postulates from basic gates, properties of Boolean algebra, De Morgans theorems, simplification of compound expressions, sum of product and products of sum form. Minimisation by the use of Karnaugh's map for 2, 3, 4, 5 and 6 variables. Codes: Need of Coding, Weighted codes (BCD), Exess - 3 code, Gray code and conversion. Alpha numeric code- ASCII and EBCDIC, Decimal to binary encoder, octal to binary encoder.

Unit-II: Logic Gates **(L 15, H 15, M 15)**

Basic Logic operation, AND, OR, NOT, NAND, NOR, XOR, gates. Universal gates, Truth tables, Bipolar logic families, DTL families, RTL families, TTL families, Schottky TTL, Emitter coupled logic (ECL), NAND and NOR gates, voltage transfer function. Fanout, Noise-immunity and propagation delay of logic families. Flip-flops: Combinational and sequential circuits, flip-flops, NAND flip-flop, SR flip-flop. Clocked SR flip-flop, D-latch, JK flip-flop. Master-slave flip-flop.

Unit-III: Counters and Registers **(L 15, H 15, M 15)**

Asynchronous counter. Asynchronous decade counter. Synchronous counters. Up/down counters. Self stopping counter, Sequential counter design procedure and applications. Shift Serial in shift registers, parallel-in shift register, universal shift register, 3-bits CMOS shift register.

Unit-IV: Arithmetic Circuits **(L 15, H 15, M 15)**

Half adder, Full adder, parallel binary adder. Half subtractor. Full subtractor, parallel subtractor, subtraction using full adder. Memory: Introduction, RAM, ROM, PROM. EPROM, EAPROM, secondary memory, floppy, Hard disk, Magnetic storage. DC and DAC: Digital to analog converter, Weighted Register DAC, R-2R ladder DAC, Analog to digital converter, Successive approximation ADC, parallel ADC, Dual slope ADC.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester assessment:

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Digital System Design, *M. Morris Mano*, Pearson Education Asia.

2. Digital Fundamentals, *Thomas L. Flyod*, Pearson Education Asia.
3. Digital Electronics: An Introduction to Theory and Practice, *W. H. Gothmann*, Prentice Hall of India.
4. Digital Principles, *R. L. Tokheim*, Schaum's Outline Series, Tata McGraw- Hill.
5. Digital Principles and Applications, *Donald P. Leach, Albert Paul Malvino*, Tata McGraw Hill.
6. Modern Digital Electronics, *R. P. Jain*, Tata McGraw-Hill

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Course Title: Microprocessor and Microcontroller
Course code: ELT-MIN-7
Nature of the course: Minor
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course offers an in-depth study of microprocessors and microcontrollers, focusing on their architecture, programming, and applications. It begins with an introduction to microprocessors, covering machine, assembly, and high-level languages, and explores the architecture of various processors, including INTEL 8085, 8086, 80386, 80486, and Pentium. Students will learn 8085 microprocessor programming, including instruction sets, stack and subroutine management, and interrupt handling. The course also covers memory mapping, I/O interfacing, and peripheral devices such as the 8255 PPI, 8253 PIT, and 8259 PIC. In the latter part, the course delves into microcontrollers, emphasizing the 8051 microcontroller, its architecture, memory organization, and interfacing. This comprehensive course equips students with the knowledge and skills required to design, program, and implement microprocessor and microcontroller-based systems in various applications.

Course Objectives: This course aims to provide students with a thorough understanding of microprocessor and microcontroller systems. It begins with the foundational concepts of microprocessors and microcomputers, including machine language, assembly language, and high-level languages. Students will explore microprocessor architecture, focusing on the INTEL 8085, 8086, 80386, 80486, and Pentium processors. The course includes in-depth programming of the 8085 microprocessor, including the use of instructions, stack and subroutine management, and interrupt handling. Additionally, it covers memory mapping, I/O interfacing, and peripheral devices. Finally, students will delve into microcontroller architecture, specifically the 8051 microcontroller, and learn about its applications in embedded systems. Through this course, students will gain the skills necessary to design, program, and interface microprocessor and microcontroller systems in various applications.

Prerequisites:

- Basic understanding of digital electronics.
- Familiarity with number systems and Boolean algebra.

- Knowledge of basic electronic components such as resistors, capacitors, and transistors.
- Understanding of fundamental electrical concepts like voltage, current, and power.
- Introductory knowledge of programming concepts.

Course Outcomes (COs): The students will able to

CO1: Understand the fundamentals of microprocessors, machine language, assembly language, and high-level language programming.

LO1.1: Describe the architecture of microprocessors, types of buses, registers, and memory mapping.

LO1.2: Explain the architecture, pin-out diagram, classification of signals, bus timings, and types of machine cycles of the Intel 8085 microprocessor.

CO2: Develop skills in programming the 8085 microprocessor and handling interrupts.

LO2.1: Understand the 8085 programming model including the accumulator, registers, flags, and instruction set.

LO2.2: Write programs using concepts such as stack and subroutine (CALL and RET statements), delay subroutines, and BCD arithmetic.

LO2.3: Explain the concepts of maskable and non-maskable interrupts, RST instructions, and interrupt vectoring (SIM & RIM instructions).

CO3: Understand memory organization, I/O interfacing techniques, and peripheral devices with the 8085 microprocessor.

LO3.1: Describe primary and secondary memory, memory mapping, and different modes of data transfer.

LO3.2: Explain serial and parallel I/O interfacing, programmable I/O, DMA, memory-mapped I/O, and I/O-mapped I/O techniques.

LO3.3: Understand the operation and interfacing of peripheral devices such as 8255, 8253, 8259, 8279, and 8251 with the 8085 microprocessor.

CO4: Analyze the differences between microprocessors and microcontrollers, and understand the architecture and features of the 8051 microcontroller.

LO4.1: Compare microprocessors and microcontrollers, and explain the advantages of microcontrollers in embedded systems.

LO4.2: Describe different types of microcontrollers, processor architectures (Harvard vs Princeton, CISC vs RISC), and microcontroller features.

LO4.3: Explain the architecture, registers, pin diagram, I/O ports, internal and external memory organization of the 8051 microcontroller.

LO4.4: Understand the interfacing of external memory (ROM & RAM) with the 8051 microcontroller.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	CO1, LO1.1, LO1.2	LO2.1, LO3.1, LO3.3	CO2, LO2.2, LO2.3, LO3.2, LO4.3	CO4, LO4.1, LO4.2, LO4.4		
Conceptual				LO4.1, LO4.2		
Procedural			LO2.2, LO2.3, LO2.2	CO3, LO3.2, LO4.4 LO3.3		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	H	M	M	H	W	M	H	W	M	H
CO2	M	H	W	M	M	H	M	W	M	M
CO3	M	M	M	H	W	M	M	H	W	M
CO4	W	M	V	M	M	W	M	M	H	H

S: Strong, M: Medium, W: Weak

Course Contents:

Unit-I: Fundamentals (L 15, H 15, M 15)

Introduction to microprocessors and microcomputers, machine language, assembly language and high-level language. Microprocessor architecture, types of buses, registers, memory mapping. Basic idea of INTEL 8085, 8086, 80386, 80486, Pentium processors. 8085 Microprocessor: pin-out diagram, classification of the signals, bus timings, types of machine cycles and their functioning.

Unit-II: 8085 Programming (L 15, H 15, M 15)

8085 programming model: Accumulator, register and flags, instruction classification & programming concepts, stack and subroutine (CALL and RET statements), delay subroutines, Code conversion, BCD Arithmetic, introduction to transmission format, modes of data transfer. Interrupts: Maskable and non-maskable interrupts, RST (Restart), vectored interrupts & instructions (SIM & RIM).

Unit-III: Stack and Subroutines Memory (L 15, H 15, M 15)

Primary & Secondary Memory, Memory Mapping, Serial and Parallel I/O & Memory Interfacing with 8085, Programmable I/O and DMA, Memory Mapped I/O and I/O Mapped I/O techniques. Peripheral Devices: 8255-Programmable Peripheral Interface, 8253-

Programmable interval Timer, 8259- Priority Interrupt Controller, 8279-Programmable Keyboard/Display Interface, 8251- USART, 8237/8257- Programmable DMA Controller.

Unit-IV: Microcontrollers **(L 15, H 15, M 15)**

Introduction, Microprocessor vs Microcontroller, advantages of microcontrollers, Different types of microcontrollers, embedded microcontrollers, processor architectures. Harvard vs Princeton, CISC vs RISC architectures, microcontroller memory types, microcontroller features, clocking, I/O pins, interrupts, timers, peripherals.

8051 Microcontroller: 8051 Architecture - Registers, Pin diagram, I/O ports functions, Internal Memory organization. External Memory (ROM & RAM) interfacing.

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Mode of In-semester Assessment

1. Two internal examinations **(20 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.: **(20 Marks)**

Recommended Readings:

1. Microprocessor Architecture, Programming and Applications with 8085, *Ramesh S. Gaonkar*, Wiley Eastern Ltd.
2. Fundamentals of Microprocessor & Microcomputer: *B. Ram*, Dhanpat Rai Publications.
3. Microprocessors and Microcontrollers, *Muhammad Ali Mazidi*, Pearson.
4. Introduction to Microprocessors, *A. P. Mathur*, McGraw Hill.
5. The 8051 Microcontroller and Embedded Systems, *M. A. Mazidi*, Pearson.

Course Title: Electronics LAB-II
Course code: ELT-MIN-8
Nature of the course: Minor
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course explores fundamental principles and advanced applications in electronics and digital circuits. Students will delve into modulation techniques such as Amplitude Modulation (AM) and Frequency Modulation (FM), alongside pulse modulation methods including Pulse Width Modulation (PWM) and Pulse Code Modulation (PCM). Practical skills in digital electronics cover logic gates, sequential circuits, and advanced digital systems like multiplexers and arithmetic circuits. Additionally, the course emphasizes proficiency in 8085 Assembly Language programming for microprocessors, focusing on tasks ranging from basic data manipulation to complex algorithms. By the end, students will be equipped with theoretical knowledge and practical skills essential for careers in electronics and embedded systems.

Course Objectives: This course aims to equip students with a comprehensive understanding of electronics and digital circuits through structured learning objectives. Starting with modulation techniques such as Amplitude Modulation (AM), Frequency Modulation (FM), and pulse modulation methods like Pulse Width Modulation (PWM) and Pulse Code Modulation (PCM), students will gain practical skills in designing and implementing these techniques. The curriculum covers digital electronics fundamentals including logic gates, sequential circuits, and advanced digital systems like multiplexers and arithmetic circuits. Additionally, proficiency in 8085 Assembly Language programming for microprocessors is emphasized, enabling students to perform tasks ranging from basic data manipulation to complex algorithm implementation, preparing them for roles in electronics and embedded systems.

Prerequisites:

- Basic understanding of electrical circuits and components.
- Familiarity with basic electronics principles and theories.
- Knowledge of mathematics including algebra and trigonometry.
- Proficiency in using laboratory equipment such as oscilloscopes and multimeters.
- Understanding of computer programming concepts (for Digital Electronics).
- Prior knowledge of communication systems and modulation techniques.
- Familiarity with programming fundamentals.

Course Outcomes (COs): The students will able to

CO1: Understanding Modulation Techniques.

- **LO1.1:** Analyze and explain the principles of Amplitude Modulation (AM).
- **LO1.2:** Demonstrate the process of Amplitude Demodulation.
- **LO1.3:** Investigate the principles and characteristics of Frequency Modulation (FM).
- **LO1.4:** Perform Frequency Demodulation techniques.

CO2: Pulse Modulation Techniques.

- **LO2.1:** Study Pulse Amplitude Modulation (PAM) and its applications.
- **LO2.2:** Explore Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM).
- **LO2.3:** Understand Pulse Code Modulation (PCM) and its implementation.

CO3: Digital Modulation Techniques.

- **LO3.1:** Investigate Amplitude Shift Keying (ASK), Phase Shift Keying (PSK), and Frequency Shift Keying (FSK).

CO4: Multiplexing Techniques.

- **LO4.1:** Study Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM).

CO5: Logic Gates and Boolean Algebra.

- **LO5.1:** Verify and design basic logic gates (AND, OR, NOT, XOR) using NAND gates.
- **LO5.2:** Convert Boolean expressions into logic gate circuits and implement using ICs.

LO5.3: Design Half Adder and Full Adder circuits.

CO6: Sequential Logic Circuits.

LO6.1: Design Flip-Flop circuits (RS, Clocked RS, D-type) using elementary gates.
LO6.2: Implement counters using D, T, and JK Flip-Flops.
LO6.3: Design and analyze shift registers for serial and parallel data shifting.

CO7: Advanced Digital Circuits.

LO7.1: Implement Multiplexers (4x1, 8x1), Demultiplexers, Decoders (2x4, 3x8), Encoders, and Priority Encoders.
LO7.2: Design and simulate a 4-bit Adder and other arithmetic circuits (half subtractor, full subtractor).
LO7.3: Study clocked D Flip-Flops (FF), T Flip-Flops (FF), JK Flip-Flops (FF) with reset inputs.

CO8: Data Conversion and Counters.

LO8.1: Implement code converters (Binary to Gray and vice versa), magnitude comparators, and ripple counters.

CO9: Proficiency in 8085 Assembly Language Programming.

LO9.1: Write programs to transfer a block of data using 8085 Assembly language and multibyte addition and subtraction programs in 8085 Assembly.
LO9.2: Develop programs to multiply two 8-bit numbers and divide a 16-bit number by an 8-bit number using 8085 Assembly.
LO9.3: Create programs to search for a given number in a list and generate terms of the Fibonacci series.
LO9.4: Implement programs to find minimum, maximum, square root, and sorting algorithms to sort numbers in ascending/descending order using 8085 assembly.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	CO8, LO8.1	CO1, LO1.1, LO1.3, LO5.1	CO2, LO1.4, LO2.1, LO2.2, LO2.3, LO3.1, LO4.1	CO7, LO7.1, CO9, LO9.1, LO9.2, LO9.3, LO9.4		
Conceptual		LO1.2, LO1.5, CO3, LO3.3, LO5.2, LO5.3, LO6.1	LO2.1, LO2.2, LO2.3, LO2.4, LO3.1, LO3.2, LO4.2, LO4.3	LO7.2		
Procedural			LO3.2, LO3.3, CO4, LO4.1, CO6, LO6.2, LO6.3, LO7.3	CO5		

Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

COs\POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	M	M	M	S	M	S
CO2	M	S	S	M	S	M	M	S	M	S
CO3	S	M	S	W	W	M	M	S	W	S
CO4	M	S	S	W	S	M	M	S	W	S
CO5	S	S	S	W	M	W	M	S	W	S
CO6	S	S	S	W	W	M	M	S	W	S
CO7	S	S	S	M	W	M	M	S	M	S
CO8	W	S	S	M	W	M	M	S	M	S
CO9	S	M	S	W	M	W	M	S	W	S

S: Strong, M: Medium, W: Weak

List of Experiments:

A. Communication Electronics Lab:

1. Study of Amplitude Modulation
2. Study of Amplitude Demodulation
3. Study of Frequency Modulation
4. Study of Frequency Demodulation
5. Study of Pulse Amplitude Modulation
6. AM Transmitter/Receiver
7. FM Transmitter/Receiver
8. Study of TDM, FDM
9. Study of Pulse Width Modulation
10. Study of Pulse Position Modulation
11. Study of Pulse Code Modulation
12. Study of Amplitude Shift Keying
13. Study of Phase Shift Keying,
14. Study of Frequency Shift Keying.

B. Digital Electronics Lab:

1. To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. To convert a Boolean expression into logic gate circuit and assemble it using logic gate IC's.
3. Design a Half and Full Adder.
4. Design a Half and Full Subtractor.
5. Design a seven-segment display driver.
6. Design a 4 x 1 Multiplexer using gates.
7. To build a Flip- Flop Circuits using elementary gates. (RS, Clocked RS, D-type).

8. Design a counter using D/T/JK Flip-Flop.
9. Design a shift register and study Serial and parallel shifting of data.
10. Write code to realize basic and derived logic gates.
11. Half adder, Full Adder using basic and derived gates.
12. Half subtractor and Full Subtractor using basic and derived gates.
13. Clocked D FF, T FF and JK FF (with Reset inputs).
14. Multiplexer (4x1, 8x1) and Demultiplexer using logic gates.
15. Decoder (2x4, 3x8), Encoders and Priority Encoders.
16. Design and simulation of a 4-bit Adder.
17. Code converters (Binary to Gray and vice versa).
18. 2-bit Magnitude comparator.
19. 3-bit Ripple counter

C. Microprocessor and Microcontroller Lab:

8085 Assembly language programs:

1. Program to transfer a block of data.
2. Program for multibyte addition
3. Program for multi byte subtraction
4. Program to multiply two 8-bit numbers.
5. Program to divide a 16-bit number by 8-bit number.
6. Program to search a given number in a given list.
7. Program to generate terms of Fibonacci series.
8. Program to find minimum and maximum among N numbers
9. Program to find the square root of an integer.
10. Program to find GCD of two numbers.
11. Program to sort numbers in ascending/descending order.
12. Program to verify the truth table of logic gates.

(Total Practical Classes 60, Total Contact Hours 120, Total Marks 60)

At least five experiments must be performed from each unit.

Mode of In-semester Assessment:

1. Viva-voce: **(20 Marks)**
2. Attendance / Laboratory performance / Notebook: **(20 Marks)**

Mode of End-semester Assessment:

1. Laboratory experiments: **(60 Marks)**
2. Two experiments (not more than one from a single unit) from the list to be performed.
