ELECTRONICS

SYLLABUS

FOUR-YEARS
EIGHT SEMESTERS
B.SC. (HONOURS WITH/WITHOUT RESEARCH)

&

THREE-YEARS
SIX SEMESTERS
B.SC. (MULTIDISCIPLINARY)

COURSES OF STUDIES

UNDER CURRICULUM AND CREDIT FRAMEWORK-2022
(CCF-2022)

UNIVERSITY OF CALCUTTA
2023

Syllabus for the Undergraduate (B.Sc.) Course in Electronics (Major)

The structure of the revised syllabus of Semesters 1 to 6 for the B.Sc. Course in Electronics (Major) is as follows.

Each paper carries 4 Credits, equivalent to 100 marks.

DSCC/CC: Discipline Specific Core Course/Core Course (Major Course)
Minor: Minor Course
SEC: Skill Enhancement Course
IDC: Inter Disciplinary Course
TH: Theory, P: Practical, TU: Tutorial

Semester	Course Code	Paper Code	Paper Name	Credit
Semester – 1	CC-1	ELT-H-CC-1-1	Fundamentals of Circuit Theory and Electronic Devices	3TH+1P
	SEC-1	ELT-H-SEC-1-1	Introduction to Programming in Python	3TH+1P
	IDC-1	***-H-IDC	#	2TH+1P/TU
Semester – 2	CC-2	ELT-H-CC-2-2	Operational Amplifier and Digital Systems	3TH+1P
	SEC-2	ELT-H-SEC-2-2	Artificial Intelligence for Everyone	3TH+1TU
	IDC-2	***-H-IDC	#	2TH+1P/TU
Semester – 3	CC-3	ELT-H-CC-3-3	Microprocessor and Microcontroller	3TH+1P
	CC-4	ELT-H-CC-4-3	Mathematical Foundation, Numerical Analysis and Scilab	3TH+1P
	SEC-3	ELT-H-SEC-3-3	Circuit Simulation with PSPICE	3TH+1P
	IDC-3	***-H-IDC	#	2TH+1P/TU
Semester – 4	CC-5	ELT-H-CC-5-4	Electronic Communication	3TH+1P
	CC-6	ELT-H-CC-6-4	Signals and Systems	3TH+1P
	CC-7	ELT-H-CC-7-4	Applied Physics	3TH+1P
	CC-8	ELT-H-CC-8-4	Electromagnetism	3TH+1P
Semester – 5	CC-9	ELT-H-CC-9-5	Electronic Devices and Circuits (CC-9-5)	3TH+1P
	CC-10	ELT-H-CC-10-5	Linear Integrated and Digital Circuits Design	3TH+1P
	CC-11	ELT-H-CC-11-5	Power and Opto Electronic Devices	3TH+1P
	CC-12	ELT-H-CC-12-5	C Programming and Data Structures	3TH+1P
Semester – 6	CC-13	ELT-H-CC-13-6	Transmission lines, Antenna and Microwave Devices	3TH+1P
	CC-14	ELT-H-CC-14-6	Electronic Instrumentation and Control Systems	3TH+1P
	CC-15	ELT-H-CC-15-6	VLSI Basics and VHDL	3TH+1P

Note:

An Electronics Major student has to study 3 Inter Disciplinary Courses (IDCs) in the first three Semesters 1, 2 and 3 choosing 1 each from the subjects other than Electronics Major and other two Minor subjects.

A Major student of other subjects (other than Electronics) can opt for Electronics IDC (ELT-H-IDC) in any one of the first three Semesters 1, 2, and 3.

SEMESTER-1

CC-1: Fundamentals of Circuit Theory and Electronic Devices
[Credits: 4 (3TH+1P)]

ELT-H-CC-1-1-TH
Course Name: Fundamentals of Circuit Theory and Electronic Devices
[Credits: 3; Lecture Hours: 45]

UNIT-I [12 Lecture Hours]
Electric Circuit Elements: Resistance and Resistors: Types, Color Coding and Power Rating, Variable Resistors, Capacitance and Capacitors: Types, Color Coding and Voltage Rating, Inductance and Inductors: Types, Color Coding, Inductor Coils, Air-core and Iron-core Coils, Self-inductance and Mutual-inductance, Transformers.
Circuit Analysis: Concept of Voltage and Current Sources, Conservations of Flux Leakage associated with Inductors and Charge associated with Capacitors, Kirchhoff's Voltage Law, Kirchhoff's Current Law, Transformation of Voltage and Current Sources, Mesh Analysis and Node Analysis, Star-Delta Networks and Conversion.
DC Analysis: Transient Responses of Series RL and RC Circuits under DC Excitation.
AC Analysis: Responses of Circuit Parameters, Frequency Response of Series RL, RC and RLC Circuits under AC Excitation, Quality (Q) Facor of Inductor and Capacitor, Series and Parallel Resonance Circuits, Q-Factor.
Network Therems: Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, and Maximum Power Transfer Theorem.

UNIT-II [11 Lecture Hours]
Semiconductor Basics: Semiconductor Materials: Types and Properties, Concept of Energy Bands in Solids: Metal, Insulator and Semiconductor, Intrinsic and Extrinsic Semiconductors, P-Type and N-Type Semiconductors, Energy Band Diagram, Concept of: Effective Mass, Direct and Indirect Bandgap Semiconductors, Fermi Level, Density of States, Mechanism of Current Conduction in Semiconductors (Drift and Diffusion), Drift Velocity, Mobility, Resitivity, Conductivity, Hall Effect (No derivation).
Junction Diode and Its Applications: PN Junction: Wafer Level Structure, Energy Band Diagram, Depletion Layer, Diode Equation and I-V Characteristics, Ideal Diode, Static and Dynamic Resistance, Reverse Saturation Current, Zener and Avalanche Breakdown, Zener Diode, Zener Diode as Voltage Regulator, Rectifiers: Half Wave Rectifier, Full Wave Rectifiers (Center tapped and Bridge), Peak Inverse Voltage, Ripple Factor, Efficiency, Line Regulation, Load Regulation, Transformer Utilization Factor, Shunt Capacitor Filter, Concept of Bleeder Resistor.

UNIT-III [11 Lecture Hours]
Bipolar Junction Transistor: Wafer Level Structure and Brief Manufacturing Techniques (Growth, Alloy or Fused, Diffusion, Epitaxy), Energy Band Diagram, Doping Profile, PNP and NPN Transistors, Common Base (CB), Common Emitter (CE) and Common Collector (CC) Configurations, Working Principle, Emitter (Injection) Efficiency, Base Transportation Factor, Current Components in BJT, Current Gains: α, β and γ, Input and Output Characteristics in CB, CE and CC Modes, Early Effect and Voltage, Leakage Currents.
Transistor Biasing: Need for Biasing and Bias Stabilization, Load Line and Q-Point, Stability and Stability Factor, Thermal Runaway, Fixed Bias, Collector to Base Bias, Voltage Divider Bias and Emitter Bias.

UNIT-IV [11 Lecture Hours]
BJT Amplifiers: r_e-model and h-Parameter Equivalent Circuit of BJT, Small Signal Analysis of Single Stage CE Amplifier, Frequency Response, Input and Output Impedances, Current, Voltage and Power Gains, Concept of Class A, B, AB and C Amplifiers.

Field Effect Transistor: Junction FET, Formation of Channel and Operating Principle, Pinch Off and Saturation Voltages and Currents, Drain and Transfer Characteristics of N-Channel JFET, FET Parameters, Small Signal Equivalent Circuits of JFET in Common Source (CS), Common Drain (CD) Configurations, Voltage Gain, Input and Output Imedances of CS FET Amilifier, Normally-Off and Normally-On MESFET.

ELT-H-CC-1-1-P
Course Name: Fundamentals of Circuit Theory and Electronic Devices Lab
[Credit: 1; Contact Hours: 30]

1. To Familiarize with Basic Electronic Components (R, C, L, Diodes, Transistors), Digital Multimeter, Function Generator and Oscilloscope.
2. Verification of (a) Thevenin's Theorem and (b) Norton's Theorem.
3. Verification of (a) Superposition Theorem and (b) Maximum Power Transfer Theorem.
4. Study of the I-V Characteristics of (a) P-N Junction Diode and (b) Zener Diode.
5. Study of (a) Half Wave Rrectifier and (b) Full Wave Rrectifier (FWR) without and with Capacitor Filter.
6. Study of Zener Diode as Voltage Regulator and its Load Regulation.
7. Study of the I-V Characteristics of the Common Emitter Configuration of BJT
8. Study of the I-V Characteristics of the Common Base Configuration of BJT
9. Study of the I-V Characteristics of JFET.

Reference Books:

- Nasar, Electric Circuits, Schaum's Solved Problems Series, Tata McGraw Hill.
- Nahvi and Edminister, Electric Circuits, Schaum's Outline Series, Tata McGraw Hill.
- Boylestad, Essentials of Circuit Analysis, Pearson.
- Chattopadhyay and Rakshit, Fundamentals of Electric Circuit Theory, S. Chand.
- Hyat, Kemmerly and Durbin, Engineering Circuit Analysis, Tata McGraw Hill.
- Sadiku, Musa and Alexander, Applied Circuit Analysis, Tata McGraw-Hill.
- Bel, Electric Circuits, Oxford.
- Kuo, Network Analysis and Synthesis, Wiley.
- DeCarlo and Lin, Linear Circuit Analysis, Oxford.
- Ghosh, Network Theory: Analysis and Synthesis, PHI.
- Smith and Alley, Electrical Circuits: An Introduction, Cambridge.
- Ryder, Network, Lines and Fields, Pearson.
- Boylestead and Nashelsky, Electronic Devices and Circuit Theory, Pearson.
- Bell, Electronic Devices and Circuits, Oxford.
- Chattopadhyay and Rakshit, Electronics: Fundamentals and Applications, New Age.
- Sedra, Smith and Chandorkar, Microelectronic Circuits, Oxford.
- Millman and Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, Tata McGraw Hill.
- Cathey, 2000 Solved Problems in Electronics, Schaum's Outline Series, Tata McGraw Hill.
- Mottershead, Electronic Devices and Circuits: An Introduction, PHI.
- Dutta, Semiconductor Devices and Circuits, Oxford.
- Rashid, Electronic Devices and Circuits, Cengage.

Practical:

- Basic Electronics: A Text Lab Manual, Zbar, TMH
- Laboratory Manual for Electronic Devices and Circuits, Bell, PHI.
- Advanced Practical Physics, Volume II, B. Ghosh,New Central Book Agency.

SEC-1: Introduction to Programming in Python
[Credits: 4 (3TH+1P)]

ELT-H-SEC-1-1-TH
Course Name: Introduction to Programming in Python
[Credits:3; Lecture Hours: 45]

UNIT-I [15 Lecture Hours]
Python Installation, PIP Package Manager, Concept of Installing Python in a Virtual Environment, Executing Python Source File from Command Line, Examples of Python IDEs and Code Editors.
Python Syntax, Code Indentation, Identifiers and Keywords, Variables, Strings, Literals, Data Types, type() Function, Type Casting, Operators (Arithmetic Operator, Relational Operator, Logical or Boolean Operator, Assignment, Operator, Ternary Operator, Bit Wise Operator) and Expressions, Operator Precedence and Associativity, Reading Input from and Printing Output to Console.
Brief Idea and Use of Python Libraries Like NumPy, SciPy, Matplotlib, Pandas and Skikit-learn.

UNIT-II [15 Lecture Hours]
Python Strings: String Methods and Operations, Use of Escape Characters in String.
Python Collections: Lists, List Items, List Constructor, List Operations, Tuples, Tuple Items, Tuple Constructor, Tuple Operations, Sets, Set Items, Set Constructor, Set Operations, Dictionaries, Dictionary Items, Dictionary Constructor, Dictionary Operations.
Branching and Looping Constructs, if, if-else, if-elif Statements, while loop and for loop, Continue and Break Statements, Range Function, Pass Statement, Nested Loops.
User Defined Functions, def Keyword, Calling a Function, Function Arguments, Arbitrary Arguments, Keyword Arguments, Return Statement, Recursive Functions., built-in Functions: Built-in Math Functions in Python.

UNIT-III [15 Lecture Hours]
Python Modules, Creating and Importing Modules, Built-in Modules, Datetime Module.
File I/O: Reading from, writing to, creating and deleting a file in Python.
OOP Concepts in Python: Creating Classes and Objects, init_() Function, Concept of Inheritance, Parent and Child Classes, super() Method, Concept of Polymorphism.
Exception Handling in Python: try, except, else and finally Blocks, Raising an Exception.

ELT-H-SEC-1-1-P
Course Name: Introduction to Programming in Python Lab
[Credit: 1; Contact Hours: 30]

1. Generate and print Fibonacci Numbers, starting from 0 to N (the number N being read from the keyboard). Also calculate and print the number of elements in the series.
2. Generate and print Prime numbers up to an Integer N (N being read from the keyboard). Also obtain and print the sum of these numbers.
3. Find the Highest Common Factor of two Integer numbers read from the keyboard. Print the result.
4. Calculate and print the Factorial of a given number read from the keyboard.
5. Find and print all the two real roots of a Quadratic equation Ax2 + Bx + C = 0 (coefficients A, B and C are to be read from the keyboard) using the pertinent formula. Print a relevant message if an exception occurs.
6. Calculate and print the values of sin(x) and cos(x) using their respective Power Series representations. Also compare the values with those obtained using the corresponding Math library functions in Python.
7. Read in elements of a List of integer numbers from the keyboard. Find and print all the numbers in the list which are less than a given number N (N to be read from the keyboard).

8. Read strings as elements of a List from the keyboard. Sort the list. Change an item, add an item, and remove an item from the list. Print the list before sorting, after sorting, and also after making each change. Repeat the problem with integers instead of strings.
9. Create a Tuple constructor with strings and integers as items. The items are to be read from the keyboard. Unpack the items from the tuple to corresponding variables. Print the value of the variables.
10. Create one or more sets of items whose values are read from the keyboard. Make use of Set related methods copy(), difference(), difference_update(), intersection(), intersection_update(), union(), update(). Print the set(s) before and after invoking the methods.
11. Create a dictionary where the keys are numbers between 1 and N (keys and N to be read from the keyboard) and the values are square of keys. Copy the dictionary to another using the copy() and dict() methods. Print both the dictionaries.
12. Program making using of inheritance and polymorphism in Python.

Reference Books:

- Think Python, Allen Downey, O'Reilly.
- Introduction to Problem Solving with Python, E. Balaguruswamy, TMH.
- Learning Python, Mark Lutz, O'Reilly.
- Python Programming for the Absolute Beginner, Michael Dawson, Cengage Learning.
- Introduction to Computation and Programming Using Python, John V. Guttag, MIT Press.
- Scientific Computing in Python, Abhijit Kar Gupta, Techno World.

SEMESTER-2

CC-2: Operational Amplifier and Digital Systems
[Credits: 4 (3TH+1P)]

ELT-H-2-2-TH
Course Name: Operational Amplifier and Digital Systems
[Credits: 3; Lecture Hours: 45]

Unit-I [11 Lecture Hours]
Operational Amplifiers: Characteristics of Ideal and Practical Op-Amp, Open and Closed Loop Configuration, Frequency Response, Concept of Offset Voltage and Current, Bias Current, CMRR, PSRR, Slew Rate.
Applications of Op-Amps: Inverting and Non-Inverting Amplifiers, Concept of Virtual Ground, Summing and Difference Amplifiers, Differentiator, Integrator, Multiplier and Divider, Logarithmic and Anti-logarithmic Amplifiers, Voltage to Current and Current to Voltage Converters, Comparator and Zero-Crossing Detector, Schmitt Trigger.

Unit-II [12 Lecture Hours]
Number System and Codes: Weighted and Non-Weighted Codes, Decimal, Binary, Octal and Hexadecimal Number Systems, Base Conversions, 1's and 2's Complements, Representation of Signed and Unsigned Numbers, Binary Codes (BCD, 8-4-2-1, Excees-3, Gray Codes), Alphanumeric Codes, ASCII, EBCDIC, Fixed and Floating Point Arithmetic, Binary and Hexadecimal Arithmetic, Addition, Subtraction by 2's Complement Method, BCD Addition, Parity Bits, Error Detecting and Correcting Code (Hamming).
Boolean Algebra and Logic Gates: Positive and Negative Logic, Basic Postulates and Fundamental Theorems of Boolean Algebra, De Morgan's Theorems, Logic Symbol and Truth Tables of Basic Logic Gates (AND, OR, NOT), Derived Logic Gates (NAND, NOR, XOR and XNOR), Universal Property of NOR and NAND gates.
Digital Logic Families: Characteristics of Logic Families (TTL and CMOS), Fan-in, Fan-out, Noise Immunity, Noise Margin, Power dissipation, Figure of Merit, Speed Power Product, Propagation Delay, Comparison of TTL and CMOS Families.
Combinational Logic Analysis: Standard Representation of Logic Functions (SOP and POS), Karnaugh Map Minimization (up to 4 Variables).

Unit-III [11 Lecture Hours]
Combinational Circuits Design: Half and Full Adder, Half and Full Subtractor, 4-Bit Binary Adder and Subtractor, Multiplexers, Demultiplexers, Encoder, Decoder, Code Converters.
D-A and A-D Conversion: 4-Bit Binary Weighted and R-2R D-A Converter, Circuit and Working, Accuracy and Resolution, A-D Conversion Characteristics, Successive Approximation ADC. (Mention of relevant ICs for all).

Unit-IV [11 Lecture Hours]
Sequential Circuits: Latches, Flip Flops (SR, JK, D and T), Truth Table, Excitation Table and Excitation Equation, Clocked (Level and Edge Triggered) Flip Flops, Preset and Clear Operations, Race Around Conditions in JK Flip Flop, Master-Slave JK Flip Flop.
Shift Registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (up to 4 Bits).
Counters (4 bits): Ripple, Ring, Johnson, Synchronous, Asynchronous, Decade and Modulo-N Counters (Asynchronous only).

ELT-H-2-2-P
Course Name: Operational Amplifier and Digital Systems Lab
[Credit: 1; Contact Hours: 30]

1. To Design Inverting and Non-Inverting Amplifiers using Op-Amp (741/351) for DC Voltage of given Gain.
2. To Add two DC Voltages using Op-Amp in Inverting and Non-Inverting Mode.
3. To Design Differentiator and Integrator Circuit using Op-Amp (741/351).
4. To Design Comparator and Schmitt Trigger Circuit using OPAMP.
5. To Verify and Design AND, OR, NOT and XOR Gates using NAND Gates.
6. To Convert Boolean Expression into Logic Circuit and Design it using Logic Gate ICs.
7. To Design Half Adder and Full Adder.
8. To Design Half Subtractor and Full Subtractor.
9. To Design 4-Bit Binary Adder and Adder-Subtractor using Full Adder IC 7483.
10. To Design 4×1 Multiplexer using Logic Gates.
11. To Design RS, D and JK Master-Slave Flip Flops using NAND Gates.
12. To Construction of 4-Bit Shift Registers (Serial and Parallel) using JK/D Type FF.
13. To Design Ripple Counter.

Reference Books:

- Gayakwad, Op-Amps and Linear Integrated Circuits, Pearson.
- Coughlin and Driscoll, Operational Amplifiers and Linear Integrated Circuits, Pearson.
- Malvino, Electronic Principals, Tata McGraw-Hill.
- Kishore, Operational Amplifiers and Linear Integrated Circuits, Pearson.
- Bel, Operational Amplifiers and Linear Ics, Oxford.
- Jacob, Analog Integrated Circuits Applications, Pearson.
- Fiore, Op-Amps and Linear Integrated Circuits: Concepts and Applications, Cengage.
- Ganesh Babu, Linear Integrated Circuits and Applications, Scitech.
- Tokheim, Digital Principles, Schaum's Outline Series, Tata McGraw Hill.
- Flyod, Digital Fundamentals, Pearson.
- Raychaudhuri, Digital Circuits, Vol. 1&2, Platinum.
- Gothmann, Digital Electronics: An Introduction to Theory and Practice, PHI.
- Kumar, Fundamentals of Digital Circuits, PHI.
- Dueck, Digital Design, Cengage.
- Comer, Digital Logic and State Machine Design, Oxford.
- Salivahanan and Kumar, Digital Circuits and Design, Vikas.
- Fletcher, An Engineering Approach to Digital Design, Pearson.
- Wakerly, Digital Design: Principles and Practices, Pearson.

Practical:

- Practical Physics, Rakshit and Chattopadhyay.
- Advanced Practical Physics, Volume II, B. Ghosh, New Central Book Agency.
- Laboratory Manual for Electric Circuits, Bell, Oxford.

SEC-2: Artificial Intelligence for Everyone
[Credits: 4 (3TH+1TU)]

ELT-H-SEC-2-2
Course Name: Artificial Intelligence for Everyone
[Credits:3; Lecture Hours: 45]
[Credits: 4 (3TH + 1TU); Lecture Hours: 45TH + 15TU]

Unit-1: Introduction to Artificial Intelligence (8 Lecture Hours)
- Definition and scope of AI.
- Historical overview and key milestones.
- Differentiating AI from human intelligence.

Unit-2: AI Subfields and Technologies (9 Lecture Hours)
- Machine learning: Supervised, unsupervised, and reinforcement learning.
- Deep learning and neural networks.
- Natural language processing (NLP) and computer vision.

Unit 3: Applications of AI (12 Lecture Hours)
- AI in healthcare: Diagnosis, treatment, and medical imaging.
- AI in finance: Fraud detection, algorithmic trading, and risk assessment.
- AI in transportation: Autonomous vehicles and traffic optimization.
- AI in customer service and chatbots.
- AI in education: Personalized learning and intelligent tutoring systems.

Unit 4: Ethical and Social Implications of AI (8 Lecture Hours)
- Bias and fairness in AI systems.
- Privacy and data protection concerns.
- Impact of AI on employment and the workforce.
- AI and social inequality.

Unit 5: Other Important Issues (8 Lecture Hours)
- Ethical guidelines and responsible AI practices.
- AI and Innovation.
- Emerging trends and future directions in AI.
- AI and creativity: Generative models and artistic applications.

Reference Book:

- Russell/Norvig , Artificial Intelligence: A Modern Approach, 4th Edition , Pearson Education, 2022.

SEMESTER-3

CC-3: Microprocessor and Microcontroller
[Credits: 4 (3TH+1P)]

ELT-H-CC-3-3-TH
Course Name: Microprocessor and Microcontroller
[Credits: 3; Lecture Hours: 45]

Unit-I [11 Lecture Hours]
Introduction to Microprocessors: History of Microprocessors, Applications, Speed, Word Size, Memory Capacity, Classification of Microprocessors (Mention of Different Microprocessors being used), Microcomputer, Basic Block Diagram of Microcomputer, CPU, ALU, Control Unit, Buses, Memory, Input/Output.
8085 Microprocessor: Features, Architecture, Functional Block Diagram, General Purpose Registers, Register Pairs, Flags, Special Purpose Resisters, Stack Pointer, Program Counter, Types of Buses, Multiplexed Address Bus and Data Bus, Generation of Control Signals, Pin-out Diagram and Pin Description, Basic Memory and I/O Interfacing Concepts, Memory Mapped I/O and I/O Mapped I/O, Partial and Full Address Decoding.

Unit-II [14 Lecture Hours]
8085 Instructions and Programming: Operation Codes, Operands and Mnemonics, Instruction Set, Addressing Modes, Instruction Format, Instruction Classification, Data Transfer Instructions, Arithmetic Instructions, Increment and Decrement Instructions, Logical Instructions, Branch Instructions and Machine Control Instructions, Stack Operations, PUSH and PULL Instructions, Subroutine, Call and Return Instructions, Program Status Word (PSW), Delay Loops, Use of Counters, Instruction Cycle, Machine Cycle, Timing Diagrams, T-States, Op-Code Fetch, Memory Read, Memory Write, I/O Read and I/O Write, Examples of Timing Diagrams for Selective Instructions MVI and STA,Assembly Language Programming and Examples.
8085 Interrupts and Interfacing: Interrupt Structure, EI and DI Instructions, INTR and $\overline{\text{INTA}}$ Signals, Handling Multiple Interrupts using Priority Encoder, RST Instructions, Maskable and Non-Maskable Interrupts, Vectored Interrupts (TRAP, RST 7.5, 6.5 and 5.5) Non-Vectored Interrupts, SIM and RIM Instructions, Latency Time and Response Time, Direct Memory Access (DMA), HOLD and HLDA Signals, Interfacing with Analog to Digital Converter (ADC) IC 0801/0808, Interfacing using General Purpose Programmable Peripheral Interface (PPI)IC 8255, Block Diagram, Pins, Control Word, Different Modes of Operation, BSR and I/O Modes, Illustration of Application of 'Mode 0'.

Unit-III [10 Lecture Hours]
Introduction to Microcontroller: Definition and Use of Microcontroller, Difference with Microprocessor,Types of Microcontrollers, Embedded Microcontrollers, Microcontroller Architectures, Internal Block Diagram, Key Features, Pin Diagram, CISC vs. RISC Architectures, Microcontroller Memory Types, Microcontroller Features, Clocking, I/O Pins, Interrupts, Timers, Peripherals.
8051 Programming: 8051 Addressing Modes and Accessing Memory Locations using Various Addressing Modes, Assembly Language Instructions using Addressing Mode, Arithmetic and Logic Instructions, 8051 Assembly Language Programming Examples, I/O Port Programming in 8051 (using Assembly Language).

Unit-IV [10 Lecture Hours]
Introduction to Arduino Uno: Functional Block Diagram of Arduino Uno Board, ATmega328P: Microcontroller inside Arduino Uno, Functions of different Pins of Arduino Uno, Other Arduino Development Boards, Arduino IDE, Serial Monitor , Arduino Sketch, Variables, setup Function, I/O Functions: pinMode(), digitalRead(), digitalWrite(), analogRead(), analogWrite(), delay()

Function, Looping Techniques, Decision Making Techniques, Designing of 1st Sketch, Arduino In-System-Programmer (ISP), Serial Port Communication with PC, Basic Interfacing and I/O Concept, Interfacing LED and Switch, Interfacing with Temperature Sensor LM35.

ELT-H-CC-3-3-P
Course Name: Microprocessor and Microcontroller Lab
[Credit: 1; Lecture Hours: 30]

Section-A: 8085 Microprocessor Assembly Language Programming

1. Program to Transfer a Block of Data.
2. Program for Addition and Subtraction of Numbers using Direct Addressing Mode.
1. Program for Addition and Subtraction of Numbers using Indirect Addressing Mode.
3. Program to Multiply Two 8-Bit Numbersusing Repeated Addition Algorithm.
4. Program to Divide Two 8-Bit Numbersusing Repeated Subtraction Algorithm.
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 Find Number of Zeroes and Ones in an 8-Bit Number.
8. Program to Find Whether an 8-Bit Number is Even or Odd.
9. Use of CALL and RETURN Instruction.
10. Program to Implement a Subroutine Operation.
11. Program to Implement a Stack Operation.
12. Program to Generate Fibonacci Series.
13. Program to Find Minimum and Maximum among N Numbers.
14. Program to Find Square Root of an Integer.
15. Program to Find GCD of Two Numbers.
16. Program to Sort Numbers in Ascending/Descending Order.
17. Program to Verify the Truth Table of Logic Gates.

Section-B: 8051 Microcontroller Assembly Language and Arduino Programming

1. Program to Find Whether the Numbers are Prime or Not.
2. Program to Find Factorial of a Number.
3. Program to Find (a) Largest of N Numbers and (b) Smallest of N Numbers.
4. Program to Arrange Numbers in Ascending/Descending Order.
5. Write and Execute a Sketch in Arduino Uno IDE to Blink an LED.
6. Write and Execute a Sketch in Arduino Uno IDE to Interface a Switch to Turn an LED On and Off.
7. Write and Execute a Sketch in Arduino Uno IDE to Interface with Ttemperature Controller IC LM35 to Monitor Temperature.

Reference Books:

- Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085, Penram.
- B. Ram, Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai.
- Mazidi, McKinlay, Mazidi and Das, Microprocessors and Microcontrollers, Pearson.
- Mathur and Panda, Microprocessors and Microcontrollers, PHI.
- Krishna Kant, Microprocessors and Microcontrollers: Architecture, Programming and System Design, PHI.
- Kumar, Saravanan, and Jeevananthan, Microprocessors and Microcontrollers, Oxford.
- Shah, 8051 Microcontrollers: MCS 51 Family and its Variants, Oxford.
- Ashwin Pajankar,ARDUINO Made Simple, BPB Publications.

CC-4: Mathematical Foundation, Numerical Analysis and Scilab
[Credits: 4 (3TH+1P)]

ELT-H-CC-4-3-TH
Course Name: Mathematical Foundation, Numerical Analysis and Scilab
[Credits: 3; Lecture Hours: 45]

UNIT-I [8 Lecture Hours]
Vector Analysis: Scalar and Vector Fields, Gradient of a Scalar, Divergence and Curl of a Vector Field, del and Laplacian Operators, Gauss' Divergence, Stokes and Green's Theorems with Simple Applications.
Matrices: Eigenvalues and Eigenvectors, Solving System of Linear Algebraic Equations, Gaussian Elimination Method.

UNIT-II [15 Lecture Hours]
Ordinary Differential Equations: First Order Ordinary Differential Equations, Separable Ordinary Differential Equations, Exact Ordinary Differential Equations and Integrating Factors, Linear Ordinary Differential Equations, Second Order Linear Homogeneous and Inhomogeneous Differential Equations with Constant and Variable Coefficients, Series Solution of Differential Equations, Frobenius Method.
Partial Differentiation Equations: Functions of Several Variables: Limit and Continuity, Partial Differentiation, Variable Treated as Constant, Total Derivative, Partial Differentiation of Composite Functions: Change of Variables, Solution of PDE by Method of Separation of Variables.

Unit-III: [15 Lecture Hours]
Approximations and Errors in Numerical Analysis: Fixed and Floating-Point Representation, Round-Off Errors, Truncation Errors, Absolute and Relative Errors, Error Propagation.
Finding a Root of an Algebraic or Transcendental Equation: Bisection and Newton-Raphson Methods.
Interpolation and Curve-Fitting: Lagrange Interpolation, Newton's Divided Difference Interpolation, Newton's Forward and Backward Interpolation Formula, Divide Difference Tables, Linear Least Squares Fitting.
Numerical Differentiation and Integration: Forward, Backward and Central Difference Formula for Differentiation, Difference Tables, Trapezoidal Rule and Simpson's Composite 1/3 Formula for Numerical Differentiation, Numerical Solution of Ordinary Differential Equation: Euler Method (First Order), Runge Kutta Method(SecondOrder).

Unit-IV: [7 Lecture Hours]
Scilab Fundamentals: Scilab Environment and Console, SciNotes, Scilab Script, Variables, Functions, Vectors and Matrices, Loops, 2D and 3DPlotting.

ELT-H-CC-4-3-P
Course Name: Mathematical Foundation, Numerical Analysis and Scilab Lab
[Credit: 1; Contact Hours: 30]

Implementation with SciLab/MATLAB/Any Other Simulation Software
1. To SolveFirst-Order Ordinary Differential Equation with given Initial Values.
2. To SolveSecond-Order Ordinary Differential Equation with given Initial Values.
3. To Solve an Algebraic or Transcendental Non-Linear Equation using Bisection Method.
4. To Solve an Algebraic or Transcendental Non-Linear Equation using Newton-Raphson's Method.
5. To Implement Lagrange's Interpolation.
6. To Implement Newton's Divided Difference Interpolation.

7. To Integrate a given Function $f(x)$ within limits x_1 to x_2 using Simpson's Composite 1/3 Method.
8. To Find the Derivatives of a Function given in the form of $x_i - f(x_i)$ Tabulated Data using Difference Formulae.
9. To Solve a given First-Order Ordinary Differential Equation using Euler Method.
10. To Solve a System of Linear Algebraic Equations using Gauss Elimination.

Reference Books:

- Kreyszig, Advanced Engineering Mathematics, Wiley.
- Spiegel, Lipschutz, Schiller and Spellman, Schaum,s Outline of Complex Variables, Schaum Outline Series, Tata McGraw Hill.
- Ramana, Higher Engineering Mathematics, Tata McGraw Hill.
- Pal and Bhunia, Engineering Mathematics, Oxford.
- Garg and Gupta, Engineering Mathematics Volume I & II, Pearson.
- Dass and Verma, Higher Engineering Mathematics, S. Chand.
- John Bird, Engineering Mathematics, Elsevier-Newnes.

SEC-3: Circuit Simulation with PSPICE
[Credits: 4 (3TH+1P)]

ELT-H-SEC-3-3
Course Name: Circuit Simulation with PSPICE
[Credits:3; Lecture Hours: 45]

UNIT-I [12 Lecture Hours]

Introduction to PSpice Software: Introduction, Descriptions of Spice, Types of Spice, File Types, PSpice Platform (PSpice A/D, PSpice Schematics, OrCAD Capture), Limitations of PSpice.

Circuit Descriptions: Input Files, Element Values, Nodes, Circuit Elements, Sources, Types of Analysis, Output Variables, PSpice Output Commands, Format of Circuit Files, Format of Output Files.

DC Operation and Circuit Analysis: Modeling of Elements, Operating Temperature, Independent DC Sources, Dependent Sources, DC Output Variables, Passive Devices, Component Names, Ohm's Law, Kirchhoff's Laws, Capacitors in DC Circuits , Inductors in DC Circuits, Types of Output (.PRINT, .PLOT, .PROBE, .WIDTH) Statements and Significances, Types of DC Analysis (.OP, .TF, .DC, .PARAM) Commands and Their Uses.

UNIT-II [9 Lecture Hours]

Transient Analysis: Capacitors and Inductors, Modeling of Transient Sources (Exponential Source, Pulse Source, Piecewise Linear Source, Sinusoidal Source), Independent Voltage Source, Independent Current Source, Transient Response (.IC, .TRAN) Commands and Their Uses.

AC Circuit Analysis: AC Output Variables, Independent AC Sources, AC Analysis, Magnetic Elements.

UNIT-III [15 Lecture Hours]

Semiconductor Diodes: Diode Element Description, Diode Model Description, Diode Parameters, Zener Diode Modeling, Diode Characteristics (Forward Bias, Reverse Bias, and Breakdown Region), DC Analysis and Small Signal AC Analysis of Diode Circuits, Half-Wave Rectifier Circuit.

Bipolar Junction Transistors: BJT Element Description, BJT Model Description, BJT Statements, BJT Parameters, NPN Transistor Operation, Analysis of Transistor Circuits at DC, Different Modes of Operation of Transistors, Small-Signal Model of BJT Amplifiers, DC Bias Sensitivity Analysis (Sensitivity to Component Variation and Temperature Variation).

UNIT-IV [9 Lecture Hours]

Field Effect Transistors: Introduction to MOSFETs, MOSFET Parameters, MOSFET Element Description, MOSFET Model Description, Enhancement Mode N-Channel MOSFET Circuit, I-V Characteristics of MOSFET, Analysis of MOSFET Circuits at DC (Enhancement Mode and Depletion Mode, N-Channel and P-Channel).

ELT-H-SEC-3-P

Course Name: Circuit Simulation with PSPICE Lab

[Credit: 1; Contact Hours: 30]

1. Verification of Kirchhoff's Voltage Law and Current Law.
2. Mesh and Node Analysis of Circuits using DC Sources.
3. Transient Analysis of RC, RL Circuits using Step Input.
4. AC Analysis of Series and Parallel RLC Circuits using Sinusoidal Input.
5. I-V Characteristics of P-N Junction Diode Operated in Forward Biased Mode.
6. I-V Characteristics of Zener Diode Operated in Reverse Biased Mode.
7. Input and Output Characteristics of NPN Transistor.
8. Analysis of BJT CE Amplifier.
9. Analysis of the I-V Characteristics of Enhancement Mode N-Channel MOSFET.
10. Analysis of the I-V Characteristics of Depletion Mode N-Channel MOSFET.

Reference Books:

- SPICE: A Guide to Circuit Simulation & Analysis using PSPICE, Paul. W. Tuinenga.
- SPICE, Gordon. W. Roberts and Adel. S. Sedra.
- Introduction to PSPICE Using ORCAD For Circuits and Electronics, Muhammad. H. Rashid.
- Analog Design and Simulation using OrCAD Capture and PSPICE, Dennis Fitzpatrick.

SEMESTER-4

CC-5: Electronic Communication
[Credits: 4 (3TH+1P)]

ELT-H-CC-5-4-TH
Course Name: Electronic Communication
[Credits: 3; Lecture Hours: 45]

Unit-I [12 Lecture Hours]
Introduction to Electronic Communication: Means and Modes, Block Diagram of Electronic Communication System, Electromagnetic Spectrum, IEEE Band Designations and Applications, Brief Idea of Frequency Allocation for Radio Communication System in India (TRAI), Need for Modulation, Concept of Channels and Base-Band Signals, Concept of Bandwidth, Concept of Transmission Modes (Simplex, Half Duplex, Full Duplex).
Noise in Communication Systems: Concept of Noise, Types of Noise, Internal and External Noises, Thermal and White Noise, Signal-to-Noise (S/N) Ratio and Noise Figure, Figure of Merit, Noise Temperature.
Amplitude Modulation: Definition, Mathematical Representation of AM, Time Domain and Frequency Domain (Frequency Spectrum) Representations, Modulation Index and Percentage Modulation, Concept of Under, Over and Critical Modulation, Frequency Spectrum, Sideband Frequencies, Bandwidth Requirements, Power Carried by Carrier and Sidebands, Concept of Multitone Modulating Signals, Generation of AM (Linear and Non Linear Methods), Amplitude Demodulation (Envelope Detector), Double Side Band Suppressed Carrier (DSBSC), Chopper (Ring) and Balanced Modulators, Single Side Band Suppressed Carrier (SSBSC), Phase Shift (Discrimination) Method, Pilot Carrier Amplitude Modulation, Concepts of Vestigial Side Band (VSB) Modulation and Quadrature Amplitude Modulation (QAM), Independent Side Band Modulation, Block Diagram of AM Transmitter and Receiver, Utility of Heterodyning, Super Heterodyning Principle, Super Heterodyne Receiver (SHR), Advantages over Tuned Radio Frequency (TRF) Receiver, Different Blocks of SHR, Intermediate Frequency, Local Oscillator Frequency, Image Frequency.

Unit-II [10 Lecture Hours]
Frequency and Phase Modulation: Definition, Mathematical Representation of FM and PM, Equivalence between FM and PM, Time Domain and Frequency Domain (Frequency Spectrum) Representations, Modulation Index, Bandwidth Requirements, Frequency Deviation, Narrow Band FM (NBFM) and Wide Band FM (WBFM), Carson's Rule, Direct (Varactor Diode) and Indirect (Armstrong) Methods of FM Generation, FM Detection using Slope Detector and PLL Detector**,** Block Diagram of FM Transmitter and Receiver, Comparison between AM, FM and PM.
Analog Pulse Modulation: Channel Capacity, Sampling Theorem, Sampling and Reconstruction of Signals, Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM), Generation and Detection Techniques, Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM).

Unit-III [11 Lecture Hours]
Digital Modulation Techniques: Need for Digital Transmission, Block Diagram of Digital Transmission and Reception, Characteristics of Data Transmission Circuits, Advantages and Disadvantages of Digital Communication, Information Capacity, Shannon Limit for Information Capacity, Bandwidth Requirements, Pulse Code Modulation (PCM), Quantizing, Uniform and Non-Uniform Quantization, Quantization Noise, Companding, Coding, Decoding, Regeneration, Data Transmission Speed (Bit Rate and Baud Rate), Noise, Cross Talk, M-Array Coding, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK).

Unit-IV [12 Lecture Hours]

Radio Wave Propgation: Characteristics of Electromagnetic Wave, Different Modes of Radio Wave Propagation, Ground (Surface) Wave Propagation, Space (Tropospheric) Wave Propagation, Sky (Ionospheric) Wave Propagation, Structure of Atmosphere, Critical Frequency, Maximum Usable Frequency (MUF), Virtual Height, and Skip Distance, Duct Propagation (Qualitative Discussions Only).

Cellular Communication: Concept of Cellular Mobile Communication, Frequency Bands used in Cellular Communication, Concept of Cell Sectoring and Cell Splitting, Absolute RF Channel Numbers (ARFCN), Frequency Reuse, Roaming and Hand Off, Authentication of SIM Card of Subscribers, IMEI Number, Need for Data Encryption, Architecture (Block Diagram) of Cellular Mobile Communication Network, Concept of GSM, CDMA, TDMA and FDMA, Comparison of TDMA and FDMA Technology, Simplified Block Diagram of Cellular Phone Handset, Comparative Study of GSM and CDMA, Qualitative concepts of 2G, 3G, 4G and 5G, Qualitative Idea of GPS Navigation System.

ELT-H-CC-5-4-P
Course Name: Electronic Communication Lab
[Credit: 1; Lecture Hours: 30]

Implementation with Hardware and Circuit Simulation Software

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. Study of Pulse Width Modulation.
7. Study of Pulse Position Modulation.
8. Study of Pulse Code Modulation.
9. Study of Amplitude Shift Keying.
10. Study of Phase Shift Keying.
11. Study of Frequency Shift Keying.

Reference Books:

- Kennedy, Electronic Communication Systems, Tata McGraw Hill.
- Frenzel, Principles of Electronic Communication Systems, Tata McGraw Hill.
- Tomasi, Advanced Electronic Communications Systems, Pearson.
- Roddy and Coolen, Electronic Communications, Pearson.
- Haykin, Communication Systems, Wiley.
- Lathi and Ding, Modern Digital and Analog Communication Systems, Oxford.
- Couch, Digital and Analog Communication Systems, Pearson.
- Kundu, Analog and Digital Communications, Pearson.
- Blake, Electronic Communication Systems, Cengage.
- T. L. Singal, Analog and Digital Communication, Tata McGraw Hill.

CC-6: Signals and Systems
[Credits: 4 (3TH+1P)]

ELT-H-CC-6-4-TH
Course Name: Signals and Systems
[Credits: 3; Lecture Hours: 45]

Unit-I [11 Lecture Hours]
Signals and Systems: Continuous and Discrete Time Signals, Digital Signal, Types of Signals Deterministic and Nondeterministic, Periodic and Aperiodic, Symmetric and Antisymmetric, Energy and Power, Causal, Noncausal and Anticausal, Single and Multiple Valued Signals), Signals in Time, Spatial and Frequency Domain, Transformation of the Independent Variable, Exponential and Sinusoidal Signals, Impulse and Unit Step Functions, Continuous and Discrete Time Systems and their Classifications, Basic System Properties.

Unit-II [11 Lecture Hours]
Linear Time Invariant Systems (LTI): Discrete and Continuous Time LTI Systems, Properties of LTI Systems, Convolution, Commutative, Distributive, Associative, LTI 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 [13 Lecture Hours]
Fourier Series: Fourier Series Representation of Periodic Signals, 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.
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 [10 Lecture Hours]
Z-Transform: Introduction to Z-Transform, Region of Convergence, Properties of Z- ransforms, Inverse Z Transforms, Relation with Laplace and Fourier Transforms, Condition of Stability, Application of Z-Transforms.

ELT-H-CC-6-4-P
Course Name: Signals and Systems Lab
[Credit: 1; Lecture Hours: 30]

Implementation with Scilab/MATLAB/Any Other Simulation Software
1. Generation of Continuous Time Signals.
2. Generation of Discrete Time Signals.
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.

Reference Books:

- Haykin and Veen, Signals and Systems, Wiley.
- Lathi, Principles of Linear Systems and Signals, Oxford.
- Roberts and Sharma, Fundamentals of Signals and Systems, Tata McGraw Hill.

- Oppenheim, Willsky and Hamid, Signals and Systems, Pearson.
- Anand Kumar, Signals and Systems, PHI.
- Rawat, Signals and Systems, Oxford.
- Ramesh Babu and Anandanatarajan, Signals and Systems, Scitech.
- Nagoor Kani, Signals and Systems, Tata McGraw Hill.
- Iyer, Signals and Systems, Cengage.
- Hsu, Signals and Systems, Schaum's Outline Series, Tata McGraw Hill.
- Young, Signals and Systems with MATLAB, Springer.
- Karris, Signals and Systems with MATLAB Computing and Simulink Modelling, Orchard.

CC-7: Applied Physics
[Credits: 4 (3TH+1P)]

ELT-H-CC-7-4-TH
Course Name: Applied Physics
[Credits: 3; Lecture Hours: 45]

UNIT-I [10 Lecture Hours]
Physics of Crystalline Solids: Crystalline Materials, Crystal Structure in Solids, Concept of Lattice and Basis, Crystal Axes and Planes, Primitive and Unit Cells, Packing Fraction for Simple, Body-Cantered and Face-Cantered Cubic Lattices, Calculation of Interplaner Spacing for Cubic Lattice, Miller Indices, Concept of Reciprocal Lattice, Bragg's Equation in Direct and Reciprocal Lattice (no derivation), Bonding in Solids, Basic Ideas of Metallic Bonds, Ionic Bonds, Covalent Bonds, Vander Waal's Bonds.

UNIT-II [14 Lecture Hours]
Quantum Mechanics: Inadequacies of Classical Physics (in Relevance to Electron Diffraction Experiment), Compton's Effect, Photo-Electric Effect, Blackbody Radiation, Wien's Law, Raleigh Jeans Law, Plank's Law, Introduction to Wave Particle Duality, de Broglie's Hypothesis, Heisenberg's Uncertainty Principle, Probability Density and Born Interpretation, Basic Postulates and Formalism of Quantum Mechanics, Wavefunctions, Operators in Quantum Mechanics, Eigenstates, Eigenvalues and Eigenfunctions, Schrodinger Wave Equation, Qualitative Discussion of Phenomenon of Tunnelling, Particle in a One-Dimensional Box, Extension to a Three-Dimensional Box, Potential Barrier Problems (Free Electron, Electron in an Infinite Well), Kronig-Penney Model and Development of Band Structure, E-k Diagram in Solids, Classification of Conductors, Insulators and Semiconductors.

UNIT-III [7 Lecture Hours]
Statistical Mechanics: Macroscopic and Microscopic States, Concept of Phase Space and Density of States, Quantization of Phase Space, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein Distribution Functions and their Importance.

UNIT-IV [14 Lecture Hours]
Electric Properties: Metals (Conductors), Basic Concept of Free Electron Theory, 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, Concept of Superconductivity; Insulators, Dielectric Properties, Concepts of Polarization, Permittivity and Dielectric Constant; Semiconductors, Bonding in Elemental and Compound Semiconductors, Intrinsic and Extrinsic Semiconductor, Concept of Holes, Computation of Carrier Concentrations, Fermi Level in Semiconductors, E-k Diagrams to Explain Direct and Indirect Bandgap Semiconductors.
Magnetic Properties: Classification of Magnetic Materials, Magnetic Moment, Dia, Para, Ferro and Antiferro Magnetism, Ferrimagnetic Materials, Saturation Magnetisation, Curie Temperature.

ELT-A-CC-7-4-P: Applied Physics Lab
[Credit: 01; Contact Hours: 30]

Implementation with Hardware and/or SciLab/MATLAB/Any Circuit Simulation Software

1. To Measure the Resistivity of a Si Crystal with Temperature by Four-Probe Method from Room Temperature to 200 ^{0}C.
2. To Determine the Value of Boltzmann Constant by Studying Forward Characteristics of Diode.
3. To Determine the Value of Planck's Constant by using LEDs of Different Wavelengths.
4. Simulation Studies:
   (a) To Find Lowest Energy Eigenvalues for 1-D Schrodinger Equation.
   (b) To Plot Tunneling Probability as a Function of Barrier Width.
   (c) To Plot Energy Band-Diagram corresponding to Different Potential Profile.

Reference Books:

- Callister and Balasubramaniam, Material Science and Engineering, Wiley.
- Vijaya and Rangarajan, Material Science, Tata McGraw Hill.
- Bransden, Quantum Mechanics, Pearson.
- Griffiths, Introduction to Quantum Mechanics, Pearson.
- Majumdar, Quantum Mechanics in Physics and Chemistry with Applications to Biology, PHI.
- Lokanathan and Gambhir, Statistical and Thermal Physics: An Introduction, PHI.
- Eisberg and Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley.
- Pillai, Solid State Physics, New Age.
- Kasap, Principles of Electronic Materials and Devices, Tata McGraw Hill.
- Roy, Fundamentals of Classical and Statistical Thermodynamics, Wiley.

CC-8: Electromagnetism
[Credits: 4 (3TH+1P)]

ELT-H-CC-8-4-TH
Course Name: Electromagnetism
[Credits: 3; Lecture Hours: 45]

UNIT-I [12 Lecture Hours]

Electrostatics: Coulomb's Law and Electric Field, Field due to Discrete and Continuous Charge Distributions, Electric Flux Density, Gauss's Law and Applications, Electric Potential, Potential due to Point Charge and Charge Distribution, Lines of Force, Divergence and Curl of Electric Field, Electric Fields in Different Materials, Current and Current Density, Electric Dipole, Dipole Field and Potential, Method of Images, Dielectric Materials, Polarization, Dielectric Constant, Linear and NonlinearDielectrics, Homogeneous and InhomogeneousDielectrics, Isotropic and Anisotropic Dielectrics, Boundary Conditions, Poisson's Equation, Laplace's Equation and their Derivations and Examples of Solutions, Uniqueness Theorem, Capacitance and Capacitors, Electrostatic Energy and Forces, Energy Density.

UNIT-II [11 Lecture Hours]

Magnetostatics: Lorentz Force and concept of Magnetic Induction, Biot-Savart's Law and Applications, Magnetic Dipole, Ampere's Circuital Law and Applications, Magnetic Flux and Magnetic Flux Density, Scalar and Vector Magnetic Potentials. Magnetization in Materials and Permeability, Anisotropic Materials, Magnetic Boundary Conditions, Inductors and Inductances, Mutual and Self Inductance, Magnetic Circuits, Magnetic Energy, Forces, Torque and Moment.

UNIT-III [12 Lecture Hours]
Time-Varying Fields and Maxwell's Equations: Faraday's and Lenz's Law of Electromagnetic Induction, Stationary Circuit in Time-Varying Magnetic Field, Transformer and Motional EMF, Concept of Electric Displacement Current, Maxwell's Equations in Integral and Differential Forms and Constitutive Relations, Maxwell's Equations in Matter in terms of free Charges and Currents, Lorentz Gauge, Wave Equation for Potentials and Electromagnetic Field, Energy Density of Field, Electromagnetic Boundary Conditions, Electromagnetic Energy and Power, Poynting Vector, Poynting Theorem and Simple Problems.

UNIT-IV [10 Lecture Hours]
Electromagnetic Waves in Non-conducting and Conducting Media: Plane Waves in Source Free Isotropic Homogeneous Media, Uniform Plane Waves in Lossless and Lossy Unbounded Homogeneous Media, Uniform Plane Waves in Good Dielectrics and Conductors, Reflection and Transmission of Plane Waves at Normal and Oblique Incidence, Snell's Law, Wave Polarization, Fresnel's Equation, Brewster's Angle, Skin Effect and Skin Depth, Concept of Dispersion, Phase and Group Velocity, Normal and Anomalous Dispersion.

ELT-H-CC-8-4-P
Course Name: Electromagnetism Lab
[Credit: 1; Contact Hours: 30]

Implementation with SciLab/MATLAB/Any Other Simulation Software
1. Plots of Electric Field and Electric Potential due to Line, Surface and Volume Charge Densities.
2. Plots of Magnetic Flux Density due to Current Carrying Wire.
3. Programs and Contour Plots to illustrate Method of Images.
4. Solutions of Poisson and Laplace Equations - Contour Plots of Charge and Potential Distributions.
5. Introduction to Computational Electromagnetics - Simple Boundary Value Problems by Finite Difference/Finite Element Methods.
6. Magnetic Field Measurements in a Static Magnetic Circuit.

Reference Books:

- Spiegel, Lipschutz and Spellman, Vector Analysis, Schaum's Outline Series, Tata McGraw Hill.
- Ida, Engineering Electromagnetics, Springer.
- Sadiku, Elements of Electromagnetics, Oxford.
- Rao and Narayanappa, Engineering Electromagnetics, Cengage.
- Hayt, Buck and Akhtar, Engineering Electromagnetics, Tata McGraw Hill.
- Cheng, Field and Wave Electromagnetics, Pearson.
- Edminster, Electromagnetics, Schaum's Outline Series, Tata McGraw Hill.
- Rao, Elements of Engineering Electromagnetics, Pearson.
- Griffiths, Introduction to Electrodynamics, Pearson.
- Jordan and Balmain, Electromagnetic Waves and Radiating Systems, Pearson.

SEMESTER-5

CC-9: Electronic Devices and Circuits
[Credits: 4 (3TH+1P)]

ELT-H-CC-9-5-TH
Course Name: Electronic Devices and Circuits
[Credits: 3; Lecture Hours: 45]

UNIT-I [10 Lecture Hours]
Diode Circuits: Piece-Wise Linear Characteristics of Diode, DC Load Line Analysis, Quiescent (Q) Point, Clippers: Positive Clipper, Negative Clipper, Combinational Clipper, Transfer Characteristics of Clippers, Clampers: Positive Clamper, Negative Clamper, Combinational Clamper, Voltage Doubler and Tripler, Effect of Diode Characteristics on Clamping Voltage, Transfer Characteristics of Clampers, Filters: Types, Circuit Diagram and Explanation with Waveform, Series Inductor, Shunt Capacitor, L-Section, $\boldsymbol{\pi}$-Section and R-C Filter Circuits.

UNIT-II [13 Lecture Hours]
BJT Amplifiers and Multivibrators: Transistor as a Switch, BJT Amplifier, Voltage and Power Amplifiers, Small Signal Low Frequency Analysis of CE, CB and CC (Emitter Follower) AmplifiersUsing h-Parameters, Small Signal Low Frequency and High Frequency Response Analysis of Single Stage CE Amplifiers, Bode Plots, Gain-Bandwidth Product,Emitter Follower at High Frequencies, Cascaded RC Coupled Amplifier and Effects on its Gain and Bandwidth, Darlington and Cascode Amplifiers, Multivibrators: Astable, Bistable and Monostable Multivibrators Using BJT, Working Principle, Wave Forms and Expression for Frequency.
Single Tuned Amplifiers: Circuit Diagram, Working and Frequency Response, Limitations of Single Tuned Amplifier, Applications of Tuned Amplifiers in Communication Circuits.

UNIT-III [11 Lecture Hours]
Feedback Amplifiers: Concept of Feedback, Negative and Positive Feedback, Types of Feedback Circuits, Advantages and Disadvantages of Negative Feedback, Voltage (Series and Shunt) and Current (Series and Shunt) Feedback Amplifiers, Effect of Negative Feedback on Gain, Input and Output Impedances, Bandwidth and Distortion.
Oscillators: Positive Feedback and Principle of Oscillations, Condition for Sustained Oscillation (Barkhausen Criteria), Principal, Working and Frequency Calculation of RF Oscillators (Hartley, Colpitt and Crystal Oscillators) and AF Oscillators (Wien Bridge and Phase-Shift Oscillators).

UNIT-IV [11 Lecture Hours]
Power Amplifiers: Difference between Voltage and Power Amplifier, Classification of Power Amplifiers, Class A, Class B, Class C, Class AB and their Comparisons, Operation of Class A Single Ended Power Amplifier, Operation of Transformer Coupled Class A Power Amplifier, Efficiency, Operation of Complementary Symmetry Class B Push Pull Power Amplifier, Harmonic and Crossover Distortions in Power Amplifiers, Heat Sinks.
MOSFET: MOS Capacitor, Channel Formation, Threshold Voltage (Ideal and Real), Current-Voltage Relation, Depletion and Enhancement Type MOSFET, Biasing of MOSFETs, Small Signal Parameters, Common Source Amplifier Circuit Analysis, Complimentary MOS (CMOS).

ELT-H-CC-9-5-P
Course Name: Electronic Devices and Circuits Lab
[Credit: 1; Lecture Hours: 30]

1. To Study RC Circuit as Differentiator and High Pass Filter.
2. To Study RC Circuit as Integrator and Low Pass Filter.
3. To Study of Clipping and Clamping Circuits.

4. To Design and Study of Frequency Response of Single Stage CE Amplifier.
5. To Study of Colpitt's Oscillator.
6. To Study of Phase Shift Oscillator.
7. To Study of Wien Bridge Oscillator.
8. To Study of Class A and B Push Pull Power Amplifier.
9. To Study of the I-V Characteristics of MOSFET.
10. To Study of Common Source FET Amplifier.

Reference Books:

- Boylestead and Nashelsky, Electronic Devices and Circuit Theory, Pearson.
- Bell, Electronic Devices and Circuits, Oxford.
- Schilling and Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill.
- Neamen, Electronic Circuits: Analysis and Design, Tata McGraw Hill.
- Millman and Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, Tata McGraw Hill.
- Chattopadhyay and Rakshit, Electronics: Fundamentals and Applications, New Age.
- Cathey, 2000 Solved Problems in Electronics, Schaum's Outline Series, Tata McGraw Hill.
- Mottershead, Electronic Devices and Circuits: An Introduction, PHI.
- Sedra and Smith, Microelectronic Circuits, Oxford.
- Rashid, Electronic Devices and Circuits, Cengage.
- Bogart, Beasley and Rico, Electronic Devices and Circuits, Pearson.
- Jyoti Prasad Bandyopadhyay, Solid State Electronics Devices, Vikas.

CC-10: Linear Integrated and Digital Circuits Design
[Credits: 4 (3TH+1P)]

ELT-H-CC-10-5-TH
Course Name: Linear Integrated and Digital Circuits Design
[Credits: 3; Lecture Hours: 45]

Unit-I [11Lecture Hours]

Signal Generators: Concept of Sinusoidal and Relaxation Type, Phase Shift Oscillator, Wien Bridge Oscillator, Square Wave Generator, Triangle Wave Generator, Saw Tooth Wave Generator, Voltage Controlled Oscillator (IC 566).

Timer Circuits: Multivibrators (IC 555), Functional Block Diagram, Astable and Monostable Multivibrator Circuits and Applications, Phase Locked Loops (PLL), Block Diagram, Phase Detectors, IC 565, Voltage Controlled Oscillator (IC 566).

Unit-II [11Lecture Hours]

Fixed and Variable IC Regulators: IC 78xx and IC 79xx (Concepts only), IC LM317, Output Voltage Equation, SMPS, Principle of DC-to-DC Conversion, Block Diagram Representation of SMPS Module.

Signal Conditioning Circuits: Sample and Hold Systems, Active Filters, Butterworth Filter, First and Second Order Low Pass and High Pass Filters, Band Pass Filter, Band Reject Filter, All Pass Filter, Log and Antilog Amplifiers.

Unit-III [14 Lecture Hours]

Combinational Logic Circuits: Use of Multiplexer ICs 74150, 74151, 74153, 74157, Multiplexer Tee, Use of Demultiplexers/Decoders ICs 74138, 74139, 74154, Demultiplexer Tree, 4-Bit Adder IC 7483, Cascading of IC 7483, 2's Complement Adder/Subtracter Using IC 7483, 1-Digit (4-Bit) BCD Adder and Subtractor (9's Complement Method) Using IC 7483, Arithmatic Logic Unit (ALU) IC 74181, Design of 8-Bit Adder/Subtractor Using ALU IC 74181, Look Ahead Carry Generator IC 74182, Use of Comparator IC 7485 and its Cascading, Code Converters, BCD-to-Binary Converter

IC 74184, Binary-to-BCD Converter IC 74185, BCD-to-Decimal Decoder IC 7442, Decimal-to-BCD Encoder IC 74147, BCD-to-7-Segment Decoder/Driver IC 7447, Parity Generators/Checkers IC 74180.
Sequential Logic Circuits: Counters Design Using ICs 7490, 7492, 7493, Up/Down Counters Deign Using ICs 74190, 74192, 74193, Sequence Generators Using ICs 7474, 7476, 74107, Serial-In-Parallel-Out Shift Register IC 74164.
Timing Circuits: One-Shot IC 74121 and Retriggerable One-Shot ICs 74122, 74123.

Unit-IV [9 Lecture Hours]
Programmable Logic Devices: Basic Concepts, ROM, Programming Logic Array (PLA): Block Diagram, Program Table and Implementation, PAL, CPLD, FPGA.
Memory: Memory Technology, Types of Memory, Volatile and Non-Volatile, ROM, PROM, EPROM, EEPROM, Memory Register, Memory Unit, Memory Cell Design, Flash Memory, RAM, SRAM, DRAM, SDRAM, Concept of Primary, Secondary and Cache Memory.

ELT-H-CC-10-5-P
Course Name: Linear Integrated and Digital Circuits Design Lab
[Credits: 1; Lecture Hours: 30]

1. Construction of Square wave generator using 741 Op-Amp.
2. Construction of triangular wave generator using 741 Op-Amp.
3. Construct an astable multivibrator using Timer 555.
4. Construct a monostable multivibrator using Timer 555.
5. Design of active lowpass filter using 741 OPAMP.
6. Design of active highpass filter using 741 OPAMP.
7. Construct an Arithmetic Unit capable of performing 4-bit Subtraction and Addition using 2's complement method. Use Parallel Adders and other necessary Logic Gates.
8. Construct a Logical Unit using Logic Gates capable of performing 4-bit Bitwise OR, AND, XOR and Inversion Operation.
9. Study and Construct a 1-digit BCD/Decimal Adder using Parallel Adders and other necessary Logic Gates.
10. Subtraction with 1's Complement method using Parallel Adders and other necessary Logic Gates.
11. Binary Magnitude Comparators (up to 4-bits) using Parallel Adder and Logic Gates.
12. Construct 4-bit ALU Capable of Performing following Operation:

Selection		Function
S_1	S_0	Y
0	0	Complement
0	1	XOR Opeartion
1	0	Addition
1	1	Subtraction

Reference Books:

- Gayakwad, Op-Amps and Linear Integrated Circuits, Pearson.
- Coughlin and Driscoll, Operational Amplifiers and Linear Integrated Circuits, Pearson.
- Kishore, Operational Amplifiers and Linear Integrated Circuits, Pearson.
- Bel, Operational Amplifiers and Linear Ics, Oxford.
- Jacob, Analog Integrated Circuits Applications, Pearson.
- Fiore, Op-Amps and Linear Integrated Circuits: Concepts and Applications, Cengage.
- Ganesh Babu, Linear Integrated Circuits and Applications, Scitech.
- Raychaudhuri, Digital Circuits, Vol. 1&2, Platinum.
- Gothmann, Digital Electronics: An Introduction to Theory and Practice, PHI.
- Kumar, Fundamentals of Digital Circuits, PHI.

- Dueck, Digital Design, Cengage.
- Comer, Digital Logic and State Machine Design, Oxford.
- Salivahanan and Kumar, Digital Circuits and Design, Vikas.
- Fletcher, An Engineering Approach to Digital Design, Pearson.
- Wakerly, Digital Design: Principles and Practices, Pearson.
- J. D. Greenfield, Practical Digital Design using ICs, Prentice Hall.
- W. Kleitz, Digital Electronics: A practical Approach, Prentice Hall.
- D. Raychaudhuri, Digital Circuits: Problems and Solutions, Platinum Publishers.
- R. P. Jain, Modern Digital Electronics, Tata McGraw Hill.

CC-11: Power and Opto Electronics
[Credits: 4 (3TH+1P)]

ELT-H-CC-11-5-TH
Course Name: Power and Opto Electronics
[Credits: 3; Lecture Hours: 45]

Unit-I [11 Lecture Hours]
Power Devices: Need for Semiconductor Power Devices, Power Diodes, Enhancement of Reverse Blocking Capacity, Introduction to Family of Thyristors, UJT, Construction, Working Principle, Equivalent Circuit, Intrinsic Standoff Ratio, Characteristics, Relaxation Oscillator.
Silicon Controlled Rectifier (SCR): Structure, Two Transistor Analogy, I-V Characteristics, Turn-On and Turn-Off Characteristics, Ratings, Factors affecting the Characteristics/Ratings of SCR, Gate-Triggering Circuits, dv/dt Triggering Circuits, Control Circuits Design and Protection Circuits, Snubber Circuit.

Unit-II [11 Lecture Hours]
Diac and Triac: Basic Structure, Working and V-I Characteristics, Application of Diac as Triggering Device for Triac.
Insulated Gate Bipolar Transistors (IGBT): Basic Structure, I-V Characteristics, Switching Characteristics, Device Limitations and Safe Operating Area (SOA).
Application of SCR: SCR as Static Switch, Phase Controlled Rectification, Single Phase Half Wave, Full Wave and Bridge Rectifiers with Inductive and Non-Inductive Loads, AC Voltage Control using SCR and Triac as Switch.
Power MOSFETs: Operation Modes, Switching Characteristics, Power BJT, Second Breakdown, Saturation and Quasi-Saturation State.

Unit-III [13 Lecture Hours]
Light Emitting Diodes: Construction, Materials, Operation, Concept of Quantum Efficiency.
Lasers: Interaction of Radiation and Matter, Einstein Coefficients, Condition for Amplification, Laser Cavity, Threshold for Laser Oscillation, Line Shape Function, Examples of Common Lasers, Semiconductor Injection Laser Diode.
Photodetectors: Bolometer, Photomultiplier Tube, Charge Coupled Device, Photo Transistors and Photodiodes (p-i-n, Avalanche), Quantum Efficiency and Responsivity.
Solar Cells: PN Junction Solar Cells, Photovoltaic Mechanism, I-V Characteristics, Conversion Ffficiency, Fill Factor, Spectral Response and Quantum Efficiency, Thin Film Solar Cells. PIN Solar Cells.
LCD Displays: Types of Liquid Crystals, Principle of Liquid Crystal Displays, Applications, Advantages over LED displays.

Unit-IV [10 Lecture Hours]
Guided Waves and Optical Fiber: Evolution of Fiber Optic System, Elements of Optical Fiber Transmission Link,TE and TM Modes in Symmetric Slab Waveguides, Effective Refractive Index,

Field Distributions, Dispersion Relation and Group Velocity, Step Indexand Graded Index Optical Fiber Structures, Total Internal Reflection, Concept of Linearly Polarized Waves in Step Index Circular Dielectric Waveguides, Single Mode and Multimode Fibers, Attenuation and Dispersion in Optical Fiber, Basic Idea of OEIC (Optoelectronic Communication System).

ELT-H-CC-11-5-P
Course Name: Power and Opto Electronics Lab
[Credit: 1; Contact Hours: 30]

1. Study of I-V Characteristics of DIAC.
2. Study of I-V Characteristics of a TRIAC.
3. Study of I-V Characteristics of a SCR.
4. Study of SCR as a Half Wave and Full Wave Rectifiers with R and R-L Loads.
5. Design of Snubber Circuit.
6. Design of AC Voltage Controller using TRIAC with UJT Triggering.
7. Study o V-I Characteristic of MOSFET and IGBT (Both).
8. Study of I-V Characteristics of LEDs and Photo-Detector.
9. Study of I-V Characteristics of solar cell and find the fill factor.
10. Determine the Numerical Aperture of an Optical Fiber.

Reference Books:

- Sen, Power Electronics, Tata McGraw Hill.
- Datta, Power Electronics and Controls, Reston/Prentice Hall.
- Singh and Khanchandani, Power Electronics, Tata McGraw Hill.
- Rashid, Power Electronics: Circuits, Devices and Applications, Pearson.
- Mohan, Undeland and Robbins, Power Electronics: Converters, Applications and Design, Wiley.
- Hari Babu, Power Electronics, Scitech.
- Asghar, Power Electronics, PHI.
- Moorthi, Power Electronics, Oxford.
- Wilson and Hawkes, Optoelectronics: An Introduction, Pearson.
- Kasap, Optoelectronics and Photonics: Principles and Practices, Pearson.
- Ghatak and Thyagarajan, An Introduction to Fiber Optics, Cambridge.
- Khare, Fiber Optics and Optoelectronics, Oxford.
- Roy, Advanced Optical Fiber Communications, Scitech.

CC-12: C Programming and Data Structures
[Credits: 4 (3TH+1P)]

ELT-H-CC-12-5-TH
Course Name: C Programming and Data Structures
[Credits: 3; Lecture Hours: 45]

Unit-I [12 Lecture Hours]
C Programming Fundamentals: Introduction, Importance of C Programming, Character Set, Tokens, Keywords, Identifier, Constants, Basic Data Types, Variables, Declaration and Assigning Values, Structure of C Program, Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Increment and Decrement Operators, Conditional Operators, Bitwise Operators, Expressions and Evaluation of Expressions, Type Cast Operator, Implicit Conversions, Operator Precedence and Associativity.
Arrays and Functions: Arrays, Declaration, Accessing Elements, Storing Elements, One-Dimensional, Two-Dimensional and Multi-Dimensional Arrays, Library Functions (Input-Output

Functions, Math and String Related Functions), User Defined Functions, Defining Functions, Passing Function Arguments, Returning Values from Functions.

Unit-II [12 Lecture Hours]

Decision Making, Branching and Looping: Decision Making, Branching and Looping, if, if-else, else-if, switch Statement, break Statement, continue Statement, for loop, while loop, do-while loop, goto Statement.

Structures and Pointers: Defining and Declaring a Structure Variables, Accessing Structure Members, Initializing a Structure, Copying and Comparing Structure Variable, Array of Structures, Arrays within Structures, Structures within Structures, Structures and Functions, Pointer Declaration, Pointer Initialization, Pointer Dereferencing.

Unit-III [9 Lecture Hours]

Introduction to C++: Object Oriented Programming, Characteristics of an Object Oriented Language, Meaning of '#include <iostream>' and 'using namespace std', cout, cin, extraction and insertion Operators, function overloading, classes and objects, creating classes and objects, constructors, inheritance and polymorphism in C++ (Basic Idea).

Unit-IV [12 Lecture Hours]

Data Structures: Definition of Stack, Array Implementation of Stack, Conversion of Infix Expression to Prefix and Postfix Expressions, Evaluation of Postfix Expression, Definition of Queue, Types of Queues, Array Implementation of a Linear Queue, Linked List, Types of Linked Lists: Singly, Doubly and Circular Linked Lists, Implementation of Singly Linked List.

Sorting and Searching: Need for Sorting, Bubble Sort and its Implementation, Basic Idea and Pros and Cons of Sorting Algorithms like Insertion Sort, Selection Sort, Merge Sort, Applications of Searching Algorithms: Linear Search and Binary Search, Binary Search Tree (BST), Insertion and Searching in a BST, Preorder, Postorder and Inorder Traversal (Recursive).

ELT-H-CC-12-5-P: C Programming and Data Structures Lab
[Credit1: 1; Lecture Hours: 30]

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 from a given set of N Numbers.
3. Find the GCD of Two Integer Numbers.
4. Calculate Factorial of a given Number.
5. Find all possible Real Roots of a Quadratic Equation: $Ax^2 + Bx + C = 0$ for given Non -Zero Coefficients A, B and C.
6. Calculate the Value of sin(x) and cos(x) using the Series representation. Also print their values using corresponding Library Function.
7. Generate and Print Prime Numbers up to a given Integer N.
8. Sort given N Numbers in Ascending and Decending Order.
9. Find the Sum and Difference of two given Matrices of Order M×N and P×Q.
10. Find the Product of two given Matrices of Order M×N and N×Q.
11. Find the Transpose of given M×N Matrix.
12. Find the Sum of Principal and Secondary Diagonal Elements of a given M×N Matrix.
13. Implement a Structure. Create two or more corresponding Structure Variables and Assign Values for the Structure Members for each such Variable.
14. Implement a Linear Linked List. Perform the Pertinent Functions Associated with such a list.
15. Create a Stack using an Array and perform Push and Pop Operations on the Stack.
16. Create a Linear Queue using Array and implement Queue Operations Insert and Delete.
17. Implement Linear search.
18. Implement Bubble sort.

Reference Books:

- Kanetkar, Let Us C, BPB.
- Balagurusamy, Programming in ANSI C, Tata McGraw Hill.
- Gottfried, Programming with C, Schaum's Outlines Series, Tata McGraw Hill.
- Kernighan and Ritchie, The C Programming Language, Pearson.
- Kanetkar, Understanding Pointers in C, BPB.
- Sahani and Horowitz, Data Structures, Galgotia.
- Tenenbaum, Langsam and Augenstein, Data Structures using C, Pearson.
- Horowitz and Sahani, Fundamentals of Computer Algorithms, Computer Science Press.
- Forouzan, C Programming and Data Structures, Cengage.
- Ghosh, All of C, PHI.
- Samanta, Classic Data Structures, PHI.
- Thareja, Data Structure Using C, Oxford.
- Thareja, Programming in C, Oxford.

SEMESTER-6

CC-13: Transmission Lines, Antenna and Microwave Devices
[Credits: 4 (3TH+1P)]

ELT-H-CC-13-6-TH
Course Name: Transmission Lines, Antenna and Microwave Devices
[Credits: 3; Lecture Hours: 45]

Unit-I [13 Lecture Hours]
Transmission Lines: Typical Transmission Lines, Co-Axial, Two Wire, Microstrip, Coplanar and Slot Lines, Transmission Line Parameters, Transmission Line Equations, Wave Propagation in Transmission Lines, Characteristics Impedance, Propagation Constant, Lowloss and Lossless and Distortionless Line, Input Impedance, Reflection Coefficient, Standing Wave and Standing Wave Ratio, Power and Lossy Lines, Short-Circuited and Open-Circuited Line, Matched Line, Smith Chart, Transmission Line Applications.
Guided Waves and Waveguides: Wave Propagation between Parallel Conducting Planes, TEM, TE and TM Modes, Rectangular Waveguides, Circular Waveguides, Power Transmission and Attenuation, Rectangular Cavity Resonator.

Unit-II [16 Lecture Hours]
Antenna Fundamentals and Parameters: Concept of Retarded Potentials, Antenna Radiation Mechanism, Current Distribution on a Thin Wire Antenna, Input Impedance, Radiation Resistance, Radiation Pattern (Field, Power and Phase Patterns), Radiation Power Density, Radiation Intensity, Directive Gain, Directivity, Power Gain, Antenna Efficiency, Beamwidth, Bandwidth, Beam Efficiency, Effective Height, Effective Aperture, Aperture Efficiency, Polarization, Antenna Noise Temperature and Noise Figure.
Antenna as Transmitter/Receiver: Radiation from Elementary Dipole (Hertzian Dipole), Field Regions around Antenna (Radiation, Induction and Electrostatic Fields), Radiation Field of Half Wave Dipole, and their Radiation Resistance.
Types of Antennas (Qualitative Study Only): Monopole, Dipole, Folded Dipole, Loop, Helical, Rhombic, Yagi-Uda, Log Periodic, Antenna Array.

Unit-III [8 Lecture Hours]
Propagation of Radio Waves: Different Modes of Propagation, Ground Wave, Space Wave, Radio Horizons, Sky Wave, Structure of Ionosphere, Critical Frequency, Maximum Usable Frequency (MUF), Skip Distance, Virtual Height, Duct Propagation.

Unit-IV [8 Lecture Hours]
Microwave Devices: Microwave Domains, Two-Cavity Klystron, Reflex Klystron, Travelling Wave Tube (TWT), Magnetron, Transferred Electron Mechanism and Gunn Diode, Avalanche Transit Time Mechanism and IMPATT Diode, Tunnel Diode (Qualitative Discussions Only).

ELT-H-CC-13-6-P
Course Name: Transmission Lines, Antenna and Microwave Devices Lab
[Credit: 1; Contact Hours: 30]

Implementation with Hardware and/or SciLab/MATLAB/Any Other Simulation Software
1. Program to Determine the Phasor of Forward Propagating Field.
2. Program to Determine the Instantaneous Field of Plane Wave.
3. Program to Find the Phase Constant, Phase Velocity, Electric Field Intensity and Intrinsic Ratio.
4. Program to Find Skin Depth, Loss Tangent and Phase Velocity.

5. Program to Determine the Total Voltage as Function of Time and Position in Loss Less Transmission Line.
6. Program to Find the Characteristic Impedance, Phase Constant and Phase Velocity.
7. Program to Find the Output Power and Attenuation Coefficient.
8. Program to Find the Power Dissipated in Lossless Transmission Line.
9. Program to Find the Total Loss in Lossy Lines.
10. Program to Find the Load Impedance of Slotted Line.
11. Program to Find the Input Impedance of Transmission Line Terminated with Pure Capacitive Impedance.
12. Program to Determine the Operating Range of Frequency for TE_{10} Mode of Air-Filled Rectangula Waveguide.
13. Program to Determine Directivity, Bandwidth, Beamwidth of Antenna.
14. Program to Find Minimum Distance between Primary and Secondary Antenna.

Reference Books:

- Sadiku, Principles of Electromagnetics, Oxford.
- Hayt and Buck, Engineering Electromagnetics, Tata McGraw Hill.
- J. A. Edminster, Electromagnetics, Schaum's Outline Series, Tata McGraw Hill.
- Rao, Elements of Engineering, Electromagnetics, Pearson.
- Ballanis, Antenna Theory: Analysis and Design, Wiley.
- Yadava, Antenna and Wave Propagation, PHI.
- Harish and Sachidananda, Antennas and Wave Propagation, Oxford.
- Raju, Antennas and Wave Propagation, Pearson.
- Liao, Microwave Devices, Pearson.
- Das and Das, Microwave Engineering, Tata McGraw Hill.
- Raghuvanshi, Microwave Engineering, Cengage.
- Das, Microwave Engineering, Oxford.
- Lonngren, Savov and Jost, Fundamentals of Electromagnetics with MATLAB, SciTech.

CC-14: : Electronic Instrumentation and Control Systems
[Credits: 4 (3TH+1P)]

ELT-H-CC-14-6-TH
Course Name: Electronic Instrumentation and Control Systems
[Credits: 3; Lecture Hours: 45]

Unit-I [12 Lecture Hours]

Quality and Standards of Measurement : Static and Dynamic Characteristics of Instruments, Errors in Measurement (Gross Error, Systematic Error, Absolute Error and Relative Error), Statistical Analysis, Probability of Errors, Classification of Standards, Electrical Standards, Time and Frequency Standards, IEEE Standards.

Basic Measurement Instruments: PMMC Instrument, Galvanometer, Ammeter, Voltmeter (DC and AC), Digital Voltmeter (Integrating and Nonintegrating type), Digital Multimeter, Digital Frequency Meter.

Connectors and Probes: Low Capacitance Probes, High Voltage Probes, Current Probes, Identifying Electronic Connectors, Audio and Video, RF/Coaxial, USB etc.

Measurement of Resistance, Impedance, Capacitance and Frequency: Maxwell's Bridge, Hay's Bridge and Anderson's Bridge, Schering's Bridge, DeSauty's Bridge, Wien's Bridge.

Unit-II [15 Lecture Hours]

Oscilloscope: CRT, Waveform Display and Electrostatic Focusing, Time Base and Sweep Synchronization, Block Diagram, Working Principle, Measurement of Voltage, Frequency and Phase by CRO, Advantages and Applications of Dual Trace Oscilloscope, Digital Storage Oscilloscope, CRO Specifications (Bandwidth, Sensitivity, Rise Time).

Signal Generators and Analysers: Audio Frequency Oscillator, Pulse Generator, Function Generators, Wave Analyzer, Spectrum Analyzer.
Transducers and Sensors: Classification of Transducers, Basic Requirement/Characteristics of Transducers, Active and Passive Transducers, Resistive Strain Gauge, Capacitive (Variable Area, Variable Air Gap), Inductive (LVDT) and Piezoelectric Transducers, Measurement of Temperature (RTD, Thermocouple, Thermistor, Semiconductor IC Sensors), Light Transducers (Photoresistors, Photovoltaic Cells, Photodiodes).
Introduction to Biomedical Instrumentation: Origin of Bioelectric Signals, Biomedical Recorders, ECG, EEG and EMG, MEMS Based Biosensors, Recording Electrodes, Electrodes for ECG, EMG and EEG, Measurement of Heart Rate, Blood Pressure, Temperature, Respiration Rate.

Unit-III [10 Lecture Hours]
Introduction to Control Systems: Open Loop and Closed Loop Control Systems, Mathematical Modeling of Physical Systems (Electrical,Thermal), Block Diagram Representation and Signal Flow Graph, Reduction Technique, Mason's Gain Formula, Effect of Feedback on Control Systems.
Time and Frequency Domain Analysis: Time Domain Performance Criteria, Transient Response of First, Second and Higher Order Systems. Correlation between Time and Frequency Response, Polar and Inverse Polar Plots, Frequency Domain Specifications.

Unit-IV [8 Lecture Hours]
Concept of Stability: Asymptotic Stability and Conditional Stability, Routh-Hurwitz Criterion, Relative Stability Analysis, Root Locus Plots and their Applications.
Controllers and Compensation Techniques: Response with P, PI and PID Controllers, Concept of Compensation, Lag, Lead and Lag-Lead Networks.

ELT-H-CC-14-6-P
Course Name: Electronic Instrumentation and Control Systems Lab
[Credit: 1; Lecture Hours: 30]

Implementation with Hardware and Circuit Simulation Software
1. Design of Multi Range Ammeter and Voltmeter using Galvanometer.
2. Measurement of Resistance by Wheatstone Bridge and Measurement of Bridge Sensitivity.
3. To Determine the Characteristics of Resistance Transducer - Strain Gauge (Measurement of Strain using Half and Full Bridge).
4. To Determine the Characteristics of LVDT.
5. To Determine the Characteristics of Thermistors and RTD.
6. Measurement of Temperature by Thermocouples and Study of Transducers like AD590 (Two Terminal Temperature Sensor), PT-100, J- type, K-type. (any one)
7. To Study the Characteristics of Photodiode: (a) Variable Illumination; (b) Linear Displacement.
8. Measurement of Heart Sound using Electronic Stethoscope. Study on ECG Heart Rate Monitor/Simulator.
9. Measurement of Respiration Rate using Thermistor/Other Electrodes.
10. Measurement of Pulse Rate using Photoelectric Transducer and Pulse Counting for known Period.
11. Design and Implementation of Temperature Controller.
12. To Study Speed and Position Control of DC Motor.
13. To Study Time and Frequency Response Characteristics of First and Second Order System.
14. To Study Effect of Damping Factor on Performance of Second Order System.
15. Study of P, PI and PID Controller.

Reference Books:

- Kalsi, Electronic Instrumentation, Tata McGraw Hill.

- Helfrick and Cooper, Modern Electronic Instrumentation and Measurement Techniques, Pearson.
- Patranabis, Principles of Electronic Instrumentation, PHI.
- Carr, Elements of Electronic Instrumentation and Measurement, Pearson.
- Bell, Electronic Instrumentation and Measurements, Oxford.
- Oliver and Cage, Electronic Measurements and Instrumentation, Tata Mcgraw Hill.
- Sawhney, Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai.
- Ghosh, Introduction to Measurements and Instrumentation, PHI.
- Chatterjee, Biomedical Instrumentation System, Cengage.
- Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill.
- Natarajan, Biomedical Instrumentation and Measurements, PHI.
- Nagrath and Gopal, Control System Engineering, New Age.
- Ogata, Modern Control Engineering, Pearson.
- Golnaraghi and Kuo, Automatic Control System, Wiley.
- Anand Kumar, Control Systems, PHI.
- Distefano, Stubberud, Williams and Mandal, Control Systems, Schaum's Outline Series, Tata McGraw Hill.

CC-15: : VLSI Basics and VHDL
[Credits: 4 (3TH+1P)]

ELT-H-CC-15-6-TH
Course Name: VLSI Basics and VHDL
[Credits: 3; Lecture Hours: 45]

Unit-I [13 Lecture Hours]
VLSI Basics: Introduction of Semiconductor Process Technology, Clean Room Classification, Semiconductor Materials, Single Crystal, Polycrystalline and Amorphous Materials.
Bulk Growth Techniques and Processes: Czochralski (CZ) Process and Float Zone (FZ) Process for Silicon Single Crystal Growth, Wafer Preparation.
Thin Film Growth Techniques and Processes: Vacuum Pumps, Basic working principle of Primary Pump (Mechanical) and Secondary Pump (Diffusion), Vacuum Gauges (Pirani and Penning, Concepts only), Evaporation (Thermal and E-Beam), Sputtering, Pulse Laser Deposition (PLD), Chemical Vapor Deposition (CVD), Epitaxial Growth (Vapour Phase and Liquid Phase Epitaxy), Molecular Beam Epitaxy (MBE).

Unit-II [14 Lecture Hours]
Oxidation: Thermal Oxidation Process, Dry and Wet Oxidation, Masking Property of Silicon Oxide, Chemical Vapour Deposition of Silicon Oxide.
Diffusion: Basic Diffusion Process, Diffusion Profiles, Extrinsic Diffusion, Lateral Diffusion, Ion Implantation.
Lithographic Processes: Exposure Tools, Masks, Photoresist, Pattern transfer, Optical Lithography of Different Types (Contact, Proximity and Projection), Electron Beam Lithography and X-Ray Lithography and Ion Beam Lithography (Concepts only).
Etching: Wet Chemical Etching, Basic Process and Examples of Etchants, Dry Etching using Plasma Etching Technique.
Metallization: Uses of Physical Vapour Deposition and Chemical Vapour Deposition Technique for Aluminium and Copper Metallization.
Fabrication: Basic Fabrication Process of P-N Junction Diode.

Unit-III [9 Lecture Hours]
VHDL Programming: Introduction, Brief History of HDL, Structure of HDL Module, Introduction to Simulation and Synthesis Tools, Test Benches. VHDL Modules, Delays, Data

Flow Style, Behavioral Style, Structural Style, Mixed Design Style, Simulating Design. Introduction to Language Elements, Keywords, Identifiers, White Space Characters, Comments, Format, VHDL Terms, Hardware in VHDL, Entity, Architectures, Concurrent signal Assignment, Event Scheduling, Statement Concurrency, Structural Designs, Sequential Behavior, Process Statements, Process Declarative Region, Process Statement Region, Process Execution, Sequential Statements, Architecture Selection, Configuration Statements, Power of Configuration.

Unit-IV [9 Lecture Hours]

Behavioural Modelling: Introduction to Behavioral Modeling, Inertial Delay and Model, Transport Delay and Model, Inertial vs Transport Delay, Simulation Delta Drivers, Driver Creation, Generics, Block Statements, Guarded Blocks.

Sequential Processing: Process Statement, Sensitivity List, Signal Assignment vs Variable Assignment, Sequential Statements, IF, CASE, LOOP, NEXT, EXIT and ASSERT Statements, Assertion BNF, WAIT ON Signal, WAIT UNTIL Expression, WAIT FOR Time Expression, Multiple Wait Conditions, WAIT Time-Out, Sensitivity List vs WAIT Statement Concurrent Assignment, Passive Processes.

Data Types: Object Types,Signal, Variable, Constant, Data Types, Scalar Types, CompositeTIncomplete Types, File Type Caveats, Subtypes, Subprograms and Functions.

ELT-H-CC-15-6-TH
Course Name: VLSI Basics and VHDL Lab
[Credit: 1; Lecture Hours: 30]

Implementation with Hardware and Circuit Simulation Software

Section-A: Experiments in VLSI Basics

1. To Determine the Type (n or p) and Mobility of Semiconductor Material using Hall-Effect.
2. Oxidation Process Simulation.
3. Diffusion Process Simulation.
4. Process Integration Simulation.
5. Fabrication of Thin Film using Spin Coating System.
6. Crystallographic Analysis and Particle Size Determination by X-Ray Diffraction (XRD) (of the given XRD Spectra). Introduction to JCPDS Card.
7. Determination of Optical Bandgap through Transmission Spectra from Published Literature.

Section-B: Experiments in VHDL

1. Write Code to Realize Basic and Derived Logic Gates.
2. Half Adder and Full Adder using Basic and Derived Gates.
3. Half Subtractor and Full Subtractor using Basic and Derived Gates.
4. Clocked D FF, T FF and JK FF (with Reset Inputs).
5. Multiplexer (4×1, 8×1) and Demultiplexer using Logic Gates.
6. Decoder (2×4, 3×8), Encoders and Priority Encoders.
7. Design and Simulation of 4-Bit Adder.
8. Code Converters (Binary to Gray and Vice Versa).
9. 2-bit Magnitude Comparator.
10. 3-bit Ripple Counter.

Reference Books:

- Simon Sze, VLSI Technology, McGraw Hill Education.
- May and Sze, Fundamentals of Semiconductor Fabrication, Wiley.
- Ghandhi, VLSI Fabrication Principles: Silicon and Gallium Arsenide, Wiley.
- Bose, IC Fabrication Technology, Tata McGraw Hill.
- Campbell, The Science and Engineering of Microelectronic Fabrication, Oxford.
- Eckertova, Physics of Thin Films, Springer.

- Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Pearson.
- Pedroni, Circuit Design and Simulation with VHDL, PHI.
- Bhasker, A VHDL Primer, Pearson.

IDC: Fundamentals of Electronics
[Credits: 3 (2TH+1TU)]

ELT-H-IDC-TH
Course Name: Fundamentals of Electronics
[Credits: 3 (2TH + 1TU); Lecture Hours: 30TH + 15TU]

Unit-I [9 Lecture Hours]
Basic Circuit Components: Circuit Elements: Resistors, Inductors, Capacitors, Transformers, Concept of Voltage and Current Sources, Kirchhoff's Current and Voltage Laws, Concept of Impedance, Equivalent Impedance of Series and Parallel Combinations of R, L and C.
Operational Amplifiers and Its Applications: Op-Amp and its Characteristics (Ideal and practical), Open and Closed Loop Configuration, Concept of Virtual Ground, Inverting, Non-Inverting, Summing and Difference Amplifiers.

Unit-II [11 Lecture Hours]
Semiconductor Devices and Circuits: Intrinsic and Extrinsic Semiconductors, Direct and Indirect Bandgap Semiconductors, Basic Concept of P-N Junction, P-N Junction Diode, Zener Diode, Solar Cell, LED and their I-V Characteristics, Use of Diode as Half-Wave and Full-Wave (Center Tapped) Rectifier.
Bipolar Junction Transistors (BJT): NPN **and PNP Transistors, E**nergy Band Diagram, Working Principle of Transistor as Amplifier and Switch, CE, CB, CC Configurations, Input and Output Characteristics of NPN Transistor in CB and CE modes, Cut-off, Active and Saturation Regions, Current Components in Active Mode, Need for Biasing and Bias Stability, Operating (Q) Point, Small Signal h-Parameter Model of CE Transistor.
Field Effect Transistor: MOSFET Structure, Depletion and Enhancement Modes, Complimentary MOS (CMOS).

Unit-III [10 Lecture Hours]
Digital Logic Circuits: Number Systems (Binary, Decimal, Hexadecimal), Addition and Subtraction (using 1's and 2's complement method) of Binary Numbers, Basic Postulates and Fundamental Theorems of Boolean Algebra, De Morgan's Theorems, Logic Symbol and Truth Tables of Basic Logic Gates (AND, OR, NOT), Derived Logic Gates (NAND, NOR, XOR and XNOR), Universal Property of NOR and NAND gates, Karnaugh Map Simplification (up to 4 Variables), Half-Adder and Full-Adder Circuits, Multiplexer, de-Multiplexer, SR, JK, D and T Flip Flops (Truth Table Only).
Electronic Communication: Introduction to Communication, Need for Modulation, Concept of AM and FM (Qualitative Discussions, No Derivations).

Reference Books:

- Chattopadhyay and Rakshit, Fundamentals of Electric Circuit Theory, S. Chand.
- Ghosh, Network Theory: Analysis and Synthesis, PHI.
- Chattopadhyay and Rakshit, Electronics: Fundamentals And Applications, New Age.
- Mottershead, Electronic Devices and Circuits: An Introduction, PHI.
- Rashid, Electronic Devices and Circuits, Cengage.
- Gayakwad, Op-Amps and Linear Integrated Circuits, Pearson.
- Malvino, Electronic Principals, Tata McGraw-Hill.
- Raychaudhuri, Digital Circuits, Vol. 1&2, Platinum.
- Kumar, Fundamentals of Digital Circuits, PHI.

Syllabus for the Undergraduate (B.Sc.) Course in Electronics (Multidisciplinary)

The structure of the revised syllabus of Semesters 1 to 6 for the B.Sc. Course in Electronics (Multidisciplinary) is as follows.

Each paper carries 4 Credits, equivalent to 100 marks.

MD-CC: Multidisciplinary Core Course/Major Course
MD-Minor: Multidisciplinary Minor Course
MD-SEC: Multidisciplinary Skill Enhancement Course
MD-IDC: Multidisciplinary Inter Disciplinary Course
TH: Theory, P: Practical, TU: Tutorial

Semester	Course Code	Paper Code	Paper Name	Credit
Semester – 1	CC-1	ELT-MD-CC-1-1	Fundamentals of Circuit Theory and Electronic Devices	3TH+1P
	SEC	ELT-MD-SEC	Circuit Simulation with PSPICE	3TH+1P
	IDC	***-MD-IDC	#	2TH+1P/TU
Semester – 2	CC-2	ELT-MD-CC-2-2	Operational Amplifier and Digital Systems	3TH+1P
	SEC	ELT-MD-SEC	Circuit Simulation with PSPICE	3TH+1P
	IDC	***-MD-IDC	#	2TH+1P/TU
Semester – 3	CC-3	ELT-MD-CC-3-3	Microprocessor and Microcontroller	3TH+1P
	Minor-1	ELT-MD-Minor-1-3	Fundamentals of Circuit Theory and Electronic Devices	3TH+1P
	SEC	ELT-MD-SEC	Circuit Simulation with PSPICE	3TH+1P
	IDC	***-MD-IDC	#	2TH+1P/TU
Semester – 4	CC-4	ELT-MD-CC-4-4	Electronic Communication	3TH+1P
	CC-5	ELT-MD-CC-5-4	Electromagnetism	3TH+1P
	Minor-2	ELT-MD-Minor-2-4	Operational Amplifier and Digital Systems	3TH+1P
Semester – 5	CC-6	ELT-MD-CC-6-5	Electronic Devices and Circuits	3TH+1P
	CC-7	ELT-MD-CC-7-5	Power and Opto Electronics	3TH+1P
	Minor-3	ELT-MD-Minor-3-5	Microprocessor and Microcontroller	3TH+1P
	Minor-4	ELT-MD-Minor-4-5	Electronic Communication	3TH+1P
Semester – 6	CC-7	ELT-MD-CC-7-6	Power and Opto Electronics	3TH+1P
	CC-8	ELT-MD-CC-8-6	Electronic Instrumentation	3TH+1P
	Minor-5	ELT-MD-Minor-5-6	Electromagnetism	3TH+1P
	Minor-6	ELT-MD-Minor-6-6	Electronic Devices and Circuits	3TH+1P

Note:

A student opting for Multidisciplinary Course (MDC) may opt for Electronics as a Major subject with 8 papers, or as a Minor subject with 6 papers.

An MDC Electronics Major student has to take 1 Core Course in each of the Semesters 1, 2, and 3 and 2 Core Courses in Semester 4. In Semesters 5 and 6, (s)he has to take either 2 Core Courses (CC-6 & CC-7) in Semester 5 and 1 Core Course (CC-8) in Semester 6 or 1 Core Course (CC-6) in Semester 5 and 2 Core Courses (CC-7 & CC-8) in Semester 6.

An MDC Electronics Minor student has to take 1 Minor Course in each of the Semesters 3 and 4, and 2 Minor Courses in each of the Semesters 5 and 6.

An MDC Electronics Major or Minor student has to take 3 Inter Disciplinary Courses (IDCs) in in the first three Semesters 1, 2 and 3 choosing 1 each from the subjects other than the concerned Major and Minor subjects.

An MDC Electronics Major or Minor student has to take Electronics Skill Enhancement Course ELT-MD-SEC in any of the first three Semesters 1, 2 and 3.

An MDC student opting Major or Minor subject(s) other than Electronics may opt for Electronics IDC (ELT-MD-IDC) in any of the first three Semesters 1, 2 and 3.

SEMESTER-1

MD-CC-1: Fundamentals of Circuit Theory and Electronic Devices
[Credits: 4 (3TH+1P)]

ELT-MD-CC-1-1-TH
Course Name: Fundamentals of Circuit Theory and Electronic Devices
[Credits: 3; Lecture Hours: 45]
Deatil syllabus same as **ELT-H-CC-1-1-TH**

UNIT-I [12 Lecture Hours]
Electric Circuit Elements: Resistance and Resistors: Types, Color Coding and Power Rating, Variable Resistors, Capacitance and Capacitors: Types, Color Coding and Voltage Rating, Inductance and Inductors: Types, Color Coding, Inductor Coils, Air-core and Iron-core Coils, Self-inductance and Mutual-inductance, Transformers.
Circuit Analysis: Concept of Voltage and Current Sources, Conservations of Flux Leakage associated with Inductors and Charge associated with Capacitors, Kirchhoff's Voltage Law, Kirchhoff's Current Law, Transformation of Voltage and Current Sources, Mesh Analysis and Node Analysis, Star-Delta Networks and Conversion.
DC Analysis: Transient Responses of Series RL and RC Circuits under DC Excitation.
AC Analysis: Responses of Circuit Parameters, Frequency Response of Series RL, RC and RLC Circuits under AC Excitation, Quality (Q) Facor of Inductor and Capacitor, Series and Parallel Resonance Circuits, Q-Factor.
Network Therems: Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, and Maximum Power Transfer Theorem.

UNIT-II [11 Lecture Hours]
Semiconductor Basics: Semiconductor Materials: Types and Properties, Concept of Energy Bands in Solids: Metal, Insulator and Semiconductor, Intrinsic and Extrinsic Semiconductors, P-Type and N-Type Semiconductors, Energy Band Diagram, Concept of: Effective Mass, Direct and Indirect Bandgap Semiconductors, Fermi Level, Density of States, Mechanism of Current Conduction in Semiconductors (Drift and Diffusion), Drift Velocity, Mobility, Resitivity, Conductivity, Hall Effect (No derivation).
Junction Diode and Its Applications: PN Junction: Wafer Level Structure, Energy Band Diagram, Depletion Layer, Diode Equation and I-V Characteristics, Ideal Diode, Static and Dynamic Resistance, Reverse Saturation Current, Zener and Avalanche Breakdown, Zener Diode, Zener Diode as Voltage Regulator, Rectifiers: Half Wave Rectifier, Full Wave Rectifiers (Center tapped and Bridge), Peak Inverse Voltage, Ripple Factor, Efficiency, Line Regulation, Load Regulation, Transformer Utilization Factor, Shunt Capacitor Filter, Concept of Bleeder Resistor.
UNIT-III [11 Lecture Hours]
Bipolar Junction Transistor: Wafer Level Structure, Brief Manufacturing Techniques (Growth, Alloy or Fused, Diffusion, Epitaxy), Energy Band Diagram, Doping Profile, PNP and NPN Transistors, Common Base (CB), Common Emitter (CE) and Common Collector (CC) Configurations, Working Principle, Emitter (Injection) Efficiency, Base Transportation Factor, Current Components in BJT, Current Gains: α, β and γ, Input and Output Characteristics in CB, CE and CC Modes, Early Effect and Voltage, Leakage Currents.
Transistor Biasing: Need for Biasing and Bias Stabilization, Load Line and Q-Point, Stability and Stability Factor, Thermal Runaway, Fixed Bias, Collector to Base Bias, Voltage Divider Bias and Emitter Bias.

UNIT-IV [11 Lecture Hours]
BJT Amplifiers: r_e-model and h-Parameter Equivalent Circuit of BJT, Small Signal Analysis of Single Stage CE Amplifier, Frequency Response, Input and Output Impedances, Current, Voltage and Power Gains, Concept of Class A, B, AB and C Amplifiers.

Field Effect Transistor: Junction FET, Formation of Channel and Operating Principle, Pinch Off and Saturation Voltages and Currents, Drain and Transfer Characteristics of N-Channel JFET, FET Parameters, Small Signal Equivalent Circuits of JFET in Common Source (CS), Common Drain (CD) Configurations, Voltage Gain, Input and Output Imedances of CS FET Amilifier, Normally-Off and Normally-On MESFET.

ELT-MD-CC-1-1-P
Course Name: Fundamentals of Circuit Theory and Electronic Devices Lab
[Credit: 1; Contact Hours: 30]
Deatil syllabus same as **ELT-H-CC-1-1-P**

1. To Familiarize with Basic Electronic Components (R, C, L, Diodes, Transistors), Digital Multimeter, Function Generator and Oscilloscope.
2. Verification of (a) Thevenin's Theorem and (b) Norton's Theorem.
3. Verification of (a) Superposition Theorem and (b) Maximum Power Transfer Theorem.
4. Study of the I-V Characteristics of (a) P-N Junction Diode and (b) Zener Diode.
5. Study of (a) Half Wave Rrectifier and (b) Full Wave Rrectifier (FWR) without and with Capacitor Filter.
6. Study of Zener Diode as Voltage Regulator and its Load Regulation.
7. Study of the I-V Characteristics of the Common Emitter Configuration of BJT
8. Study of the I-V Characteristics of the Common Base Configuration of BJT
9. Study of the I-V Characteristics of JFET.

Reference Books:

- Nasar, Electric Circuits, Schaum's Solved Problems Series, Tata McGraw Hill.
- Nahvi and Edminister, Electric Circuits, Schaum's Outline Series, Tata McGraw Hill.
- Boylestad, Essentials of Circuit Analysis, Pearson.
- Chattopadhyay and Rakshit, Fundamentals of Electric Circuit Theory, S. Chand.
- Hyat, Kemmerly and Durbin, Engineering Circuit Analysis, Tata McGraw Hill.
- Sadiku, Musa and Alexander, Applied Circuit Analysis, Tata McGraw-Hill.
- Bel, Electric Circuits, Oxford.
- Kuo, Network Analysis and Synthesis, Wiley.
- DeCarlo and Lin, Linear Circuit Analysis, Oxford.
- Ghosh, Network Theory: Analysis and Synthesis, PHI.
- Smith and Alley, Electrical Circuits: An Introduction, Cambridge.
- Ryder, Network, Lines and Fields, Pearson.
- Boylestead and Nashelsky, Electronic Devices and Circuit Theory, Pearson.
- Bell, Electronic Devices and Circuits, Oxford.
- Chattopadhyay and Rakshit, Electronics: Fundamentals And Applications, New Age.
- Sedra, Smith and Chandorkar, Microelectronic Circuits, Oxford.
- Millman and Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, Tata McGraw Hill.
- Cathey, 2000 Solved Problems in Electronics, Schaum's Outline Series, Tata McGraw Hill.
- Mottershead, Electronic Devices and Circuits: An Introduction, PHI.
- Dutta, Semiconductor Devices and Circuits, Oxford.
- Rashid, Electronic Devices and Circuits, Cengage.
- Basic Electronics: A Text Lab Manual, Zbar, TMH
- David A. Bell, Laboratory Manual for Electronic Devices and Circuits, PHI.
- B. Ghosh, Advanced Practical Physics, Volume II, New Central Book Agency

SEMESTER-2

MD-CC-2: Operational Amplifier and Digital Systems
[Credits: 4 (3TH+1P)]

ELT-MD-CC-2-2-TH
Course Name: Operational Amplifier and Digital Systems
[Credits: 3; Lecture Hours: 45]
Deatil syllabus same as **ELT-H-CC-2-2-TH**

Unit-I [11 Lecture Hours]
Operational Amplifiers: Characteristics of Ideal and Practical Op-Amp, Open and Closed Loop Configuration, Frequency Response, Concept of Offset Voltage and Current, Bias Current, CMRR, PSRR, Slew Rate.
Applications of Op-Amps: Inverting and Non-Inverting Amplifiers, Concept of Virtual Ground, Summing and Difference Amplifiers, Differentiator, Integrator, Multiplier and Divider, Logarithmic and Anti-logarithmic Amplifiers, Voltage to Current and Current to Voltage Converters, Comparator and Zero-Crossing Detector, Schmitt Trigger.

Unit-II [12 Lecture Hours]
Number System and Codes: Weighted and Non-Weighted Codes, Decimal, Binary, Octal and Hexadecimal Number Systems, Base Conversions, 1's and 2's Complements, Representation of Signed and Unsigned Numbers, Binary Codes (BCD, 8-4-2-1, Excees-3, Gray Codes), Alphanumeric Codes, ASCII, EBCDIC, Fixed and Floating Point Arithmetic, Binary and Hexadecimal Arithmetic, Addition, Subtraction by 2's Complement Method, BCD Addition, Parity Bits, Error Detecting and Correcting Code (Hamming).
Boolean Algebra and Logic Gates: Positive and Negative Logic, Basic Postulates and Fundamental Theorems of Boolean Algebra, De Morgan's Theorems, Logic Symbol and Truth Tables of Basic Logic Gates (AND, OR, NOT), Derived Logic Gates (NAND, NOR, XOR and XNOR), Universal Property of NOR and NAND gates.
Digital Logic Families: Characteristics of Logic Families (TTL and CMOS), Fan-in, Fan-out, Noise Immunity, Noise Margin, Power dissipation, Figure of Merit, Speed Power Product, Propagation Delay, Comparison of TTL and CMOS Families.
Combinational Logic Analysis: Standard Representation of Logic Functions (SOP and POS), Karnaugh Map Minimization (up to 4 Variables).

Unit-III [11 Lecture Hours]
Combinational Circuits Design: Half and Full Adder, Half and Full Subtractor, 4-Bit Binary Adder and Subtractor, Multiplexers, Demultiplexers, Encoder, Decoder, Code Converters.
D-A and A-D Conversion: 4-Bit Binary Weighted and R-2R D-A Converter, Circuit and Working, Accuracy and Resolution, A-D Conversion Characteristics, Successive Approximation ADC. (Mention of relevant ICs for all).

Unit-IV [11 Lecture Hours]
Sequential Circuits: Latches, Flip Flops (SR, JK, D and T), Truth Table, Excitation Table and Excitation Equation, Clocked (Level and Edge Triggered) Flip Flops, Preset and Clear Operations, Race Around Conditions in JK Flip Flop, Master-Slave JK Flip Flop.
Shift Registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (up to 4 Bits).
Counters (4 bits): Ripple, Ring, Johnson, Synchronous, Asynchronous, Decade and Modulo-N Counters (Asynchronous only).

ELT-MD-CC-2-2-P
Course Name: Operational Amplifier and Digital Systems Lab
[Credit: 1; Contact Hours: 30]
Deatil syllabus same as **ELT-H-CC-2-2-P**

1. To Design Inverting and Non-Inverting Amplifiers using Op-Amp (741/351) for DC Voltage of given Gain.
2. To Add two DC Voltages using Op-Amp in Inverting and Non-Inverting Mode.
3. To Design Differentiator and Integrator Circuit using Op-Amp (741/351).
4. To Design Comparator and Schmitt Trigger Circuit using OPAMP.
5. To Verify and Design AND, OR, NOT and XOR Gates using NAND Gates.
6. To Convert Boolean Expression into Logic Circuit and Design it using Logic Gate ICs.
7. To Design Half Adder and Full Adder.
8. To Design Half Subtractor and Full Subtractor.
9. To Design 4-Bit Binary Adder and Adder-Subtractor using Full Adder IC 7483.
10. To Design 4×1 Multiplexer using Logic Gates.
11. To Design RS, D and JK Master-Slave Flip Flops using NAND Gates.
12. To Construction of 4-Bit Shift Registers (Serial and Parallel) using JK/D Type FF.
13. To Design Ripple Counter.

Reference Books:

- Gayakwad, Op-Amps and Linear Integrated Circuits, Pearson.
- Coughlin and Driscoll, Operational Amplifiers and Linear Integrated Circuits, Pearson.
- Malvino, Electronic Principals, Tata McGraw-Hill.
- Kishore, Operational Amplifiers and Linear Integrated Circuits, Pearson.
- Bel, Operational Amplifiers and Linear Ics, Oxford.
- Jacob, Analog Integrated Circuits Applications, Pearson.
- Fiore, Op-Amps and Linear Integrated Circuits: Concepts and Applications, Cengage.
- Ganesh Babu, Linear Integrated Circuits and Applications, Scitech.
- Tokheim, Digital Principles, Schaum's Outline Series, Tata McGraw Hill.
- Flyod, Digital Fundamentals, Pearson.
- Raychaudhuri, Digital Circuits, Vol. 1&2, Platinum.
- Gothmann, Digital Electronics: An Introduction to Theory and Practice, PHI.
- Kumar, Fundamentals of Digital Circuits, PHI.
- Dueck, Digital Design, Cengage.
- Comer, Digital Logic and State Machine Design, Oxford.
- Salivahanan and Kumar, Digital Circuits and Design, Vikas.
- Fletcher, An Engineering Approach to Digital Design, Pearson.
- Wakerly, Digital Design: Principles and Practices, Pearson.
- Rakshit and Chattopadhyay,Practical Physics,New Central Book Agency.
- B. Ghosh, Advanced Practical Physics, Volume II, New Central Book Agency
- David A. Bell,Laboratory Manual for Electric Circuits, Oxford University Press.

SEMESTER-3

MD-CC-3: Microprocessor and Microcontroller
Credits: 4 (3TH+1P)]

ELT-MD-CC-3-3-TH
Course Name: Microprocessor and Microcontroller
[Credits: 3; Lecture Hours: 45]
Deatil syllabus same as **ELT-H-CC-3-3-TH**

Unit-I [12 Lecture Hours]
Introduction to Microprocessors: History of Microprocessors, Applications, Speed, Word Size, Memory Capacity, Classification of Microprocessors (Mention Different Microprocessors being used), Microcomputer, Basic Block Diagram of Microcomputer.
8085 Microprocessor: Features, Architecture, Functional Block Diagram, CPU, ALU, Control Unit, General Purpose Registers, Register Pairs, Flags, Special Purpose Resisters: Stack Pointer and Program Counter, Types of Buses, Multiplexed Address Bus and Data Bus, Control Signals, Pin-out Diagram and Pin Description.

Unit-II [13 Lecture Hours]
8085 Instructions and Programming: Operation Codes, Operands and Mnemonics, Instruction Set, Addressing Modes, Instruction Format, Instruction Classification, Data Transfer Instructions, Arithmetic Instructions, Increment and Decrement Instructions, Logical Instructions, Branch Instructions and Machine Control Instructions, Stack Operations, PUSH and POP Instructions, Subroutines, Call and Return Instructions, Program Status Word (PSW), Delay Loops, Use of Counters, Instruction Cycle, Machine Cycle, Timing Diagram, T-States, Op-Code Fetch, Memory Read, Memory Write, I/O Read and I/O Write, Assembly Language Programming and Examples.
Interrupts: Interrupt Structure, EI and DI Instructions, INTR and $\overline{\text{INTA}}$ Signals, RST Instructions, Maskable and Non-Maskable Interrupts, Vectored Interrupts (TRAP, RST 7.5, 6.5 and 5.5) Non-Vectored Interrupts, SIM and RIM Instructions, Latency Time and Response Time.
Interfacing: Direct Memory Access (DMA), HOLD and HLDA Signals, Interfacing of Programmable Peripheral Interface (PPI) IC 8255, Block Diagram of 8255, Different Modes of Operation (Basic Idea).

Unit-III [12 Lecture Hours]
Introduction to Microcontroller: Definition and Use of Microcontroller, Difference with Microprocessor, Different Types of Microcontrollers, Embedded Microcontrollers, Microcontroller Architectures, Internal Block Diagram, Key Features, Pin Diagram, CISC vs. RISC Architectures, Microcontroller Memory Types, Microcontroller Features, Clocking, I/O Pins, Interrupts, Timers, Peripherals.
8051 Programming: 8051 Addressing Modes and Accessing Memory Locations using Various Addressing Modes, Assembly Language Instructions using Addressing Mode, Arithmetic and Logic Instructions, 8051 Assembly Language Programming Examples, I/O Port Programming in 8051 (using Assembly Language).

Unit-IV [8 Lecture Hours]
Introduction to Arduino Uno: Functional Block Diagram of Arduino Uno Board, ATmega328P:Microcontroller inside Arduino Uno, Functions of Different Pins of Arduino Uno, Other Arduino Development Boards, Arduino IDE, Serial Monitor, Arduino Sketch, Variables, setup Function, I/O Functions: pinMode(), digitalRead(), digitalWrite(), analogRead(), analogWrite(), delay() Function, Looping Techniques, Decision Making Techniques, Designing of 1st Sketch, Serial Port Communication with PC, Basic Interfacing and I/O Concept, Interfacing LED and Switch.

ELT-MD-CC-3-3-P
Course Name: Microprocessor and Microcontroller Lab
[Credit: 1; Lecture Hours: 30]
Deatil syllabus same as **ELT-H-CC-3-3-P**

Section-A: 8085 Microprocessor Assembly Language Programming:
2. Transfer of Block of Data.
3. Addition and Subtraction of Numbers using Direct Addressing Mode.
4. Addition and Subtraction of Numbers using Indirect Addressing Mode.
5. Multiplication by Repeated Addition.
6. Division by Repeated Subtraction.
7. Handling of 16-Bit Numbers.
8. Search a given Number in a given List.
9. Generate Fibonacci Series.
10. Sorting of Numbers in Ascending/Descending Order.
11. Use of CALL and RETURN Instruction.
12. Program to Verify Truth Table of Logic Gates.

Section-B: 8051 MicrocontrollerAssembly Language and Arduino Programming:
1. To Find whether the given Numbers are Prime or not.
2. To Find the Factorial of a Number.
3. To Find (a) Largest of N Numbers and (b) Smallest of N Numbers.
4. To Arrange the Numbers in Ascending/Descending Order.
5. Write and execute a sketch in Arduino Uno IDE to blink an LED.
6. Write and execute a sketch in Arduino Uno IDE to interface a switch to turn an LED on and off.

Reference Books:

- Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085, Penram.
- B. Ram, Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai.
- Krishna Kant, Microprocessors and Microcontrollers: Architecture, Programming and System Design, PHI.
- Mathur and Panda, Microprocessors and Microcontrollers, PHI.
- Shah, 8051 Microcontrollers: MCS 51 Family and its Variants, Oxford.
- Raj Kamal, Embedded Systems: Architecture, Programming and Design, Tata McGraw Hill.
- Valvano, Embedded Microcomputer System: Real Time Interfacing, Cengage Learning.
- Ashwin Pajankar,ARDUINO Made Simple, BPB Publications.

MD-Minor-1: Fundamentals of Circuit Theory and Electronic Devices
[Credits: 4 (3TH+1P)]

ELT-MD-Minor-1-3-TH
Course Name: Fundamentals of Circuit Theory and Electronic Devices
[Credits: 3; Lecture Hours: 45]
Deatil syllabus same as **ELT-MD-CC-1-1-TH** & **ELT-H-CC-1-1-TH**

ELT-MD-Minor-1-3-P
Course Name: Fundamentals of Circuit Theory and Electronic Devices Lab
[Credit: 1; Lecture Hours: 30]
Deatil syllabus same as **ELT-MD-CC-1-1-P** & **ELT-H-CC-1-1-P**

SEMESTER- 4

MD-CC-4: Electronic Communication
[Credits: 4 (3TH+1P)]

ELT-MD-CC-4-4-TH
ELT-H-CC-5-4-TH
Course Name: Electronic Communication
[Credits: 3; Lecture Hours: 45]
Deatil syllabus same as **ELT-H-CC-5-4-TH**

Unit-I [12 Lecture Hours]
Introduction to Electronic Communication: Means and Modes, Block Diagram of Electronic Communication System, Electromagnetic Spectrum, IEEE Band Designations and Applications, Brief Idea of Frequency Allocation for Radio Communication System in India (TRAI), Need for Modulation, Concept of Channels and Base-Band Signals, Concept of Bandwidth, Concept of Transmission Modes (Simplex, Half Duplex, Full Duplex).
Noise in Communication Systems: Concept of Noise, Types of Noise, Internal and External Noises, Thermal and White Noise, Signal-to-Noise (S/N) Ratio and Noise Figure, Figure of Merit, Noise Temperature.
Amplitude Modulation: Definition, Mathematical Representation of AM, Time Domain and Frequency Domain (Frequency Spectrum) Representations, Modulation Index and Percentage Modulation, Concept of Under, Over and Critical Modulation, Frequency Spectrum, Sideband Frequencies, Bandwidth Requirements, Power Carried by Carrier and Sidebands, Concept of Multitone Modulating Signals, Generation of AM (Linear and Non Linear Methods), Amplitude Demodulation (Envelope Detector), Double Side Band Suppressed Carrier (DSBSC), Chopper (Ring) and Balanced Modulators, Single Side Band Suppressed Carrier (SSBSC), Phase Shift (Discrimination) Method, Pilot Carrier Amplitude Modulation, Concepts of Vestigial Side Band (VSB) Modulation and Quadrature Amplitude Modulation (QAM), Independent Side Band Modulation, Block Diagram of AM Transmitter and Receiver, Utility of Heterodyning, Super Heterodyning Principle, Super Heterodyne Receiver (SHR), Advantages over Tuned Radio Frequency (TRF) Receiver, Different Blocks of SHR, Intermediate Frequency, Local Oscillator Frequency, Image Frequency.

Unit-II [10 Lecture Hours]
Frequency and Phase Modulation: Definition, Mathematical Representation of FM and PM, Equivalence between FM and PM, Time Domain and Frequency Domain (Frequency Spectrum) Representations, Modulation Index, Bandwidth Requirements, Frequency Deviation, Narrow Band FM (NBFM) and Wide Band FM (WBFM), Carson's Rule, Direct (Varactor Diode) and Indirect (Armstrong) Methods of FM Generation, FM Detection using Slope Detector and PLL Detector**,** Block Diagram of FM Transmitter and Receiver, Comparison between AM, FM and PM.
Analog Pulse Modulation: Channel Capacity, Sampling Theorem, Sampling and Reconstruction of Signals, Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM), Generation and Detection Techniques, Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM).

Unit-III [11 Lecture Hours]
Digital Modulation Techniques: Need for Digital Transmission, Block Diagram of Digital Transmission and Reception, Characteristics of Data Transmission Circuits, Advantages and Disadvantages of Digital Communication, Information Capacity, Shannon Limit for Information Capacity, Bandwidth Requirements, Pulse Code Modulation (PCM), Quantizing, Uniform and Non-Uniform Quantization, Quantization Noise, Companding, Coding, Decoding, Regeneration, Data Transmission Speed (Bit Rate and Baud Rate), Noise, Cross Talk, M-Array Coding, Amplitude Shift

Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK).

Unit-IV [12 Lecture Hours]

Radio Wave Propgation: Characteristics of Electromagnetic Wave, Different Modes of Radio Wave Propagation, Ground (Surface) Wave Propagation, Space (Tropospheric) Wave Propagation, Sky (Ionospheric) Wave Propagation, Structure of Atmosphere, Critical Frequency, Maximum Usable Frequency (MUF), Virtual Height, and Skip Distance, Duct Propagation (Qualitative Discussions Only).

Cellular Communication: Concept of Cellular Mobile Communication, Frequency Bands used in Cellular Communication, Concept of Cell Sectoring and Cell Splitting, Absolute RF Channel Numbers (ARFCN), Frequency Reuse, Roaming and Hand Off, Authentication of SIM Card of Subscribers, IMEI Number, Need for Data Encryption, Architecture (Block Diagram) of Cellular Mobile Communication Network, Concept of GSM, CDMA, TDMA and FDMA, Comparison of TDMA and FDMA Technology, Simplified Block Diagram of Cellular Phone Handset, Comparative Study of GSM and CDMA, Qualitative concepts of 2G, 3G, 4G and 5G, Qualitative Idea of GPS Navigation System.

ELT-MD-CC-4-4-P
ELT-H-CC-5-4-P
Course Name: Electronic Communication Lab
[Credit: 1; Lecture Hours: 30]
Deatil syllabus same as **ELT-H-CC-5-4-P**

Implementation with Hardware and Circuit Simulation Software

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. Study of Pulse Width Modulation.
7. Study of Pulse Position Modulation.
8. Study of Pulse Code Modulation.
9. Study of Amplitude Shift Keying.
10. Study of Phase Shift Keying.
11. Study of Frequency Shift Keying.

Reference Books:

- Kennedy, Electronic Communication Systems, Tata McGraw Hill.
- Frenzel, Principles of Electronic Communication Systems, Tata McGraw Hill.
- Tomasi, Advanced Electronic Communications Systems, Pearson.
- Roddy and Coolen, Electronic Communications, Pearson.
- Haykin, Communication Systems, Wiley.
- Lathi and Ding, Modern Digital and Analog Communication Systems, Oxford.
- Couch, Digital and Analog Communication Systems, Pearson.
- Kundu, Analog and Digital Communications, Pearson.
- Blake, Electronic Communication Systems, Cengage.
- T. L. Singal, Analog and Digital Communication, Tata McGraw Hill.

MD-CC-5: Electromagnetism
[Credits: 4 (3TH+1P)]

ELT-MD-CC-5-4-TH
Course Name: Electromagnetism
[Credits: 3; Lecture Hours: 45]

UNIT-I [12 Lecture Hours]
Electrostatics: Coulomb's Law and Electric Field, Field due to Discrete and Continuous Charge Distributions, Electric Flux Density, Gauss's Law and Applications, Electric Potential, Potential due to Point Charge and Charge Distribution, Lines of Force, Divergence and Curl of Electric Field, Electric Dipole, Dipole Field and Potential, Dielectric Materials, Polarization, Dielectric Constant, Linear and Nonlinear Dielectrics, Homogeneous and Inhomogeneous Dielectrics, Isotropic and Anisotropic Dielectrics, Boundary Conditions, Poisson's Equation, Laplace's Equation, Simple Problems, Capacitance and Capacitors, Electrostatic Energy and Forces, Energy Density.

UNIT-II [11 Lecture Hours]
Magnetostatics: Lorentz Force and Concept of Magnetic Induction, Biot-Savart's Law and Applications, Magnetic Dipole, Ampere's Circuital Law and Applications, Magnetic Flux and Magnetic Flux Density, Scalar and Vector Magnetic Potentials, Magnetization in Materials and Permeability, Inductors and Inductances, Mutual and Self Inductance.

UNIT-III [12 Lecture Hours]
Time-Varying Fields and Maxwell's Equations: Faraday's and Lenz's Law of Electromagnetic Induction, Stationary Circuit in Time-Varying Magnetic Field, Transformer and Motional EMF, Concept of Electric Displacement Current, Maxwell's Equations in Integral and Differential Forms, Wave Equation for Free Space Conditions, Electromagnetic Energy and Power.

UNIT-IV [10 Lecture Hours]
Electromagnetic Waves in Non-conducting and Conducting Media: Plane Waves in Source Free Isotropic Homogeneous Media, Uniform Plane Waves in Lossless Unbounded Homogeneous Media, Reflection and Transmission of Plane Waves at Normal Incidence, Skin Effect and Skin Depth, Phase and Group Velocity, Poynting Vector, Poynting Theorem and Power Flow.

ELT-MD-CC-5-4-P
Course Name: Electromagnetism Lab
[Credit: 1; Contact Hours: 30]

Implementation with Scilab/MATLAB/Any Other Similar Software
1. Plots of Electric Field and Electric Potential due to Line, Surface and Volume Charge Densities.
2. Plots of Magnetic Flux Density due to Current Carrying Wire.
3. Solutions of Poisson and Laplace Equations - Contour Plots of Charge and Potential Distributions.
4. Magnetic Field Measurements in a Static Magnetic Circuit, Inductance.

Reference Books:

- Spiegel, Lipschutz and Spellman, Vector Analysis, Schaum's Outline Series, Tata McGraw Hill.
- Ida, Engineering Electromagnetics, Springer.
- Sadiku, Elements of Electromagnetics, Oxford.
- Rao and Narayanappa, Engineering Electromagnetics, Cengage.
- Hayt, Buck and Akhtar, Engineering Electromagnetics, Tata McGraw Hill.
- Cheng, Field and Wave Electromagnetics, Pearson.

- Edminster, Electromagnetics, Schaum's Outline Series, Tata McGraw Hill.
- Rao, Elements of Engineering Electromagnetics, Pearson.
- Griffiths, Introduction to Electrodynamics, Pearson.
- Jordan and Balmain, Electromagnetic Waves and Radiating Systems, Pearson.

MD-Minor-2: : Operational Amplifier and Digital Systems

ELT-MD-Minor-2-4-TH
Course Name: Operational Amplifier and Digital Systems
[Credits: 3; Lecture Hours: 45]
Deatil syllabus same as **ELT-MD-CC-2-2-TH** & **ELT-H-CC-2-2-TH**

ELT-MD-Minor-2-4-P
Course Name: Operational Amplifier and Digital Systems Lab
[Credit: 1; Lecture Hours: 30]
Deatil syllabus same as **ELT-MD-CC-2-2-P** & **ELT-H-CC-2-2-P**

SEMESTER-5

MD-CC-6: Electronic Devices and Circuits
[Credits: 4 (3TH+1P)]

ELT-MD-CC-6-5-TH
Course Name: Electronic Devices and Circuits
[Credits: 3; Lecture Hours: 45]

UNIT-I [10 Lecture Hours]
Diode Circuits: Piece-Wise Linear Characteristics of Diode, DC Load Line Analysis, Quiescent (Q) Point, Clippers: Positive Clipper, Negative Clipper, Combinational Clipper, Clampers: Positive Clamper, Negative Clamper, Combinational Clamper, Voltage Doubler, Filters: Types, Circuit Diagram and Explanation with Waveform - Series Inductor, Shunt Capacitor, L-Section and R-C Filter Circuits.

UNIT-II [10 Lecture Hours]
BJT Circuits: Transistor as a Switch, Small Signal Analysis of Single Stage CE Amplifier, Load Line Analysis, h-Parameter Equivalent Circuit, Study of Frequency Response of Single Stage CE Amplifier, Input and Output Impedances, Current and Voltage Gains, Effect on Gain and Bandwidth of Cascaded RC Coupled CE Amplifier.

UNIT-III [13 Lecture Hours]
Feedback Amplifiers: Concept of Feedback, Negative and Positive Feedback, Types of Feedback Circuits, Advantages and Disadvantages of Negative Feedback, Voltage (Series and Shunt) and Current (Series and Shunt) Feedback Amplifiers, Effect of Negative Feedback on Gain, Input and Output Impedances, Bandwidth and Distortion.
Oscillators: Positive Feedback and Principle of Oscillations, Condition for Sustained Oscillation (Barkhaussen Criteria), Principal, Working and Frequency Calculation of Hartley Oscillator, Colpitt's Oscillator, Wein Bridge Oscillator and Phase-Shift Oscillator.

UNIT-IV [12 Lecture Hours]
Power Amplifiers: Difference between Voltage and Power Amplifier, Classification of Power Amplifiers, Class A, Class B, Class C, Class AB and their Comparisons, Operation of Class A Single Ended Power Amplifier, Operation of Transformer Coupled Class A Power Amplifier and its Efficiency, Operation of Complementary Symmetry Class B Push Pull Power Amplifier, Crossover Distortion in power amplifiers.
MOSFET: MOS Capacitor, Channel Formation, Threshold Voltage (Ideal and Real), Current-Voltage Relation, Depletion and Enhancement Type MOSFET, Complementary MOS (CMOS).

ELT-MD-CC-6-5-P
Course Name: Electronic Devices and Circuits Lab
[Credit: 1; Lecture Hours: 30]

Implementation with Hardware and/or Scilab/MATLAB/Any Other Simulation Software
1. Study of RC Circuit as Differentiator and High Pass Filter.
2. Study of RC Circuit as Integrator and Low Pass Filter.
3. Study of Clipping and Clamping Circuits.
4. Study of Colpitt's Oscillator.
5. Study of the RC Phase Shift Oscillator.
6. Study of the Wien Bridge Oscillator.
7. Study of Class A and B Push-Pull Power Amplifier.
8. Study of the I-V Characteristics of MOSFET.

Reference Books:

- Boylestead and Nashelsky, Electronic Devices and Circuit Theory, Pearson.
- Bell, Electronic Devices and Circuits, Oxford.
- Schilling and Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill.
- Sedra, Smith and Chandorkar, Microelectronic Circuits, Oxford.
- Millman and Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, Tata McGraw Hill.
- Neamen, Electronic Circuits: Analysis and Design, Tata McGraw Hill.
- Cathey, 2000 Solved Problems in Electronics, Schaum's Outline Series, Tata McGraw Hill.
- Mottershead, Electronic Devices and Circuits: An Introduction, PHI.
- Dutta, Semiconductor Devices and Circuits, Oxford.
- Rashid, Electronic Devices and Circuits, Cengage.
- Bogart, Beasley and Rico, Electronic Devices and Circuits, Pearson.
- B. Ghosh, Advanced Practical Physics, Volume II, New Central Book Agency
- David A. Bell, Laboratory Manual for Electronic Devices and Circuits, PHI.

MD-CC-7: Power and Opto Electronics
[Credits: 4 (3TH+1P)]

ELT-MD-CC-7-5-TH
Course Name: Power and Opto Electronics
[Credits: 3; Lecture Hours: 45]

Unit-I [12 Lecture Hours]

Power Electronic Devices: Need for Semiconductor Power Devices, Power MOSFET (Qualitative), UJT, Basic Construction, Working, Equivalent Circuit and I-V Characteristics. Introduction to Family of Thyristors, Silicon Controlled Rectifier (SCR), Structure, I-V Characteristics, Turn-On and Turn-Off Characteristics, Ratings, Gate Triggering Circuits, Diac and Triac, Basic Structure, Working and I-V Characteristics, Application of Diac as Triggering Device for Triac.

Insulated Gate Bipolar Transistors (IGBT): Basic Structure, I-V Characteristics, Switching Characteristics, Device Limitations and Safe Operating Area (SOA).

Unit-II [9 Lecture Hours]

Applications of SCR: Phase Controlled Rectification, AC Voltage Control using SCR and Triac, Power Invertors, Need for Commutating Circuits and their Various Types, DC Link Invertors, Parallel Capacitor Commutated Invertors, Series Invertors, Limitations and its Improved Versions, Bridge Invertors.

Unit-III [12 Lecture Hours]

Optoelectronic Devices: Classification of Photonic Devices, Interaction of Radiation and Matter, Radiative Transition and Optical Absorption, Light Emitting Diodes, Construction, Materials and Operation, Semiconductor Laser, Condition for Amplification, Laser Cavity, Heterostructure and Quantum Well Devices, Charge Carrier and Photon Confinement, Line Shape Function, Threshold Current, Laser Diode.

Photodetectors: Photoconductor, Photodiodes (p-i-n, Avalanche) and Photo Transistors, Quantum Efficiency and Responsivity, Photomultiplier Tube.

Unit-IV [12 Lecture Hours]

Solar Cell: Construction, Working and Characteristics.

LCD Displays: Types of Liquid Crystals, Principle of Liquid Crystal Displays, Applications, Advantages over LED Displays.

Introduction to Fiber Optics: Evolution of Fiber Optic System, Elements of Optical Fiber Transmission Link, Optical Fiber Modes and Configurations, Mode Theory of Circular Wave Guides, Overview of Modes, Key Modal Concepts, Linearly Polarized Modes, Single Mode Fibers and Graded Index Fiber Structure.

ELT-MD-CC-7-5-P
Course Name: Power and Opto Electronics Lab
[Credit: 1; Lecture Hours: 30]

1. To Determine I-V Characteristics of (a) LEDs, (b) Photo Voltaic Cell and (c) Photo Diode.
2. To Study I-V Characteristics of LDR and Photodiode with (a) Variable Illumination Intensity and (b) Linear Displacement of Source.
3. To Measure the Numerical Aperture of an Optical Fiber.
4. Output and Transfer Characteristics of a Power MOSFET.
5. Study of I-V Characteristics of SCR.
6. SCR as Half Wave and Full Wave Rectifiers with R and RL Loads.
7. Study of I-V Characteristics of DIAC.
8. Study of I-V Characteristics of TRIAC.

Reference Books:

- Kasap, Optoelectronics and Photonics: Principles and Practices, Pearson.
- Ghatak and Thyagarajan, An Introduction to Fiber Optics, Cambridge.
- Wilson and Hawkes, Optoelectronics: An Introduction, Pearson.
- Gupta, Optoelectronic Devices and Systems, PHI.
- Khare, Fiber Optics and Optoelectronics, Oxford.
- Sen, Power Electronics, Tata McGraw Hill.
- Singh and Khanchandani, Power Electronics, Tata McGraw Hill.
- Rashid, Power Electronics: Circuits, Devices and Applications, Pearson Education.
- Thareja and Thareja, A Textbook of Electrical Technology, Vo. II, S. Chand.
- Asghar, Power Electronics, PHI.
- Moorthi, Power Electronics, Oxford.
- Varmah and Abraham, Power Electronics, Cengage.

MD-Minor-3: Microprocessor and Microcontroller

ELT-MD-Minor-3-5-TH
Course Name: Microprocessor and Microcontroller
[Credits: 3; Lecture Hours: 45]
Deatil syllabus same as **ELT-MD-CC-3-3-TH & ELT-H-CC-3-3-TH**

ELT-MD-Minor-3-5-P
Course Name: Microprocessor and Microcontroller Lab
[Credit: 1; Lecture Hours: 30]
Deatil syllabus same as **ELT-MD-CC-3-3-P & ELT-H-CC-3-3-TH**

MD-Minor-4: Electronic Communication
[Credits: 4 (3TH+1P)]

ELT-MD-Minor-4-5-TH
Course Name: Electronic Communication
[Credits: 3; Lecture Hours: 45]
Deatil syllabus same as **ELT-MD-CC-4-4-TH & ELT-H-CC-5-4-TH**

ELT-MD-Minor-4-5-P
Course Name: Electronic Communication Lab
[Credit: 1; Lecture Hours: 30]
Deatil syllabus same as **ELT-MD-CC-4-4-P & ELT-H-CC-5-4-P**

SEMESTER-6
MD-CC-7: Power and Opto Electronics
[Credits: 4 (3TH+1P)]

ELT-MD-CC-7-6-TH
Course Name: Power and Opto Electronics
[Credits: 3; Lecture Hours: 45]
Deatil syllabus same as **ELT-MD-CC-7-5-TH**

ELT-MD-CC-7-6-P
Course Name: Power and Opto Electronics Lab
[Credit: 1; Lecture Hours: 30]
Deatil syllabus same as **ELT-MD-CC-7-5-P**

MD-CC-8: Electronic Instrumentation
[Credits: 4 (3TH+1P)]

ELT-MD-CC-8-6-TH
Course Name: Electronic Instrumentation
[Credits: 3; Lecture Hours: 45]

Unit-I [12 Lecture Hours]
Quality and Standards of Measurement: Static and Dynamic Characteristics of Instruments, Errors in Measurement (Gross Error, Systematic Error, Absolute Error and Relative Error), Statistical Analysis, Probability of Errors, Classification of Standards, Electrical Standards, Time and Frequency Standards, IEEE Standards.
Basic Measurement Instruments: PMMC Instrument, Galvanometer, Ammeter, Voltmeter (DC and AC), True RMS Voltmeter, Digital Voltmeter (Integrating and Nonintegrating type), Succesive Approximation, Digital Multimeter, Digital Frequency Meter.
Measurement of Resistance, Impedance, Capacitance by AC Bridges: Maxwell's Bridge, Hay's Bridge, Resonance Bridge, Anderson's Bridge, Wien's Bridge.

Unit-II [11 Lecture Hours]
Connectors and Probes: Low Capacitance Probes, High Voltage Probes, Current Probes, Identifying Electronic Connectors, Audio and Video, RF/Coaxial, USB, Serial and parallel Interfacing.
Oscilloscope: CRT, Waveform Display and Electrostatic Focusing, Time Base and Sweep Synchronization, Block Diagram, Working Principle, Measurement of Voltage, Frequency and Phase by CRO, Advantages and Applications of Dual Trace Oscilloscope, Digital Storage Oscilloscope, CRO Specifications (Bandwidth, Sensitivity, Rise Time).

Unit-III [11 Lecture Hours]
Signal Generators and Analysers: Audio Frequency Oscillator, Pulse Generator, Function Generator, Wave Analyzer, Spectrum Analyzer.
Transducers and Sensors: Classification of Transducers, Basic Requirement and Characteristics of Transducers, Active and Passive Transducers, Resistive Strain Gauge, Capacitive (Variable Area, Variable Air Gap), Inductive (LVDT) and Piezoelectric Transducers, Measurement of Temperature (RTD, Thermocouple, Thermistor, Semiconductor IC Sensors), Light Transducers (Photoresistors, Photovoltaic Cells, Photodiodes).

Unit-IV [11 Lecture Hours]
Introduction to Biomedical Instrumentation: Origin of Bioelectric Signals, Biomedical Recorders: ECG, EEG and EMG, MEMS Based Biosensors,Recording Electrodes, Electrodes for ECG, EMG and EEG, Measurement of Heart Rate, Blood Pressure, Temperature, Respiration Rate.

Basics of Control Systems : Classification of Control Systems, Basic control actions, Analog Electronic Process controllers, Digital Process Controllers, Programmable Logic Controller (Only Basic Principles, Operations and Applications).

ELT-MD-CC-8-6-P
Course Name: Electronic Instrumentation Lab
[Credit: 1; Lecture Hours: 30]

Implementation using Hardware and SciLab/MATLAB/Any Other Circuit Simulator

1. Design of Multi Range Ammeter and Voltmeter using Galvanometer.
2. Measurement of Resistance by Wheatstone Bridge and Measurement of Bridge Sensitivity.
3. To Determine the Characteristics of Resistance Transducer : Strain Gauge (Measurement of Strain using Half and Full Bridge).
4. To Determine the Characteristics of LVDT.
5. To Determine the Characteristics of Thermistors and RTD.
6. To Study the Characteristics of Photodiode
   (a) Variable Illumination, (b) Linear Displacement.
7. Measurement of Heart Sound using Electronic Stethoscope. Study on ECG Heart Rate Monitor/Simulator.
8. Measurement of Respiration Rate using Thermistor/Other Electrodes.

Reference Books:

- Kalsi, Electronic Instrumentation, Tata McGraw Hill.
- Helfrick and Cooper, Modern Electronic Instrumentation and Measurement Techniques, Pearson.
- Patranabis, Principles of Electronic Instrumentation, PHI.
- Carr, Elements of Electronic Instrumentation and Measurement, Pearson.
- Oliver and Cage, Electronic Measurements and Instrumentation, Tata Mcgraw Hill.
- Morris, Measurement and Instrumentation Principles, Elsevier (Buterworth-Heinmann).
- Sawhney, Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai.
- Ghosh, Introduction to Measurements and Instrumentation, PHI.
- Chatterjee, Biomedical Instrumentation System, Cengage.
- Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill.
- Natarajan, Biomedical Instrumentation and Measurements, PHI.

MD-Minor-5: Electromagnetism
[Credits: 4 (3TH+1P)]

ELT-MD-Minor-5-6-TH
Course Name: Electromagnetism
[Credits: 3; Lecture Hours: 45]
Deatil syllabus same as **ELT-MD-CC-5-4-TH**

ELT-MD-Minor-5-6-P
Course Name: Electromagnetism Lab
[Credit: 1; Lecture Hours: 30]
Deatil syllabus same as **ELT-MD-CC-5-4-P**

MD-Minor-6: Electronic Devices and Circuits
[Credits: 4 (3TH+1P)]

ELT-MD-Minor-6-6-TH
Course Name: Electronic Devices and Circuits
[Credits: 3; Lecture Hours: 45]
Deatil syllabus same as **ELT-MD-CC-6-5-TH**

ELT-MD-Minor-6-6-P
Course Name: Electronic Devices and Circuits Lab
[Credit: 1; Lecture Hours: 30]
Deatil syllabus same as **ELT-MD-CC-6-5-P**

MD-SEC: Circuit Simulation with PSPICE
[Credits: 4 (3TH+1P)]

ELT-MD-SEC-TH
Course Name: Circuit Simulation with PSPICE
[Credits:3; Lecture Hours: 45]

UNIT I [12 Lecture Hours]
Introduction to PSpice Software: Introduction, Descriptions of Spice, Types of Spice, File Types, PSpice platform (PSpice A/D, PSpice Schematics, OrCAD Capture), Limitations of PSpice.
Circuit Descriptions: Input files, Element values, Nodes, Circuit elements, Sources, Types of analysis, Output variables, PSpice output commands, Format of Circuit Files, Format of Output Files.
DC Operation and Circuit Analysis: Modelling of elements, Operating temperature, Independent DC Sources, Dependent Sources, DC Output variables, Passive Devices, Component names, Ohm's Law, Kirchhoff's Laws, Capacitors in DC circuits, Inductors in DC circuits, Types of Output (.PRINT, .PLOT, .PROBE, .WIDTH) statements and significances, Types of DC analysis (.OP, .TF, .DC, .PARAM) commands and their uses.

UNIT II [15 Lecture Hours]
Transient Analysis: Capacitors and Inductors, Modelling of Transient Sources (Exponential Source, Pulse Source, Piecewise Linear Source, Sinusoidal Source), Independent voltage Source, Independent Current Source, Transient response (.IC, .TRAN) commands and their uses.
AC Circuit Analysis: AC Output variables, Independent AC Sources, AC analysis, Magnetic elements.
Semiconductor Diodes: Diode element description, Diode Model description, Diode Parameters, Zener Diode Modelling, Diode Characteristics (Forward Bias, Reverse Bias, and Breakdown Region), DC analysis and Small Signal AC analysis of diode circuits, Half -Wave Rectifier Circuit.

UNIT III [18 Lecture Hours]
Bipolar Junction Transistors: BJT Element Description, BJT Model Description, BJT Statements, BJT Parameters, NPN Transistor operation, Analysis of Transistor circuits at DC, Different modes of Operation of Transistors, Small- Signal Model of BJT Amplifiers, DC Bias Sensitivity Analysis (Sensitivity to Component Variation and Temperature Variation).
Field Effect Transistors: Introduction to MOSFETs, MOSFET Parameters, MOSFET Element Description, MOSFET Model Description, Enhancement Mode N-Channel MOSFET Circuit, I-V Characteristics of MOSFET, Analysis of MOSFET Circuits at DC (Enhancement Mode and Depletion Mode, N-Channel and P- Channel).

ELT-MD-SEC-P
Course Name: Circuit Simulation with PSPICE Lab
[Credit: 1; Contact Hours: 30]

1. Verification of Kirchhoff's Voltage Law and Current Law.
2. Mesh and Node Analysis of Circuits using DC Sources.
3. Transient Analysis of RC, RL Circuits using Step Input.
4. AC Analysis of Series and Parallel RLC Circuits using Sinusoidal Input.
5. I-V Characteristics of P-N Junction Diode Operated in Forward Biased Mode.
6. I-V Characteristics of Zener Diode Operated in Reverse Biased Mode.
7. Input and Output Characteristics of NPN Transistor.
8. Analysis of BJT CE Amplifier.
9. Analysis of the I-V Characteristics of Enhancement Mode N-Channel MOSFET.
10. Analysis of the I-V Characteristics of Depletion Mode N-Channel MOSFET.

Reference Books:

- SPICE: A Guide to Circuit Simulation & Analysis using PSPICE, Paul W. Tuinenga.
- SPICE, Gordon W. Roberts and Adel S. Sedra.
- Introduction to PSPICE Using ORCAD For Circuits and Electronics, Muhammad H. Rashid.
- Analog Design and Simulation using OrCAD Capture and PSPICE, Dennis Fitzpatrick.

MD-IDC: Fundamentals of Electronics
[Credits: 3 (2TH+1TU)]

ELT-MD-IDC-TH
Course Name: Fundamentals of Electronics
[Credits: 3 (2TH + 1TU); Lecture Hours: 30TH + 15TU]
Deatil syllabus same as **ELT-H-IDC-TH**

Unit-I [9 Lecture Hours]
Basic Circuit Components: Circuit Elements: Resistors, Inductors, Capacitors, Transformers, Concept of Voltage and Current Sources, Kirchhoff's Current and Voltage Laws, Concept of Impedance, Equivalent Impedance of Series and Parallel Combinations of R, L and C.
Operational Amplifiers and Its Applications: Op-Amp and its Characteristics (Ideal and practical), Open and Closed Loop Configuration, Concept of Virtual Ground, Inverting, Non-Inverting, Summing and Difference Amplifiers.

Unit-II [11 Lecture Hours]
Semiconductor Devices and Circuits: Intrinsic and Extrinsic Semiconductors, Direct and Indirect Bandgap Semiconductors, Basic Concept of P-N Junction, P-N Junction Diode, Zener Diode, Solar Cell, LED and their I-V Characteristics, Use of Diode as Half-Wave and Full-Wave (Center Tapped) Rectifier.
Bipolar Junction Transistors (BJT): NPN **and PNP Transistors, E**nergy Band Diagram, Working Principle of Transistor as Amplifier and Switch, CE, CB, CC Configurations, Input and Output Characteristics of NPN Transistor in CB and CE modes, Cut-off, Active and Saturation Regions, Current Components in Active Mode, Need for Biasing and Bias Stability, Operating (Q) Point, Small Signal h-Parameter Model of CE Transistor.
Field Effect Transistor: MOSFET Structure, Depletion and Enhancement Modes, Complimentary MOS (CMOS).

Unit-III [10 Lecture Hours]
Digital Logic Circuits: Number Systems (Binary, Decimal, Hexadecimal), Addition and Subtraction (using 1's and 2's complement method) of Binary Numbers, Basic Postulates and Fundamental Theorems of Boolean Algebra, De Morgan's Theorems, Logic Symbol and Truth Tables of Basic Logic Gates (AND, OR, NOT), Derived Logic Gates (NAND, NOR, XOR and XNOR), Universal Property of NOR and NAND gates, Karnaugh Map Simplification (up to 4 Variables), Half-Adder and Full-Adder Circuits, Multiplexer, de-Multiplexer, SR, JK, D and T Flip Flops (Truth Table Only).
Electronic Communication: Introduction to Communication, Need for Modulation, Concept of AM and FM (Qualitative Discussions, No Derivations).

Reference Books:

- Chattopadhyay and Rakshit, Fundamentals of Electric Circuit Theory, S. Chand.
- Ghosh, Network Theory: Analysis and Synthesis, PHI.
- Chattopadhyay and Rakshit, Electronics: Fundamentals And Applications, New Age.
- Mottershead, Electronic Devices and Circuits: An Introduction, PHI.
- Rashid, Electronic Devices and Circuits, Cengage.
- Gayakwad, Op-Amps and Linear Integrated Circuits, Pearson.
- Malvino, Electronic Principals, Tata McGraw-Hill.
- Raychaudhuri, Digital Circuits, Vol. 1&2, Platinum.
- Kumar, Fundamentals of Digital Circuits, PHI.

Syllabus for the Undergraduate (B.Sc.) Course in Electronics (Minor)

The structure of the revised syllabus of Semesters 1 to 6 for the B.Sc. Course in Electronics (Minor) is as follows.

Each paper carries 4 Credits, equivalent to 100 marks.

Minor: Minor Course

TH: Theory, P: Practical, TU: Tutorial

Semester	Paper Code	Paper Name	Credit	Lecture
Semester – 1	ELT-Minor-1-1	Fundamentals of Circuit Theory and Electronic Devices	TH: 3, P: 1	L-45; P-30
	If Electronics is taken as Minor-1			
Semester – 2	ELT-Minor-2-2	Operational Amplifier and Digital Systems	TH: 3, P: 1	L-45; P-30
	If Electronics is taken as Minor-2			
Semester – 3	ELT-Minor-1-3	Fundamentals of Circuit Theory and Electronic Devices	TH: 3, P: 1	L-45; P-30
	If Electronics is taken as Minor-1			
Semester – 4	ELT-Minor-2-4	Operational Amplifier and Digital Systems	TH: 3, P: 1	L-45; P-30
	If Electronics is taken as Minor-2			
Semester – 5	ELT-Minor-3-5	Microprocessor and Microcontroller	TH: 3, P: 1	L-45; P-30
Semester – 6	ELT-Minor-4-6	Electronic Communication	TH: 3, P: 1	L-45; P-30

Note: Students with Major in other Discipline can opt for Electronics as one of the two Minor subjects. If it is chosen as the first Minor paper (Minor-1), they have to take ELT-Minor-1-1 and ELT-Minor-2-2 in Semesters 1 and 2 respectively. If it is chosen as the second Minor paper (Minor-2), they need to take the identical courses in Semesters 3 and 4 respectively. In Semesters 5 and 6 they have to take 1 Minor Course in each of the Semesters.

SEMESTER-1
Minor-1: Fundamentals of Circuit Theory and Electronic Devices
[Credits: 4 (3TH+1P)]

ELT-Minor-1-1-TH

Course Name: Fundamentals of Circuit Theory and Electronic Devices

[Credits: 3; Lecture Hours: 45]

Deatil syllabus same as **ELT-MD-CC-1-1-TH** & **ELT-H-CC-1-1-TH**

ELT-Minor-1-1-P

Course Name: Fundamentals of Circuit Theory and Electronic Devices Lab

[Credit: 1; Lecture Hours: 30]

Deatil syllabus same as **ELT-MD-CC-1-1-P** & **ELT-H-CC-1-1-P**

SEMESTER-2
Minor-2: Operational Amplifier and Digital Systems
[Credits: 4 (3TH+1P)]

ELT-Minor-2-2-TH

Course Name: Operational Amplifier and Digital Systems

[Credits: 3; Lecture Hours: 45]

Deatil syllabus same as **ELT-MD-CC-2-2-TH** & **ELT-H-CC-2-2-TH**

ELT-Minor-2-2-P

Course Name: Operational Amplifier and Digital Systems Lab

[Credit: 1; Lecture Hours: 30]

Deatil syllabus same as **ELT-MD-CC-2-2-P** & **ELT-H-CC-2-2-TH**

SEMESTER-3
Minor-1: Fundamentals of Circuit Theory and Electronic Devices
[Credits: 4 (3TH+1P)]

ELT-Minor-1-3-TH
Course Name: Fundamentals of Circuit Theory and Electronic Devices
[Credits: 3; Lecture Hours: 45]
Deatil syllabus same as **ELT-MD-CC-1-1-TH** & **ELT-H-CC-1-1-TH**

ELT-Minor-1-3-P
Course Name: Fundamentals of Circuit Theory and Electronic Devices Lab
[Credit: 1; Lecture Hours: 30]
Deatil syllabus same as **ELT-MD-CC-1-1-P** & **ELT-H-CC-1-1-P**

SEMESTER-4
Minor-2: Operational Amplifier and Digital Systems
[Credits: 4 (3TH+1P)]

ELT-Minor-2-4-TH
Course Name: Operational Amplifier and Digital Systems
[Credits: 3; Lecture Hours: 45]
Deatil syllabus same as **ELT-MD-CC-2-2-TH** & **ELT-H-CC-2-2-TH**

ELT-Minor-2-4-P
Course Name: Operational Amplifier and Digital Systems Lab
[Credit: 1; Lecture Hours: 30]
Deatil syllabus same as **ELT-MD-CC-2-2-P** & **ELT-H-CC-2-2-TH**

SEMESTER-5
Minor-3: Microprocessor and Microcontroller
[Credits: 4 (3TH+1P)]

ELT-Minor-3-5-TH
Course Name: Microprocessor and Microcontroller
[Credits: 3; Lecture Hours: 45]
Deatil syllabus same as **ELT-MD-CC-3-3-TH & ELT-H-CC-3-3-TH**

ELT-Minor-3-5-P
Course Name: Microprocessor and Microcontroller Lab
[Credit: 1; Lecture Hours: 30]
Deatil syllabus same as **ELT-MD-CC-3-3-P & ELT-H-CC-3-3-P**

SEMESTER-6
Minor-4: Electronic Communication
[Credits: 4 (3TH+1P)]

ELT-Minor-4-6-TH
Course Name: Electronic Communication
[Credits: 3; Lecture Hours: 45]
Deatil syllabus same as **ELT-MD-CC-4-4-TH & ELT-H-CC-5-4-TH**

ELT-Minor-4-6-P
Course Name: Electronic Communication Lab
[Credit: 1; Lecture Hours: 30]
Deatil syllabus same as **ELT-MD-CC-4-4-P & ELT-H-CC-5-4-P**