Electronics (Minor)

Four Years' Curriculum

in accordance with

National Education Policy

With Effective From

2023-24

Ramakrishna Mission Vidyamandira

Belurmath, Howrah – 711 202

Four Years' (Eight Semester) Course Distribution

Semester I/III	**Paper: 1ELTMIC1/3ELTMIC1**	***Circuit Theory & Network Analysis***
Semester II/IV	**Paper: 2ELTMIC1/4ELTMIC1**	***Semiconductor Devices & Circuits***
Semester V/VI	**Paper: 5ELTMIC1/6ELTMIC1**	***Analog ICs & Communication***
Semester VII/VIII	**Paper: 7ELTMIC1/8ELTMIC1**	***Digital Circuits & Applications***

Electronics

Semester I/III (Level 100/200)

Paper: 1ELTMIC1/3ELTMIC1

Circuit Theory & Network Analysis

Credits: 4 (Theory: 3 + Practical: 1)

Circuit Theory & Network Analysis (Theory)

Credits: 3 **Lectures: 45 hours**

1. ***Basic Circuit Elements and Concepts:*** Classification of Circuit Elements; Resistors, Fixed and Variable Resistors, Construction and Characteristics, Color Coding of Resistors, Resistors in Series and Parallel, Testing of Resistance using Multimeter; Inductors, Fixed and Variable Inductors, Self and Mutual Inductance, Energy Stored in an Inductor, Inductance in Series and Parallel, Testing of Inductance using Multimeter; Capacitors, Principles of Capacitance, Parallel Plate Capacitor, Permittivity, Definition of Dielectric Constant, Dielectric Strength, Energy Stored in a Capacitor, Air, Paper, Mica, Teflon, Ceramic, Plastic and Electrolytic Capacitor, Construction and Application, Capacitors in Series and Parallel, Factors Governing the Value of Capacitors, Testing of Capacitors using Multimeter, Ideal and Practical Voltage and Current Sources, Independent and Dependent Sources, Laws of Conservation of Energy and Charge. Transformer – Construction, Equivalent Circuit, Frequency Response, Auto-transformer. [8]
2. ***Circuit Analysis:*** Ohm's Law, Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis, Linear Circuits, Principle of Duality, Star-Delta Conversion. Problem Solving. [6]
3. ***Network Theorems and Applications:*** Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem, Reciprocity Theorem, Superposition Theorem, Millman's Theorem, Compensation Theorem, Tellegen's Theorem, Bisection Theorem, DC Circuit Analysis and Problem Solving. [8]
4. ***Two Port Networks:*** Concept of Port of a Network, Types of Ports, Impedance (Z), Admittance (Y) and Hybrid (*h*) Parameters of a Two Port Network. [4]
5. ***DC transient Analysis:*** Transient Response of Series RL, RC and RLC Circuits under DC Excitation, Infinite Time Solution. Problem Solving [5]
6. ***AC Circuit Analysis and Resonance:*** AC Circuit Analysis using Network Theorems, Sinusoidal Voltage and Current, Definition of Instantaneous, Peak, Peak to Peak, Root Mean Square and Average Values, Voltage-Current Relationship in Resistor, Inductor and Capacitor, Phasor, Complex Impedance, Sinusoidal Circuit Analysis for RL, RC, Series and Parallel RLC Circuits, Power in AC Circuits, Instantaneous Power, Average Power, Reactive Power, Power Factor. Problem Solving. [7]
7. ***Resonance in Reactive AC Circuits and Passive Filters:*** Resonance in Series and Parallel RLC Circuits, Quality (Q) Factor and Bandwidth, Passive Filters, Low Pass, High Pass, Band Pass and Band Stop Filers, Integrator and Differentiator. [7]

Circuit Theory & Network Analysis (Practical)

Credits: 1 **Lectures: 30 hours**

N.B.: *All of the following experiments should be done in the **Hardware Laboratory** and also should be validated with the help of **P-Spice Circuit Simulator**.*

1. Familiarization with:
   (a) Resistance in Series, Parallel and Series-Parallel; (b) Capacitors and Inductors in Series and Parallel; (c) Multimeter - Checking of Components; (d) Voltage Sources in Series, Parallel and Series-Parallel; (e) Voltage and Current Dividers.
2. Measurement of Amplitude, Frequency and Phase Difference using CRO.
3. Verification of Kirchoff's Law.
4. Verification of Thevenin's Theorem, Norton's Theorem and Maximum Power Transfer Theorem.
5. Verification of Superposition Theorem for a given circuit.
6. Design and study of RC Circuits as Differentiator and Integrator.
7. Designing of a Low Pass RC Filter and study of its Frequency Response.
8. Designing of a High Pass RC Filter and study of its Frequency Response.

Reference Books:

- Hyat, Kemmerly and Durbin, Engineering Circuit Analysis, Tata McGraw Hill.
- Boylestad, Essentials of Circuit Analysis, Pearson.
- Bel, Electronic Circuits, Oxford.
- Carlson, Circuits, Cengage.
- Kuo, Network Analysis and Synthesis, Wiley.
- Dorf and Svoboda, Introduction to Electric Circuits, Wiley.
- DeCarlo and Lin, Linear Circuit Analysis, Oxford.
- Sivanagaraju and Rao, Electrical Circuits Analysis, Cengage.
- Ghosh, Network Theory: Analysis and Synthesis, PHI.
- Sadiku, Musa and Alexander, Applied Circuit Analysis, Tata McGraw-Hill.
- Smith and Alley, Electrical Circuits: An Introduction, Cambridge.
- Ryder, Network, Lines and Fields, Pearson Education.
- Nasar, Electric Circuits, Schaum's Solved Problems Series, Tata McGraw Hill.
- Rashid, P-Spice, PHI
- Nahvi and Edminister, Electric Circuits, Schaum's Outline Series, Tata McGraw Hill.

Electronics

Semester II/IV (Level 100/200)

Paper: 2ELTMIC1/4ELTMIC1

Semiconductor Devices and Circuits

Credits: 4 (Theory: 3 + Practical: 1)

Semiconductor Devices & Circuits (Theory)

Credits: 3 **Lectures: 45 hours**

1. ***PN Junction Diodes and Applications*:** Semiconductors – Intrinsic and Extrinsic (P and N type), Carrier Drift and Diffusion, Recombination of Carriers, PN Junction – Formation, Space-charge region, Potential and Filed Distribution, Band Diagram; Piece-Wise Linear Characteristics of Diode, DC Load Line Analysis, Clipping and Clamping Circuits. Rectifiers, Half-Wave Rectifier, Full-Wave Rectifier (Center Tapped and Bridge), PIV, Ripple Factor, Efficiency, Filters, Types – Passive and Active (Basic Concept), Circuit Diagram and Explanation of Shunt Capacitor Filter with Waveforms, Zener Diode Regulator, Circuit Diagram, Load & Line Regulation. [8]
2. ***Bipolar Junction Transistors and Applications*:** BJT – Construction, Current Components and Current Gains, CE, CB and CC Characteristics and Regions of Operation. Transistor Biasing, DC Load Line, DC Operating Point or Q – Point, Thermal Runaway, Stability and Stability Factor, Fixed Bias with and without Emitter Resistor, Collector to Base Bias, Voltage Divider Bias and Emitter Bias, Transistor as a Switch, Circuit and Working; BJT as a 2-port Network – Hybrid (*h*) Parameters and Corresponding Model; BJT Amplifier, Voltage and Power Amplifier, DC and AC Load Line Analysis, Hybrid Model of CE Configuration, Frequency Response of CE Amplifier, Effect on Gain and Bandwidth for Cascaded RC Coupled CE Amplifier. [9]
3. ***Field Effect Transistor Circuits*:** FET - Concept and Types, Structure and Operation of JFET. Various Regions of Operation. Pinch-off. MOSFET - Structure and Operation of MOSFET. Enhancement and Depletion type MOSFET. Circuit Symbols. Biasing of MOSFETs, Small-signal Model. Common Source Amplifier Circuit Analysis, CMOS Circuits. CMOS - Basic Idea and Principle of Operation. Basic CMOS logic circuits. [9]
4. ***Feedback Amplifiers and Oscillators*:** Concept of Feedback, Negative and Positive Feedback, Types of Feedback Circuits, Voltage and Current (Series and Shunt) Feedback Amplifiers, Advantages and Disadvantages of Negative Feedback, Effect of Negative Feedback on Gain, Input and Output Impedances, Bandwidth and Distortion; Oscillators – Barkhausen Criteria, Phase Shift Oscillator, Colpitts Oscillator, Hartley Oscillator. [8]
5. ***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, Crossover Distortion, Heat Sinks. [7]
6. ***Tuned Amplifiers*:** Frequency Selective Networks, LC Circuits, Single and Double Tuned Amplifiers, Analysis of Voltage Gain and Selectivity, Limitations of Single Tuned Amplifier, RF and IF amplifiers, Applications of Tuned Amplifiers in Communication Circuits. [4]

Semiconductor Devices & Circuit (Practical)

Credits: 1 **Lectures: 30 hours**

N.B.: *All of the following experiments should be done in the* ***Hardware Laboratory*** *and also should be validated with the help of* ***P-Spice Circuit Simulator****.*

1. Study of current-voltage characteristic of a given Zener diode in forward and reverse bias condition and determination of diode parameters.
2. Study of the Half-Wave Rectifier and Full-Wave (Center-tap and Bridge) Rectifier.
3. Study of Voltage Regulator using Zener Diode and C Filter.
4. Study of the Clipping and Clamping Circuits.
5. Study of the output characteristics of a BJT in CE mode and determination of relevant *h* parameters.
6. Study of the BJT switch as a or inverter.
7. Designing and Testing of 5V/9V DC Regulated Power Supply using IC 78XX.
8. Study of the output characteristics of a JFET and determination of relevant FET parameters.

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.
- 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.
- Rashid, P-Spice, PHI

Electronics

Semester V/VI (Level 200)

Paper: 5ELTMIC1/6ELTMIC1

Analog ICs & Communication

Credits: 4 (Theory: 3 + Practical: 1)

Analog ICs & Communication (Theory)

Credits: 3 **Lectures: 45 hours**

1. ***Basic Operational Amplifier:*** Concept of Differential Amplifiers (Dual Input and Balanced and Unbalanced Output), Ideal Op-Amp and its Characteristics, Block Diagram of Op-Amp (IC 741), Deviations for a Real Op-Amp from Ideal Behavior. [5]
2. ***Op-Amp Parameters:*** Input offset voltage, Input offset current, Input bias current, Differential input resistance, Input capacitance, Offset voltage adjustment range, Input voltage range, Common mode rejection ratio, Slew-rate, Supply voltage rejection ratio. [5]
3. ***Op-Amp Circuits and Applications:*** Open and Closed Loop Configuration, Frequency Response, Inverting, Non-Inverting, Summing and Difference Amplifiers, Integrator, Differentiator, Multiplier and Divider, Voltage to Current and Current to Voltage Convertor, Instrumentation Amplifier. Basic Comparator, Level Detector, Schmitt Trigger. [9]
4. ***Timers Circuits:*** Multivibrators (IC 555), Functional Block Diagram, Working of timer chip, Astable and Monostable Multivibrator Circuits and Applications. [6]
5. ***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. [8]
6. ***Amplitude Modulation:*** Amplitude Modulation, Modulation Index and Frequency Spectrum, Generation of AM (Linear and Non Linear Methods), Amplitude Demodulation (Diode Detector), Concept of Double Side Band Suppressed Carrier (DSBC), Single Side Band Suppressed Carrier (SSBC), Block Diagram of AM Transmitter and Receiver. [7]
7. ***Angle Modulation:*** Frequency and Phase Modulation, Modulation Index and Frequency Spectrum, Equivalence between FM and PM, Generation of FM, FM Detector, Block Diagram of FM Transmitter and Receiver, Comparison between AM, FM and PM. [5]

Analog ICs & Communication (Practical)

Credits: 1 **Lectures: 30 hours**

1. Study of Op-Amp Characteristics: Offset and Bias parameters, CMRR and Slew Rate.
2. Designing of an Amplifier of given Gain for an Inverting and Non-Inverting Configuration using an Op-Amp.
3. Designing of Analog Adder and Subtractor Circuit.
4. Designing of an Integrator using Op-Amp for a given Specification and Study its Frequency Response.
5. Designing of a Differentiator using Op-Amp for a given Specification and Study its Frequency Response.
6. Designing of a Wien Bridge Oscillator using Op-Amp.
7. Study of IC 555 as Astable Multivibrator.
8. Study of IC 555 as Monostable Multivibrator.

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.
- Kennedy, Electronic Communication Systems, Tata McGraw Hill.
- Roddy and Coolen, Electronic Communications, Pearson.
- Kundu, Analog and Digital Communications, Pearson.
- Couch, Digital and Analog Communication Systems, Pearson.

Electronics

Semester VII/VIII (Level 300)

Paper: 7ELTMIC1/8ELTMIC1

Digital Circuits & Applications

Credits: 4 (Theory: 3 + Practical: 1)

Digital Circuits & Applications (Theory)

Credits: 3 **Lectures: 45 hours**

1. ***Integrated Circuits (Basic Concept):*** Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital ICs. Fan-in, Fan-out, Noise Immunity, Noise Margin, Power Dissipation, Figure of Merit, Speed Power Product, TTL and CMOS Families and their Comparison. [6]
2. ***Number System and Codes:*** Decimal, Binary, Hexadecimal and Octal Number Systems, Base Conversions and Arithmetic (Addition, Subtraction by Complement Method, Multiplication), Representation of Signed and Unsigned Numbers, Binary Coded Decimal (BCD) Code. [5]
3. **Logic Gates and Boolean Algebra:** Basic Postulates and Fundamental Theorems of Boolean Algebra, Switching Equivalent Circuits of Basic Gates, Truth Tables and Symbolic Representation of OR, AND, NOT, NAND, NOR XOR, XNOR Gates, Universal Logic Gates, Circuit Representation using Universal Logic Gates. [4]
4. **Combinational Logic Analysis and Design:** Standard Representation of Logic Functions (SOP and POS), Karnaugh Map Minimization, Multiplexers and Demultiplexers, Encoder and Decoder, Implementation of Logic Functions with Multiplexer, Binary Adder and Subtractor, Parallel Adder/Subtractor, Comparator, Parity Checker. [9]
5. **Sequential Logic Design:** Latches and Flip Flops, Shift Registers, Counters (Ripples, Ring, Johnson, Synchronous, Asynchronous and Modulo-N), State Table, State Diagrams, Counter Design using Excitation Table and Equations. [9]
6. **Programmable Logic Devices:** Basic Concepts, ROM, PLA, PAL, CPLD, FPGA. [5]
7. **Computer Organization**: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map. [7]

Digital Circuits & Applications (Practical)

Credits: 1 **Lectures: 30 hours**

1. Design basic gates using analog discrete components
2. Study of various logic gates and verification of truth tables
3. Universal gates – validation
4. Design half and full adder
5. Design half and full subtractor
6. Adder IC (7483/74283) and its applications – 4/8 bit adder, adder/subtractor, code converter using adder ICs
7. 1-bit comparator design and 4-bit comparator IC study
8. Designing Encoder, Decoder, MUX and DeMUX
9. Study of MUX and Decoder/DeMUX ICs
10. Use of seven segment display unit with driver
11. Study of various sequential circuits, Designing counter and register circuit, Study of functionalities and applications of IC 7476, IC 74194, IC 74193.

Reference Books:

- Mano and Cileti, Digital Design: With an Introduction to Verilog HDL, Pearson.
- 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.