NEP Syllabus
for
UG Electronic Science
West Bengal State University

Contents:

Semester – I				
Sl. No.	**Subject Type**	**Paper Name**	**Paper Code**	**Credit**
1.	Major-1 (Theory)	Electronics Foundation-I	ELSDSC101T	3
2.	Major-1 (Practical)	Electronics Foundation-I Lab	ELSDSC101P	2
3.	Minor-1 (Theory)	Basic Electronics-I	ELSCOR101T/ELSMIN101T	3
4.	Minor-1 (Practical)	Basic Electronics-I Lab	ELSCOR101P/ELSMIN101P	2
5,	SEC-1	Introduction to IoT: Components, Communication and Networking:	ELSHSE101M	3

Semester – II				
Sl. No.	**Subject Type**	**Paper Name**	**Paper Code**	**Credit**
1.	Major-2 (Theory)	Electronics Foundation-II	ELSDSC202T	3
2.	Major-2 (Practical)	Electronics Foundation-II Lab	ELSDSC202P	2
3.	Minor-2 (Theory)	Electronic Devices	ELSCOR202T/ELSMIN202T	3
4.	Minor-2 (Practical)	Electronic Device Lab	ELSCOR202P/ELSMIN202P	2
5,	SEC-2	Catch the Python: ELSHSE202M	ELSHSE202M	3

Semester – III				
Sl. No.	**Subject Type**	**Paper Name**	**Paper Code**	**Credit**
1.	Major-3 (Theory)	Semiconductor Devices	ELSDSC303T	3
2.	Major-3 (Practical)	Semiconductor Devices Lab	ELSDSC303P	2
3.	Minor-3 (Theory)	Linear and Digital Integrated Circuits	ELSCOR303T/ELSMIN303T	3

4.	Minor-3 (Practical)	Linear and Digital Integrated Circuits Lab	ELSCOR202P/ELSMIN202P	2
5,	SEC-3	Introduction to IoT: Components, Communication and Networking	ELSHSE101M/ ELSGSE301M	3

Semester – IV

Sl. No.	Subject Type	Paper Name	Paper Code	Credit
1.	Major- 4 (Theory)	Analog and Digital Electronics - I	ELSDSC404T	3
2.	Major- 4 (Practical)	Analog and Digital Electronics -I Lab	ELSDSC404P	2
3.	Major- 5 (Theory)	Analog and Digital Electronics - II	ELSDSC405T	3
4.	Major- 5 (Practical)	Analog and Digital Electronics -II Lab	ELSDSC405P	2
5.	Major- 6(Theory)	Mathematical Methods for Electronics	ELSDSC406T	3
6.	Major- 6 (Practical)	Mathematical Methods for Electronics Lab	ELSDSC406P	2
7.	Major- 7 (Theory)	Linear Integrated Circuits	ELSDSC407T	3
8.	Major- 7 (Practical)	Linear Integrated Circuits Lab	ELSDSC407P	2
9.	Minor- 4 (Theory)	Microprocessor and Digital Circuit Design	ELSCOR404T/ELSMIN404T	3
10.	Minor- 4 (Practical)	Microprocessor and Digital Circuit Design Lab	ELSCOR404P/ELSMIN404P	2

Semester – V

Sl. No.	Subject Type	Paper Name	Paper Code	Credit
1.	Major- 8 (Theory)	Signals and Systems	ELSDSC508T	3
2.	Major- 8 (Practical)	Signals and Systems Lab	ELSDSC508P	2

3.	Major- 9 (Theory)	Electromagnetics	ELSDSC509T	3
4.	Major- 9 (Practical)	Electromagnetics Lab	ELSDSC509P	2
5.	Major- 10 (Theory)	Microprocessor and Microcontroller	ELSDSC510T	3
6.	Major- 10 (Practical)	Microprocessor and Microcontroller Lab	ELSDSC510P	2
7.	Major- 11 (Theory)	Control System	ELSDSC511T	3
8.	Major- 11 (Practical)	Control System Lab	ELSDSC511P	2
9.	Minor- 5 (Theory)	Instrumentation	ELSCOR505T/ELSMIN505T	3
10.	Minor- 5 (Practical)	Instrumentation Lab	ELSCOR505P/ELSMIN505P	2

Semester – VI

Sl. No.	Subject Type	Paper Name	Paper Code	Credit
1.	Major- 12 (Theory)	Electronic Communication	ELSDSC612T	3
2.	Major- 12 (Practical)	Electronic Communication Lab	ELSDSC612P	2
3.	Major- 13 (Theory)	Instrumentation and Power Electronic Devices	ELSDSC613T	3
4.	Major- 13 (Practical)	Instrumentation and Power Electronic Devices Lab	ELSDSC613P	2
5.	Major- 14 (Theory)	Photonics	ELSDSC614T	3
6.	Major- 14 (Practical)	Photonics Lab	ELSDSC614P	2
7.	Major- 15 (Theory)	Digital Signal & Bio-Medical Image Processing	ELSDSC615T	3
8.	Major- 15 (Practical)	Digital Signal & Bio-Medical Image Processing Lab	ELSDSC615P	2

9.	Minor- 6 (Theory)	Modern Communication System	ELSCOR606T/ELSMIN606T	3
10.	Minor- 6 (Practical)	Modern Communication System Lab	ELSCOR606P/ELSMIN606P	2

Semester – VII

Sl. No.	Subject Type	Paper Name	Paper Code	Credit
1.	Major- 16 (Theory)	Computer Networks and Mobile Communication:	ELSDSC716T	3
2.	Major- 16 (Practical)	Computer Networks and Mobile Communication Lab	ELSDSC716P	2
3.	Major- 17 (Theory)	Basics of VLSI and Nanotechnology	ELSDSC717T	3
4.	Major- 17 (Practical)	Basics of VLSI and Nanotechnology Lab	ELSDSC717P	2

Semester – VIII

Sl. No.	Subject Type	Paper Name	Paper Code	Credit
1.	Major-18 (Theory)	AIOT	ELSDSC818T	3
2.	Major- 18 (Practical)	AIOT	ELSDSC818P	2
3.	Major- 19 (Theory)	Microwave Electronics	ELSDSC819T	3
4.	Major- 19 (Practical)	Microwave Electronics Lab	ELSDSC819P	2
5.	Major- 20 (Theory)	Advanced Communication	ELSDSC820T	3
6.	Major- 20 (Practical)	Advanced Communication Lab	ELSDSC820P	2

7.	Major- 21 (Theory)	VLSI Circuit Design	ELSDSC821T	3
8.	Major- 21 (Practical)	VLSI Circuit Design Lab	ELSDSC821P	2

Semester I/II/III

1. MDC-1
2. Evaluation Note

Semester–I

Major–1 (Theory): Electronics Foundation-I: ELSDSC101T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit – I: Electronics in our everyday Life (Lectures - 03)

Why Study Electronics? Make informed decisions based on our everyday needs. Science of Electronics behind working of everyday electronic devices such as mobile phones, Home inverters, Memory devices, LED lighting, LED television, Electric vehicles and solar panels. Internet of Things – the science behind smart homes. Concept of Analog and Digital electronics.

Unit – II: Introduction to Semiconductor (Lectures - 07)

Material classification on the basis of electrical conductivity and temperature coefficient- Insulator, Semiconductor and conductor, Importance of semiconductor in electronics**.**
Charge carriers in semiconductors- electrons and holes, Types of Semiconductors- p and n type, Intrinsic and extrinsic semiconductors**,** Generation and Recombination Processes, Mechanism of current conduction in semiconductors -drift and diffusion, Drift velocity, Carrier Mobility and its variation with temperature.

Unit – III: Physics of Crystalline Solids (Lectures - 13)

Crystalline materials: Crystal Structure in solids, Concept of Lattice, Basis, Crystal axes and planes, Miller indices, Primitive cells- of simple cubic cubic (s.c.), face centred cubic (f.c.c.) and body centred cubic (b.c.c.), Expressions for interplanar distance, Packing density, Coordination number of s.c., f.c.c and b.c.c. lattice, Reciprocal lattice and Brillouin zone, Bonding in Solids, Structure of Si and GaAs.

Unit - IV: Network Theory (Lectures - 22)

Concept of A.C. and DC signal, RMS and average value of AC sinusoidal signal, Concept of ideal voltage and current sources, Kirchhoff's current and voltage laws as an extension of laws of conservation of charge and energy, Ideal vs practical component properties, AC and DC behaviour of basic components, Concept of quality factor of a component, Phasor relationship between R, L and C.
Network topology and definitions, Mesh analysis, Node analysis.
Principle of duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum power transfer theorem, Millman's Theorem, Reciprocity Theorem, Compensation Theorem (Substitution Theorem), Star-delta transformation, Circuit analysis using network theorems.

Recommended Books:

1. Solid State Electronic Devices: Ben G. Streetman, S.K. Banerjee, Pearson.
2. Solid State Physics: S.O. Pillai, New Age International (P) Ltd. International (P) Ltd.
3. Solid State Physics: A.J. Dekker, Macmillan Education.
4. The Art of Electronics: Paul Horowitz, Winfield Hill, Cambridge University Press.
5. Circuits And Networks: Analysis And Synthesis, Sudhakar and Shyammohan Tata McGraw Hill.

6. Circuit Theory Analysis and Synthesis: Salivahanan, Pearson
7. Electronics Fundamentals and Applications: Chattopadhyay and Rakshit, New Age International (P) Ltd.

Major–1 (Practical): Electronics Foundation-I Lab: ELSDSC101P
(Credit:2, Full marks: 50, 60 Laboratory-Hour)

Prerequisite: Introduction to DC voltage source; Introduction to digital multimeter and its applications, Introduction to practical Resistors (with color code, wattage), Capacitors, Inductors, Diodes, Transformers and their specifications, Measurement of resistance of resistor using multimeter, Concept of voltage divider, Measurement of forward and backward resistances of diode using multimeter.

Expt. 1: Verification of Ohm's Law; Verification of Kirchhoff Current Law.

Expt. 2: Verification of equivalent resistance in cases of series and parallel combination of resistors.

Expt. 3: Verification of Thevenin's theorem.

Expt. 4: Verification of Norton's theorem.

Expt. 5: Verification of maximum power transfer theorem.

Expt. 6: Verification of Superposition Theorem.

Expt. 7: Verification of equivalence of Star-Delta conversion and vice-versa.

Minor-1 (Theory): Basic Electronics-I: ELSCOR101T/ELSMIN101T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit–I: Laws of Electronics and Passive Components (Lectures- 10)

C. Basic Laws in Electronics and their applications

1. Charge, Potential, Field, Voltage (DC and AC), Current (DC and AC), Electrical Load, Electrical Power, Root mean square and Average value of AC voltage, Ideal and practical voltage/current sources, Decibel unit in electronics.
2. Review of Coulomb's First and Second Laws in Electrostatics; Gauss's Law, Faraday's Law of Electromagnetic Induction (First, Second and Third or Lenz's Law), First Law of Joule, Biot Savart Law for Electric and Magnetic field, Ampere's Circuital Law, Lorentz force (motion of charged particle in magnetic field), Ohm's Law.

D. Basic passive components in electronics and their applications

1. Resistors, Their various types, Series-parallel combination.
2. Capacitors, Capacitive reactance, Their various types, Parallel plate capacitor, Cylindrical capacitor, Series-parallel combination, Concept of variable capacitor.
3. Inductors, Inductive reactance, Their various types, Solenoids (Solenoid, Toroid) Series-parallel combination, Self- inductance of a coil, Mutual inductance of two coils.
4. Transformers: Operating principles, Construction, Applications.

5. AC and DC behaviour of basic components, Concept of quality factor of a component, Phasor relationship between R, L and C.

Unit–II: Network Analysis – I (Lectures -23)

1. Kirchoff's Voltage and current laws -Application to Mesh analysis, Node analysis.
2. Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum power transfer theorem, Inter-conversion between Thevenin's and Norton's equivalent circuits (for DC circuits), AC circuit analysis using network theorems.
3. Star-Delta transformation Theorem, Delta-Star transformation Theorem.
4. Transient responses of series CR, LR circuits with DC excitation (using differential equation).
5. Power in AC circuits (average power, instantaneous power), Power factor, Phasor diagram, AC analysis of CR, LR, and LCR circuits, Resonance in series and parallel LCR circuits and their frequency responses, Quality factor and bandwidth.

Unit–III: PN Junction Diode and Rectifiers (Lectures -12)

1. Ideal and practical diodes, Formation of depletion layer, Schockley diode equation, I–V characteristics, Reverse saturation current, DC load line, Static and dynamic resistance.
2. Zener diode and its I–V characteristics, Reverse saturation current, Zener and avalanche breakdown, Application of Zener diode as voltage regulator.
3. Half-wave and full-wave centre-tap and bridge rectifiers, Expressions for output voltage, PIV, Ripple factor and efficiency, Operation with and without shunt capacitor filter.

Recommended Books:

1. The Art of Electronics: Paul Horowitz, Winfield Hill, Cambridge University Press.
2. Electric Circuits: Mahmood Nahvi, Joseph A Edminister, K. Uma Rao, Tata McGraw Hill.
3. Electronics Fundamentals and Applications: Chattopadhyay and Rakshit, New Age International (P) Ltd.
4. Fundamentals of Electric Circuits: Alexander, M. Sadiku, McGraw Hill.
5. Electronic Devices and Circuit Theory: Robert L. Boylestad, Louis Nashelsky, Pearson.
6. Basic Electrical Engineering: I.J. Nagrath, D.P. Kothari, Tata McGraw Hill.
7. Basic Electrical Engineering: C.L. Wadhwa, New Age International (P) Ltd. International Publishers.
8. Circuits and Networks: Analysis and Synthesis, A. Sudhakar, S.S. Palli, McGraw Hill.

Minor-1 (Practical): Basic Electronics-I: ELSCOR101P/ELSMIN101P
(Credit 2, Full marks: 50, 60 Laboratory-Hour)

Prerequisite: Introduction to DC voltage source; Introduction to digital multimeter and its applications, Introduction to practical Resistors (with color code, wattage), Capacitors, Inductors, Diodes, Transformers and their specifications, Measurement of resistance of resistor using multimeter, Measurement of forward and backward resistances of diode using multimeter.

Expt. 1: (i) Verification of equivalent resistance in case of series and parallel combination of resistors.
(ii)Verification of Thevenin's, Norton's and maximum power transfer theorem using an unbalanced Wheatstone bridge.

Expt. 2: Introduction to AC source, Introduction to CRO/DSO; Measurement of frequency, amplitude and phase of AC sources; Construct a CR circuit for predefined phase difference and measure phase difference between input and output signals.

Expt. 3: (a) Finding capacitance of a capacitor. (b) Finding the phase difference between the current and voltage across the capacitor using either of Methods 1 and 2
Hints for (a):

Method-1

Construct a series CR circuit (in which the resistor is a variable resistor) and use a AC voltage source to excite the circuit. Measure the amplitude of voltages across the resistor (V_R) and capacitor (V_C). Vary the variable resistor until $V_R = V_C$. Measure the value of the resistor (R) when $V_R = V_C$. Under such condition, the unknown capacitance is given by $C=\frac{1}{R\omega}=\frac{1}{R\times 2\pi f}$, where f is the frequency of the AC voltage source. Plot: Plot V_R and V_C as a function of R.
Typical values: $V_{AC}= -1\ to+1$, $f=1kHz$, R ~ 1 kΩ pot, C ~ 1 μF.

Method-2

Construct a series CR circuit and use an AC voltage source to excite the circuit, Measure the amplitude of the voltage across the resistor, calculate the amplitude of current thorough the circuit knowing the value of resistor, calculate the impedance in the circuit from the amplitude of the supply voltage and current in the circuit, Calculate the impedance of the circuit with known frequency and resistance value, find the unknown capacitance by equating calculated impedance with experimentally estimated impedance. Plot measured impedance of the circuit as a function of frequency and explanation of the nature of the plot. Repeat the experiment two more times.
Take another unknown capacitor and find its value.
Hints for (b):
View the waveforms across the resistor and capacitor and find their phase difference (the waveform across the resistor will represent the current waveform).

Expt. 4: (a) Finding inductance of an inductor. (b) Find the phase difference between the current and voltage across the inductor using either of Methods 1 and 2

Hints for (a)

Method-1:

Same as earlier. Construct a series LR circuit (in which the resistor is a variable resistor) and use an AC voltage source to excite the circuit. Measure the amplitude of voltages across the resistor (V_R) and capacitor (V_L). Vary the variable resistor until $V_R = V_L$. Measure the value of the resistor (R) when $V_R = V_L$. Under such condition, the unknown inductance is given by $L=R\omega=R2\pi f$, where f is the frequency of the AC voltage source. Plot: Plot V_R and V_L as a function of R. Typical values: $V_{AC}= -1\ to+1$, $f=5kHz$, R ~ 1 kΩ pot, L ~ 10 mH.

Method-2:

Similar to method as described earlier.

Hints for (b):

View the waveforms across the resistor and inductor and find their phase difference (the waveform across the resistor will represent the current waveform).

Expt. 5: Study frequency responses (amplitude of current Vs frequency) of a series LCR circuits. Find the resonance frequency, Q factor and bandwidth for each of these circuits.

Expt. 6: Study I–V characteristics of PN junction diode. Plot forward biased I–V graph. Find reverse saturation current (Hints: Plot InI_d versus V_d from forward biased data, interpolate the line up to Y-axis intercept (negative side of Y-axis), say this intercept is $y=lnI_d^{sat}$, Reverse saturation current $I_d^{sat}=e^y$).

Skill Enhancement Course

SEC-1: Introduction to IoT: Components, Communication and Networking: ELSHSE101M (Credit: 3, Full Marks: 50, 45 Tutorial/Lab Hours)

Unit -I: Introduction to Internet of Things **(Lectures -12)**

Definition and Characteristics of IoT, Sensors, Actuators, Physical Design of IoT – IoT Protocols, IoT communication models, IoT Communication APIs, Domain Specific IoTs – Home, City, Environment, Energy, Agriculture and Industry.

Unit-II: Interfaces **(Lectures -12)**

IoT Physical Devices and Endpoints, Interfaces (serial, SPI, I2C) Controlling Hardware- Connecting LED, Buzzer, Switching High Power devices with transistors, Controlling AC Power devices with Relays.

Unit-III: Sensors **(Lectures -10)**

Light sensor, Temperature sensor with thermistor, Voltage sensor, ADC and DAC, Temperature and Humidity Sensor DHT11, Motion Detection Sensors, Wireless Bluetooth Sensors, Level Sensors.

Unit -IV: **(Lectures - 11)**

Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination, Some challenges (Design challenges, Development challenges, Security challenges, other challenges).

Recommended Books:

1. Internet of Things: Jeeva Jose, Khanna Publishing House
2. Internet of Things: V.K. Jain, Khanna Publishers
3. IoT Fundamentals: David Hanes, Cisco Press (Pearson)
4. Internet of Things (IoT): Dr. Rajiv Chopra, S.K. Kataria & Sons
5. INTERNET OF THINGS (IOT): Architecture and Design Principles: Raj Kamal, Mcgraw Hill
6. Sensors, Actuators and Their Interfaces: N. Ida, SciTech Publishers, 2014

Semester – II

Major-2 (Theory): Electronics Foundation-II: ELSDSC202T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit – I: Network Analysis - II **(Lectures - 20)**

1. Introduction to Laplace transform method, Convergence of the integral, Initial and final value theorems, Differentiation, Integration and time shifting in t and s domain, Transform of standard functions and their inverse.
2. Transient responses of series CR, LR and LCR circuits with DC excitation (using differential equation and Laplace transform).
3. Power in AC circuits (average power, instantaneous power), Power factor, Phasor diagram, Bode plot, AC analysis of CR, LR, and LCR circuits, Resonance in series and parallel LCR circuits and their frequency responses, Quality factor and bandwidth.
4. Passive filters: Lowpass, Highpass, Bandpass, Bandstop.
5. Two-port Networks–Impedance (Z) parameters, Admittance (Y) Parameters, h-parameters, Transmission (ABCD) parameters.

Unit- II: Physics of Electronics **(Lectures - 25)**

1. Brief introduction to dependence of energy distribution of particles on properties of material–MB, BE and FD distribution (no mathematical derivation required only qualitative discussion using examples), Significance of Fermi energy - Its dependence on carrier concentration and temperature.
2. Basic postulation of quantum mechanics, Wave representation of particle, Phase velocity and Group velocity, Probability density, Heisenberg Uncertainty principle.
3. Schrodinger wave Equation (time independent), Quantum mechanical operators (position, momentum, energy, operator algebra not included), Particle in one dimensional box, 3D box Particle subject to one dimensional step barrier potential (concept of tunnelling only -detailed calculation of transmission and reflection coefficient not required), Schrodinger equation applied to periodic potential field - Kronig Penny Model - concept of allowed and forbidden energy bands, Classification of materials – Insulators, Conductors, Semiconductors, Dielectrics.
4. Band structure of homo and heterojunctions: E-K diagram. Direct and indirect bandgap semiconductors, Semiconductor heterostructures – Concept of creating semiconductor quantum wells using compound semiconductors. 2DEG. Its significance in optoelectronics, High speed switching and nanoelectronics.

Recommended Books:

1. Solid State Electronic Devices: Ben G. Streetman, S.K. Banerjee, Pearson.
2. Semiconductor Physics And Devices: Neamen McGraw Hill.
3. Applied Quantum Mechanics: A.F.J. Levi, Cambridge.
4. Quantum Mechanics: Theory and Applications, Ajoy Ghatak, S. Lokanathan, Kluwer Academic Publishers.

5. Quantum Mechanics, Statistical Mechanics and Solid-State Physics: D. Chattopadhyay, P.C. Rakshit, S. Chand & Co. Ltd.
6. Elements of Quantum Mechanics: K. Singh, S.P. Singh, S. Chand & Co. Ltd.
7. Linear Circuit Analysis: DeCarlo and Lin, Oxford
8. Circuits And Networks: Analysis And Synthesis, Sudhakar and Shyammohan Tata McGraw Hill.
9. Circuit Theory Analysis and Synthesis: Salivahanan, Pearson
10. Basic Electronics: D. Chattopadhyay, P.C. Rakshit, New Age International (P) Ltd.

Major–2 (Practical): Electronics Foundation-II Lab: ELSDSC202P
(Credit:2, Full marks: 50, 60 Laboratory-Hour)

Expt. 1: Construct a CR circuit for predefined phase difference and measure phase difference with input signals using CRO.

Expt. 2: (a) Finding capacitance of a capacitor. (b) Finding the phase difference between the current and voltage across the capacitor using either of Methods 1 and 2
Hints for (a):

Method-1

Construct a series CR circuit (in which the resistor is a variable resistor) and use a AC voltage source to excite the circuit. Measure the amplitude of voltages across the resistor (V_R) and capacitor (V_C). Vary the variable resistor until $V_R = V_C$. Measure the value of the resistor (R) when $V_R = V_C$. Under such condition, the unknown capacitance is given by $C = \frac{1}{R\omega} = \frac{1}{R \times 2\pi f}$, where f is the frequency of the AC voltage source. Plot: Plot V_R and V_C as a function of R.
Typical values: $V_{AC} = -1\ to +1$, $f = 1kHz$, R ~ 1 kΩ pot, C ~ 1 μF.

Method-2

Construct a series CR circuit and use a AC voltage source to excite the circuit, Measure the amplitude of the voltage across the resistor, calculate the amplitude of current thorough the circuit knowing the value of resistor, calculate the impedance in the circuit from the amplitude of the supply voltage and current in the circuit, Calculate the impedance of the circuit with known frequency and resistance value, find the unknown capacitance by equating calculated impedance with experimentally estimated impedance). Plot measured impedance of the circuit as a function of frequency and explanation of the nature of the plot. Repeat the experiment two more times.
Take another unknown capacitor and find its value.
Hints for (b):
View the waveforms across the resistor and capacitor and find their phase difference (the waveform across the resistor will represent the current waveform).

Expt. 3: (a) Finding inductance of an inductor. (b) Find the phase difference between the current and voltage across the inductor using either of Methods 1 and 2

Hints for (a)

Method-1:

Same as earlier. Construct a series LR circuit (in which the resistor is a variable resistor) and use an AC voltage source to excite the circuit. Measure the amplitude of voltages across the resistor (V_R) and capacitor (V_L). Vary the variable resistor until $V_R = V_L$. Measure the value of the resistor (R) when $V_R = V_L$. Under such condition, the unknown inductance is given by $L=R\omega=R2\pi f$, where f is the frequency of the AC voltage source. Plot: Plot V_R and V_L as a function of R. Typical values: $V_{AC}= -1\ to+1$, $f=5kHz$, R ~ 1 kΩ pot, L ~ 10 mH.

Method-2:

Similar to method as described earlier.

Hints for (b):

View the waveforms across the resistor and inductor and find their phase difference (the waveform across the resistor will represent the current waveform).

Expt. 4: Study of RC circuit as lowpass filter (plot gain in dB as a function of frequency, use semi-log graph paper). Determine passband gain, 3 dB point, slope beyond the cut-off from the graph.

Expt. 5: Study of RC circuit as highpass filter (plot gain in dB as a function of frequency, use semi-log graph paper). Determine passband gain, 3 dB point, slope beyond the cut-off from the graph.

Expt. 6: Study frequency responses (amplitude of current Vs frequency) of a series LCR circuit. Find the resonance frequency, Q factor and bandwidth for each these circuits.

Expt. 7 : Study frequency responses (amplitude of current Vs frequency) of a parallel LCR circuit. Find the resonance frequency, Q factor and bandwidth for each these circuits.

Minor-2 (Theory): Electronic Device: ELSCOR202T/ELSMIN202T (Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit-I: Physics of Bipolar Junction Transistor (Lectures -10)

Static Characteristics (Minority Carrier Distribution and Terminal Currents), Current gains α and β and their interrelationship, Base- Width Modulation, Regions of operation (active, cut off and saturation), Modes of operation, Characteristics of CB, CE and CC Configurations, Transistor biasing, DC load line, Operating point, Need for biasing, Transistor as a switch.

Unit- II: Applications of Bipolar Junction Transistor (Lectures - 10)

Amplifiers: Transistor biasing and Stabilization circuits- Fixed Bias and Voltage Divider Bias, Thermal runaway, Stability and stability factor S(qualitative), Transistor as a two-port network, h-parameter equivalent circuit, Qualitative analysis of transistor as a single stage amplifier and effects of R-C coupling on frequency response of multistage amplifiers.

Unit-III: Field Effect Transistor (Lectures - 05)

MOSFET Structure, Depletion and Enhancement Modes, Static Characteristics of MOSFET, Comparison between BJT and MOSFET, Small Signal Parameters, Concept of Complimentary MOS (CMOS).

Unit-IV: Feedback Amplifier and OPAMP (Lectures - 20)

Feedback in Amplifiers: Concept of feedback, Negative and positive feedback, Advantages of negative feedback, Effects of positive feedback, Barkhausen criterion for sustained oscillations, Qualitative discussion of different oscillators (Hartley, Colpitts) using generalized block diagram (Detailed derivation of condition for oscillation or frequency of oscillation for individual oscillators not required).

Operational Amplifiers (Black box approach): Characteristics of an Ideal and Practical Operational Amplifier (IC 741), Transfer Characteristics, Open and closed loop configuration, Frequency Response, CMRR, Slew Rate and concepts of Virtual Ground and Virtual Short.

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Summing and Difference Amplifier, (3) Differentiator, (4) Integrator, (5) Comparator and Zero-crossing detector (6) Schmitt Trigger

Recommended Books:

1. Solid State Electronic Devices: Ben G Streetman and S. Banerjee, Pearson
2. Electronic Devices and Circuit Theory: Robert L. Boylestad, Louis Nashelsky, Pearson.
3. Electronics Fundamentals and Applications: Chattopadhyay and Rakshit, New Age International (P) Ltd.
4. Op-Amps and Linear IC's: R. A. Gayakwad, Pearson
5. Linear Integrated Circuits: Roychoudhury and Jain,New Age International (P) Ltd.
6. OP-AMP and Linear Integrated Circuits: K.L.Kishore, Pearson

Minor-2 (Practical): Electronic Device Lab: ELSCOR202P/ELSMIN202P

1. Study of the I-V Characteristics of a Zener diode under reverse bias. Plot its line and load regulation
2. Study of load regulation and ripple factor of a Full wave /Bridge rectifier (FWR) with and without a capacitor filter
3. Study the input and output characteristics of a transistor in common emitter mode. Calculate h_{ie} and h_{fe} from the characteristic curves
4. Design an (a) inverting and (b) adder using IC 741 (OPAMP) for different voltage gains
5. Design a (a) non-inverting amplifier using IC 741 (OPAMP) for different voltage gains. Hence show how it can be used as a unity gain buffer
6. Design a differential amplifier using IC 741

Skill Enhancement Course

SEC-2: Catch the Python: ELSHSE202M
(Credit: 3, Full Marks: 50, 45 Tutorial/Lab Hours)

Unit-I: Introduction to Python (Lectures - 08)

Python Introduction, History of Python, Introduction to Python Interpreter and program execution, Python Installation Process in Windows and Linux, Python IDE, Introduction to anaconda, Python variable declaration, Keywords, Indents in Python, Python input/output operations.

Unit - II: Python's Operators (Lectures - 08)

Arithmetic Operators, Comparison Operators, Assignment Operators, Logical Operators, Bitwise Operators, Membership Operators, Identity Operators, Ternary Operator, Operator precedence, Simple examples and exercises.

Unit-III: Python's Built-in Data types (Lectures - 03)

String, List, Tuple, Set, Dictionary (characteristics and methods), Simple examples and exercises.

Unit - IV: Conditional Statements & Loop (Lectures - 06)

Conditional Statements (If, If-else, If-elif-else, Nested-if etc.) and loop control statements (for, while, Nested loops, Break, Continue, Pass statements), Simple examples and exercises.

Unit -V: Function in python (Lectures - 08)

Introduction to functions, Function definition and calling, Function parameters, Default argument function, Variable argument function, In built functions in python, Scope of variable in python, Simple examples and exercises.

Unit-VI: File Processing (Lectures - 07)

Concept of Files, File opening in various modes and closing of a file, Reading from a file, Writing onto a file, Some important File handling functions e.g open(), close(), read(), readline() etc., Simple examples and exercises.

Unit- VII: Modules (Lectures - 05)

Concept of modularization, Importance of modules in python, Importing modules, Built in modules (ex. Numpy), Simple examples and exercises.

Recommended Books:

1. Summerfield Programming in Python 3, 2e.
2. Head First Python – A brain-friendly guide: Paul Barry, O'Reilly.
3. Python Programming: Reema Theraja, Oxford.
4. Python Programming: Sridhar, Pearson
5. Let us Python: Y. Knetkar, BPB.
6. Scientific Computing in Python: Abhijit Kar Gupta, Techno World

Semester – III

Major-3 (Theory): Semiconductor Devices: ELSDSC303T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit -I: Carrier Transport Phenomena: (Lectures - 11)

Free Electron Theory, Factors affecting conductivity of metals, Fermi surface, Density of State, Effective mass, Expression for carrier concentration, Position of Fermi level, Fermi velocity, Conductivity, Hall Effect, Einstein Relation, Current Density Equation, Carrier Injection, Diffusion length and its significance, Equation of Continuity.

Unit -II: Physics of P-N Junctions (Lectures - 14)

Significance of Fermi level: Effect of temperature, Dependence on doping, Invariance across junctions under equilibrium, Concept of quasi-Fermi levels.
Semiconductor-semiconductor Homojunction: Depletion Layer at the junction, Junction potential in presence and absence of field, Diode capacitance (concept of varactor diode), Current-voltage Characteristics (derivation not required) .
Metal-Semiconductor Contact: Qualitative idea of Schottky and Ohmic contact
Junction breakdown Mechanism: Zener and Avalanche
Tunnel diode, p-i-n diode structure, Working principle and applications in microwave and optoelectronics.

Unit -III: Bipolar Junction Transistors (BJT) (Lectures - 10)

BJT as a current control device, Basic Transistor Action, Transistor in Thermal Equilibrium, Quantitative Analysis of Static Characteristics (Minority Carrier Distribution and Terminal Currents), Base- Width Modulation, Modes of operation, Input and Output Characteristics of CB, CE and CC Configurations.

Unit -IV: Field Effect Transistors (Lectures - 10)

Transverse Field Effect & Channel isolation, Categories of FETs.
JFET*:* Channel Formation, Pinch-Off and Saturation Voltage, Current-Voltage Output Characteristics (proof not required).
MOSFET: MOS capacitor, Channel formation, Threshold voltage (ideal & real), Current-voltage relation, Depletion & Enhancement type MOSFET.

Recommended Books:

1. Solid State Electronic Devices: Ben G. Streetman, S.K. Banerjee, Pearson.
2. Semiconductor Physics And Devices: Neamen, McGraw Hill.
3. Integrated Electronics: Millman and Halkias, McGraw Hill.
4. Semiconductor Physics Basic Principles: Jasprit Singh,Wiley
5. Electronics Fundamentals and Applications: Chattopadhyay and Rakshit, New Age International (P) Ltd.

Major-3 (Practical): Semiconductor Devices: ELSDSC303P
(Credit: 2, Full Marks: 50, 60 Laboratory Hours)

1. Study of the I-V Characteristics of Diode – Static and Dynamic
2. Study of the I-V Characteristics of Zener Diode – Forward and reverse
3. Study of the I-V Characteristics of the CE configuration of BJT and obtain r_i, r_o, β.
4. Study of the I-V Characteristics of the Common Base Configuration of BJT and obtain r_i, r_o, α.
5. Study of the I-V Characteristics of JFET.
6. Study of variation in carrier concentration of semiconductor sample with temperature.

Minor-3 (Theory): Linear and Digital Integrated Devices: ELSCOR303T/ELSMIN303T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit – I: Number System & Codes, Logic Gates and Boolean Algebra, Digital Logic Families (Lectures - 06)

Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems - Base conversions, BCD representation, Arithmetic signed and complement representation, Addition and Subtraction using Complement method, BCD addition.

Logic Gates and Boolean algebra: Basic postulates and fundamental theorems of Boolean algebra, Switching equivalents of Basic gates, Circuit representation using Universal gates.

Unit-II: Combinational Logic Analysis and Design (Lectures - 12)

Standard representation of logic functions (SOP and POS), Karnaugh map, Encoder and Decoder, Multiplexers and Demultiplexers, Implementing logic functions with multiplexer, Binary Adder (Half and Full), Binary subtractor (Half and Full)
Multiplexer - Cascading and as a function generator, Demultiplexer.
Decoder - Cascading and as a function generator.
Comparator – 1 bit only.

Unit – III: Sequential Logic Design, Programmable Logic devices and Memory

(Lectures - 15)

Sequential Circuits: SR, D, and JK Flip-Flops, 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 (only up to 4 bits).
Counters (4 bits): Ring Counter, Asynchronous counters, Decade Counter, Synchronous Counter.

Unit – IV: Conversion Techniques between Analog and Digital Signals (Lectures- 06)

Parameters of conversion - Accuracy and Resolution, D-A Techniques – 4-bit binary weighted resistor and R-2R,

A-D conversion – Ramp type, Successive approximation.

Unit – V: Linear Integrated Devices **(Lectures - 06)**

555 timer: Structure and use in monostable and astable mode.
Applications: use as oscillator, VCO, Schmitt Trigger

Recommended Books:

1. Digital System Design: M. Morris Mano, Pearson Asia, (Fourth Edition)
2. Digital Fundamentals: Thomas L. Flyod, Pearson Asia (1994)
3. Digital Circuits Vol 1&2D: Raychoudhury, Platinum Publishers
4. Digital Electronics: D. Raychaudhuri, M. Mitra, NonlinearInsights (OPC) Pvt. Ltd.
5. Fundamentals of Digital Circuits, 4th ed: Anand Kumar, PHI
6. Digital Circuits and Design: S. Salivahanan & S. Pravin Kumar, Vikas Publishing
7. Linear Integrated Circuits: D. Raychoudhury, New Age International (P) Ltd.

Minor–3 (Practical): Linear and Digital Integrated Devices: ELSCOR303P/ELSMIN303P (Credit:2, Full marks: 50, 60 Laboratory-Hour)

1. a. To verify theorems of Boolean Algebra using Logic Gates
   b. Verify NAND & NOR gate as Universal gates.
   c. Implement 4 input NAND/NOR gate from two input gates
   d. To convert Boolean expression into logic circuit & design it using logic gate ICs.
2. To implement Half Adder and Full Adder using
   a. Basic Gates
   b. NAND/NOR gates
   c. Full Adder using two half adders
3. To implement Half Subtractor and Full Subtractor using
   a. Basic Gates
   b. NAND/NOR gates
4. Implement 2:1 Multiplexer using basic gates
5. Realization of Boolean expression using 8:1 multiplexer.
6. Realization of Boolean expression using Decoder IC
7. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
8. To build JK Master-slave flip-flop using Flip-Flop ICs

Semester - IV

Major – 4 (Theory): Analog and Digital Electronics - I: ELSDSC404T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit -I: Diode Circuits (Lectures -05)

Diode as a Circuit Element: DC and AC equivalent circuit, Clipper and clamper circuit, Zener diode: load and line regulation properties, Rectifiers – DC power supply, Filters.

Unit – II: Bipolar Junction Transistor Circuits (Lectures -18)

Review of CE, CB Characteristics and regions of operation, Transistor biasing, DC load line, Operating point, Thermal runaway, Stability and stability factor (only Self-Bias)

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

Analysis of BJT as an amplifier – (CE Mode) (using Hybrid parameters. /re model)), dc and ac load line analysis, Quantitative study of the frequency response of a CE amplifier, R-C coupled amplifier-, Effect on gain and bandwidth.

Unit – III: Number System & Codes, Logic Gates and Boolean Algebra, Digital Logic Families: (Lectures - 10)

Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems - base conversions and arithmetic.
Logic Gates and Boolean algebra: Positive and Negative Logic System, Basic postulates and fundamental theorems of Boolean algebra, Switching equivalents of Basic gates, Circuit representation using Universal gates.

Parameters of Logic Gates and Logic families: Fan-in, Fan out, Noise Margin, Speed power product, Setup and hold time, Implementation of basic gates using diodes and transistors, Operation of TTL NAND gate, Overview of different logic families and their comparison.

Unit – IV: Combinational Logic Analysis and Design: (Lectures - 12)

Standard representation of logic functions, Karnaugh map, Encoder and Decoder, Multiplexers and Demultiplexers, Implementing logic functions with multiplexer, Binary Adder, Binary subtractor, Parallel adder/subtractor, Comparator, Parity Checker.

Recommended Books

1. Electronic Devices And Circuit Theory: Boylstead and Nashelsky, Pearson
2. Electronic Circuits, Analysis and Design: Neamen, McGraw Hill
3. Electronic Devices: Conventional, Floyd, Pearson
4. Integrated Electronics: Millman and Halkias, McGraw Hill.
5. Electronics Fundamentals and Applications: Chattopadhyay and Rakshit, New Age International (P) Ltd.
6. Digital Logic and Computer Design: M. Morris Mano, Pearson

7. Digital Fundamentals: Thomas L. Flyod, Pearson
8. Digital Circuits: Vol 1&2 D. Raychoudhury Platinum Publishers
9. Digital Electronics: D. Raychaudhuri, M. Mitra, Nonlinear Insights (OPC) Pvt. Ltd.
10. Fundamentals of Digital Circuits: Anand Kumar, 4th ed. PHI
11. Modern Digital Electronics: R.P.Jain , McGraw Hill
12. Digital Circuits and Design: S. Salivahanan & S. Pravin Kumar, Vikas Publishing

Major-4 (Practical): Analog and Digital Electronics - I Lab: ELSDSC404P (Credit: 2, Full Marks: 50, 60 Laboratory Hours)

1. Study of the Half wave rectifier and Full wave rectifier.
2. Load and line regulation of Zener diode
3. Designing and testing of 5V/9 V DC regulated power supply and find its load-regulation
4. Study of clipping and clamping circuits.
5. Study of Stability of Q point in Fixed Bias and Voltage divider Bias configuration for transistors
6. To construct AND, OR, NOT gates using diodes and transistors.
7. To verify and design AND, OR, NOT and XOR gates using NAND gates.
8. To convert a Boolean expression into logic gate circuit and assemble it using logic gate IC's.
9. Design a Half Adder using (a) BASIC GATES (b) NAND gates
10. Design a Full Adder using (a) two Half-Adders (b) NAND gates
11. Use of IC 7483 as ADDER/Subtractor
12. Design a Half and Full Subtractor using NAND gates only.
13. Design of 1 bit comparator using Basic gates.

Major – 5 (Theory): Analog and Digital Electronics - II: ELSDSC405T (Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit -I: MOSFET Circuits (Lectures – 05)

MOSFET Circuits: Review of Depletion and Enhancement MOSFET, Biasing of MOSFETs, Small Signal parameters, Common Source amplifier circuit analysis, Working of CMOS Inverter.

Unit -II: Feedback Amplifiers (Lectures – 10)

Concept of feedback, Negative and positive feedback, Types of feedback circuits and effect on circuit parameters, Barkhausen criteria for oscillations, Study of phase shift oscillator, Wein-Bridge oscillator, Colpitts oscillator and Hartley oscillator (Circuit diagram and working principle only).
Regulated power supply: series and shunt (using BJT), SMPS.

Unit -III: Power Amplifier **(Lectures -10)**

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

Unit -IV: Sequential Logic Design, Programmable Logic devices and Memory:

(Lectures - 20)

Sequential logic design: Latches and Flip flops, Registers, Counters (synchronous and asynchronous and modulo-N), State Table, State Diagrams, Counter design using excitation table and equations, Register counter.
Programmable Logic Devices: Basic concepts- ROM, PLA, PAL
Memory -Memory technology, Types of memory-volatile & non-volatile, Concept of Primary, Secondary and Cache memory. Memory mapping techniques.

Recommended Books:

1. Electronic Devices And Circuit Theory: Boylstead and Nashelsky, Pearson
2. Electronic Circuits, Analysis and Design: Neamen, McGraw Hill
3. Electronic Devices: Conventional, Floyd, Pearson
4. Integrated Electronics: Millman and Halkias, McGraw Hill.
5. Electronics Fundamentals And Applications: Chattopadhyay and Rakshit, New Age International (P) Ltd.
6. Digital Logic and Computer Design: M. Morris Mano, Pearson
7. Digital Fundamentals: Thomas L. Flyod, Pearson
8. Digital Circuits Vol 1&2: D. Raychoudhury Platinum Publishers
9. Digital Electronics: D. Raychaudhuri, M. Mitra, NonlinearInsights (OPC) Pvt. Ltd.
10. Fundamentals of Digital Circuits: Anand Kumar, 4th ed. PHI
11. Modern Digital Electronics: R.P.Jain ,McGraw Hill
12. Digital Circuits and Design: S. Salivahanan & S. Pravin Kumar, Vikas Publishing

Major-5 (Practical): Analog and Digital Electronics - II Lab: ELSDSC405P
(Credit: 2, Full Marks: 50, 60 Laboratory Hours)

1. Study of power supply using C filter and Zener diode.
2. Design of a series regulated power supply
3. Designing of a Single Stage CE amplifier.
4. Study of the output characteristics of a MOSFET under common source configuration
5. Design a 2 X 1 Multiplexer using gates.
6. Realization of Boolean functions using 8:1 MUX.

7. Realization of Boolean functions Using 3:8 decoder
8. Use of seven segment display driver to display a two-digit number
9. To build a a) RS Latch Circuit b) J-K Flipflop using elementary gates.
10. Design a a) MODULO 4 B) MODULO 16 C) MODULO 10 counter using D/T/JK Flip-Flop.
11. Design a 3 Bit shift register and study Serial and parallel shifting of data.

Major – 6 (Theory): Mathematical Methods for Electronics: ELSDSC406T (Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit - I: Mathematics for Electronics (Lectures - 20)

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.

Ordinary differential equations: Basic Concepts, Separable Ordinary Differential Equations, Exact Ordinary Differential Equations, Linear Ordinary Differential Equations, Second Order homogenous and non-homogeneous differential equations.

Introduction to Matrices and Determinants, Types of matrices, Matrix arithmetic, Determinant of a square matrix, Simultaneous Equations and Characteristic Matrix, Eigenvalues of a square matrix.

Unit – II: Numerical Methods (Lectures - 05)

Finding a Root of an Algebraic or Transcendental Equation: Bisection and Newton-Raphson Methods.

Unit – III: Interpolation and Polynomial approximation and Curve fitting (Lectures -10)

Interpolation and Polynomial Approximations: Taylor Series and Calculation of Functions, Langrange Interpolation,

Curve Fitting: Least square fitting

Numerical Integration, Numerical Differentiation and Numerical methods for first order differential equations (Lectures - 10)

Numerical Integration: Trapezoidal Rule, Simpson's 1/3 Rule.

Numerical Differentiation: Finite difference

Numerical methods for first order differential equations: Gauss Elimination and Euler Method.

Recommended Books:

1. Vector Analysis, Schaum series: Murray. R. Spiegel, McGraw Hill
2. Engineering Mathematics: A Foundation for Electronic, Electrical, Communications and Systems Engineers, Croft, Pearson
3. Numerical Methods : Jain ,Iyengar and Jain, New Age International Publishers
4. Higher Engineering Mathematics: Grewal Khanna
5. Numerical Methods : Balaguruswamy ,McGraw Hill
6. Engineering Mathematics: Pal & Bhunia, Oxford
7. Engineering Mathematics: Das Volume I & II Pearson

Major-6 (Practical): Mathematical Methods for Electronics Lab: ELSDSC406P

(Credit: 2, Full Marks: 50, 60 Laboratory Hours)

To be implemented using Python/Matlab/Scilab

1. To Solve First-Order Ordinary Differential Equation with given Initial Values.
2. To Solve Second-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 method

Major – 7 (Theory): Linear Integrated Circuits: ELSDSC407T

(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit – I: Basic Operational Amplifier & Op-Amp Parameters: (Lectures - 08)

Concept of differential amplifiers (Dual input balanced and unbalanced output), Constant current bias, Current mirror, Cascaded differential amplifier stages with concept of level translator, Block diagram of an operational amplifier (IC 741).
Op-Amp parameters: Input offset voltage, Input offset current, Input bias current, Differential input resistance, Input capacitance, Offset voltage adjustment range, Input voltage range, Common mode rejection ratio, Slew rate, Supply voltage rejection ratio**.**

Unit – II: Op-Amp Circuits, Closed and Open Loop Applications: (Lectures - 16)

Frequency response of an op-amp in open loop and closed loop configurations, Inverting, Non-inverting, Summing and difference amplifier, Integrator, Differentiator, Voltage to current converter, Current to voltage converter, Log and Antilog amplifier.
Comparators: Basic comparator, Level detector, Voltage limiters, Schmitt Trigger.

Unit – III: Timers circuits and Other Fixed & Variable IC regulators: (Lectures - 12)

Comparative study of IC 741 with other OPAMP IC - TL074, OP07 and LM324
Multivibrators (IC 555): Block diagram, Astable and monostable multivibrator circuit, Applications of Monostable and Astable multivibrators, Phase locked loops (PLL): Block diagram, Phase detectors, IC565. Fixed and variable IC regulators: IC 78xx and IC 79xx -concepts only, IC LM317- output voltage equation, Operation of voltage-controlled oscillator (IC 566).

Unit – IV: Signal Conditioning circuits: (Lectures - 03)

Active filters: Comparison with passive filters, Design of first order low pass and high pass Butterworth filter

Unit – V: Conversion Techniques between Analog and Digital Signals (Lectures- 06)

Parameters of conversion - Accuracy and Resolution, D-A Techniques – 4-bit binary weighted resistor, R-2R and flash converter.

A-D conversion – Ramp type, Successive approximation.

Recommended Books:

1. Op-Amps and Linear IC's: R. A. Gayakwad, Pearson
2. Operational Amplifiers & Linear ICS: Bel, Oxford
3. Analog Integrated Circuit: Jacob, Pearson
4. Linear Integrated Circuits : Roychoudhury and Jain, New Age International (P) Ltd.

Major-7 (Practical): Linear Integrated Circuits Lab: ELSDSC407P

(Credit: 2, Full Marks: 50, 60 Laboratory Hours)

1. Measurement of OPAMP offset parameters.
2. Study of op-amp characteristics: CMRR and Slew rate.
3. Designing of an amplifier of given gain for an inverting and non-inverting configuration using an op- amp.
4. Designing of analog adder and subtractor circuit.
5. Study of Schmitt Trigger
6. Designing of an integrator using op-amp for a given specification and study its frequency response.
7. Designing of a differentiator using op-amp for a given specification and study its frequency response.
8. Designing of a First Order Low-pass filter using op-amp.
9. Designing of a First Order High-pass filter using op-amp.
10. Designing of a Wein Bridge Oscillator using op-amp.
11. Study of IC 555 as an Astable Multivibrator.
12. Designing of Fixed voltage power supply using IC regulators using 78 series and 79 series
13. Comparative study of TL074, OP07 and LM324 with IC741.
14. Design of 4 bit R-2R D-A converter

Minor-4 (Theory): Microprocessor and Digital Circuit Design:ELSCOR404T/ELSMIN404T (Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit – I: Introduction to Microprocessors (Lectures - 10)

Basic Block Diagram, Speed, Word Size, Memory Capacity, Classification of Microprocessors (Mention of Different Microprocessors being used), 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 Description of Microprocessor 8085, Basic Interfacing Concepts, Memory Mapped I/O and I/O Mapped I/O, Partial/Full Memory Decoding, DMA.

Unit-II: 8085 Instructions (Lectures - 10)

Operation Code, Operand and Mnemonics, Instruction Set of 8085, Addressing Modes, Instruction Format, Instruction Classifications, Instruction Cycle, Machine Cycle, T-States, Time Delay, Timing Diagrams Assembly Language Programming

Unit – III: 8085 Interrupts and Interfacing (Lectures - 05)

Interrupt Structure, Classification of interrupts and operation interrupt pins. Mechanism of masking and handling Multiple Interrupts, Direct Memory Access, HOLD and HLDA Signals, Interfacing with Programmable Peripheral Interface (PPI) 8255 Chip: Block Diagram, Pins, Control Word, Different Modes of Operation, Interfacing with Analog to Digital Converter (ADC) 0808 Chip.

Unit-IV: (Lectures - 12)

Digital Circuit Design: ALU Design: 4-bit and 8-bit Adders using 7483 Parallel Adder IC, Subtracter using 7483 Parallel Adder IC (by 1's, 2's , 9's and 10's complement methods), Design of BDC Adder using 7483 Parallel Adder IC, Design of 4-bit Magnitude Comparator using 7483 Parallel Adder IC.

Unit-V: (Lectures - 08)

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.

Recommended books

1. Microprocessor Architecture: Programming and Applications with 8085: Gaonkar Penram
2. Microprocessor: M Rafiquzzaman,
3. Microprocessor 8085 and Its Interfacing: Mathur, 2nd ed. PHI
4. Digital Logic and Computer Design,Mano,Pearson
5. Digital Electronics: D. Raychaudhuri, M. Mitra, Nonlinear Insights (OPC) Pvt. Ltd.

6. Fundamentals of Digital Circuits: Anand Kumar, 4th ed. PHI

Minor–4 (Practical): Microprocessor and Digital Circuit Design Lab: ELSCOR404P/ELSMIN404P
(Credit:2, Full marks: 50, 60 Laboratory-Hour)

1. Program for multibyte addition (8 and 16 bit) with and without carry.
2. Program for multibyte subtraction.
3. Program to multiply two 8-bit numbers.
4. Program to divide a 16-bit number by 8-bit number.
5. Program to use look-up table to find square of an 8 bit number.
6. Program to check for even/odd numbers
7. Program to check for positive and negative numbers.
8. Program to add a series of numbers
9. Program to search a given number in a given list.
10. Program to transfer a block of data.
11. Program to convert packed BCD number to an unpacked one
    Program to sort numbers in ascending/descending order

Semester - V

Major-8 (Theory): Signals and Systems: ELSDSC508T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit-I: Continuous and Discrete Time signals **(Lectures - 05)**

Types of signals (periodic-aperiodic, Deterministic-nondeterministic, Single and multiple valued, Signals in time, Spatial and frequency domain), Transformations.

Unit-II: Fourier Series Representation of Periodic Signals &Fourier Transform

(Lectures- 20)

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 – III: Discrete Time LTI systems **(Lectures - 10)**

Continuous time LTI system, 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 - IV: Z Transform: **(Lectures - 10)**

Introduction to Z-Transform- relevance in discrete domain, Relation with Laplace & Fourier Transforms, Condition of stability, Properties of Z-Transforms, Inverse Z-Transforms, Application of Z-Transforms.

Recommended Books

1. Signals and Systems: Alan V. Oppenheim, Pearson
2. Signals & Systems: Anand Kumar, PHI
3. Signals and Systems: Lathi, Oxford
4. Signals and Systems: Proakis, Pearson
5. Theory and Application of Digital Signal Processing: Rabiner, Pearson
6. Signals & Systems: Haykin, Wiley
7. Signals & Systems: Ramesh Babu ,Scitech

Major-8 (Practical): Signals and Systems Lab: ELSDSC508P
(Using Python/Scilab/Matlab)
Credit: 2, Full Marks: 50, 60 Laboratory Hours)

1. Plot for both continuous and discrete domain - sinusoidal signal, delta function, unit step function and periodic signal.

2. Generation of Signals: discrete time
3. To create user defined functions for signal operation: signal addition, time shifting, time scaling and time inversion.
4. To compute convolution of two signals and verify its properties.
5. To compute auto-correlation and cross-correlation of two signals and verify its properties.
6. To obtain the response of LTI system defined by linear constant coefficient difference equations.
7. To synthesize the periodic signal using Fourier series
    a. (i)To calculate Fourier series coefficients associated with Square Wave.
    b. (ii)To Sum the first 10 terms and plot the Fourier series as a function of time.
8. To Sum the first 50 terms and plot the Fourier series as a function of time.
9. To analyze the spectrum of the signal using Fourier transform and verify its properties.
10. To compute and plot the impulse response and pole-zero diagram of transfer function using Laplace transform.
11. Solution of Difference equations.
12. To compute and plot the impulse response and pole-zero diagram of transfer function using Z-transform.

Simulation Experiments using Virtual Lab

i. Study of properties of Linear Time-Invariant System
ii. Study of convolution Series and Parallel System

Major-9 (Theory): Electromagnetics: ELSDSC509T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit–I: Vector Analysis (Lecture - 03)

Rectangular (Cartesian) Coordinate System, Cylindrical Coordinates, Spherical Coordinates, Differential Length, Area and Volume, Line Surface and Volume integrals, The Laplacian.

Unit-II: Electrostatic Fields (Lecture - 06)

Review of Basic Laws of Electrostatics, Gauss's Law and Applications, Divergence Theorem and Maxwell's First Equation, Dielectric materials- Polarization, Dielectric Constant, Electrostatic Boundary conditions across different interfaces, Electrostatic Energy.

Poisson's and Laplace's equation, Uniqueness Theorem (no derivation required)

Unit-III: Magnetostatics (Lecture - 05)

Review of Basic Laws of Magneto statics, Ampere's Circuital Law, Curl and Stoke's Theorem, Maxwell's Equation, Magnetic Flux and Magnetic Flux Density, Scalar and Vector Magnetic Potentials, Magnetization in Materials and Permeability, Magnetic Boundary Conditions, Magnetic Energy.

Unit- IV: Time-Varying Fields and Maxwell's Equations (Lecture - 13)

Faraday's Law of Electromagnetic Induction, Concept of displacement Current, Maxwell's Equations in differential and integral form and Constitutive Relations, Potential Functions, Lorentz gauge and the Wave Equation for Potentials, Concept of Retarded Potentials, Electromagnetic Boundary Conditions. Time-Harmonic Electromagnetic Fields, Electromagnetic Energy and Power, Poynting Vector, Poynting Theorem.

Unit- V: Electromagnetic Waves in Non-conducting and Conducting Media (Lecture -12)

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.

Unit – VI: Radiation of electromagnetic waves (Lecture - 06)

Concept of retarded potentials, Radiation Mechanism, Antenna Parameters: Radiation Pattern, Radiation Power Density, Radiation Intensity, Beamwidth, Directivity, Antenna Efficiency, Gain, Beam Efficiency, Bandwidth, Concept of radiation resistance.
Types of Antenna: Hertzian dipole, Half wave dipole, Quarter-wave dipole, Yagi-Uda, microstrip, Parabolic antenna.

Recommended Books

1. Vector Analysis: Schaum series, Murray. R. Spiegel, McGraw Hill
2. Engineering Electromagnetics: Nathan Ida, Springer
3. Elements of Electromagnetics: M. N. O. Sadiku, Oxford University Press
4. Engineering Electromagnetics: W. H. Hayt and J. A. Buck, Tata McGraw Hill
5. Field and Wave Electromagnetics: D. C. Cheng, Pearson
6. Electromagnetics: Schaum Series, J. A. Edminster, Tata McGraw Hill
7. Elements of Engineering Electromagnetics: N. Narayan Rao, Pearson
8. Introduction to Electrodynamics: D.J. Griffiths, Pearson

Major-9 (Practical): Electromagnetics Lab: ELSDSC509P
(Using Python/Scilab/Matlab or other Simulation tools)
Credit: 2, Full Marks: 50, 60 Laboratory Hours)

1. Understanding and Plotting Vectors.
2. Transformation of vectors into various coordinate systems.
3. 2D and 3D Graphical plotting with change of view and rotation.
4. Representation of the Gradient of a scalar field, Divergence and Curl of Vector Fields.
5. Plots of Electric field and Electric Potential due to charge distributions.
6. Plots of Magnetic Flux Density due to current carrying wire.
7. Solutions of Poisson and Laplace Equations – contour plots of charge and potential distributions

Major-10 (Theory): Microprocessor and Microcontroller: ELSDSC510T

(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit – I: Introduction to Microprocessors (Lectures - 10)

Basic Block Diagram, Speed, Word Size, Memory Capacity, Classification of Microprocessors (Mention of Different Microprocessors being used), 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 Description of Microprocessor 8085, Basic Interfacing Concepts, Memory Mapped I/O and I/O Mapped I/O, Partial/Full Memory Decoding, DMA.

Unit-II: 8085 Instructions (Lectures - 10)

Operation Code, Operand and Mnemonics, Instruction Set of 8085, Addressing Modes, Instruction Format, Instruction Classifications, Instruction Cycle, Machine Cycle, T-States, Time Delay, Timing Diagrams Assembly Language Programming

Unit – III: 8085 Interrupts and Interfacing (Lectures - 05)

Interrupt Structure, Classification of interrupts and operation interrupt pins, Mechanism of masking and handling Multiple Interrupts, Direct Memory Access, HOLD and HLDA Signals, Interfacing with Programmable Peripheral Interface (PPI) 8255 Chip: Block Diagram, Pins, Control Word, Different Modes of Operation, Interfacing with Analog to Digital Converter (ADC) 0808 Chip.

Unit-IV: Introduction to Microcontrollers (Lectures - 20)

Introduction, Definition and use of Microcontroller, Difference with Microprocessor, Different Types of Microcontrollers, Embedded Microcontrollers, Microcontroller Memory Types, Microcontroller Features, Clocking, I/O Pins, Interrupts, Timers, Peripherals.

Introduction to Arduino Uno: Functional Block Diagram, Microcontroller inside Arduino Uno, Functions of each Pin, Arduino Development Boards- IDE, I/O Functions, Looping Techniques, Decision Making Techniques, designing of 1st Sketch, Programming of Arduino (Arduino ISP), Serial Port Interfacing, Basic Interfacing and I/O Concept, Interfacing LED and Switch.

Recommended books

1. Microprocessor Architecture: Programming and Applications with 8085: Gaonkar Penram
2. Microprocessor: M Rafiquzzaman,
3. The 8051 Microcontrollers & Embedded Systems: Muhammad Ali Mazidi, Pearson,
4. Microprocessor 8085 and Its Interfacing: Mathur, 2nd ed. PHI
5. Microcontroller Programming with Arduino and Python: Shroff Publishers
6. Python for Microcontrollers: Getting Started With MicroPython ,McGraw Hill
7. Digital Electronics with Arduino: Bob Dukish, BPB
8. Arduino Programming for beginners: Rajat Kumar Pal etc, Techno World

9. Arduino Programming Projects: Rohan Barnwal,BPB
10. 8051 Microcontroller: Ayla, Cengage

Major-10 (Practical): Microprocessor and Microcontroller Lab: ELSDSC510P

Credit: 2, Full Marks: 50, 60 Laboratory Hours)

Microprocessor and Microcontroller System Lab

1. Program to transfer a block of data.
2. Program for multibyte addition.
3. Program for multibyte subtraction.
4. Program to multiply two 8-bit numbers.
5. Program to divide a 16-bit number by 8-bit number.
6. Program to search a given number in a given list.
7. Program to generate terms of Fibonacci series.
8. Program to sort numbers in ascending/descending order.
9. Program to find the square root of an integer.

Arduino Microcontroller Programming

1. Controlling the Light Emitting Diode (LED) with a push button.
2. Controlling the LED blink rate with the potentiometer interfacing with Arduino
3. Solid State Relay Interface.
4. To Test all the Gates of a given IC74XX is Good or Bad.
5. Display of 4-Digit Decimal Number using the Multiplexed 7-Segment Display Interface.
6. Generate Sine, Square, Sawtooth, Triangular and Staircase Waveform using DAC Interface
7. Analog to Digital Conversion using Internal ADC and Display the Result on LCD.
8. Implementation of DC Voltmeter (0-5V) using Internal ADC and LCD.
9. Interfacing the RGB LED with the Arduino
10. Detection of the light using photo resistor
11. Interfacing of temperature sensor with Arduino
12. Directional Control of the DC motor.

Major-11 (Theory): Control System: ELSDSC511T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit-I: Introduction to Control Systems (Lectures - 10)

Open loop and Closed loop control systems, Mathematical modelling of physical systems (Electrical, Mechanical and Thermal), Block diagram representation & signal flow graph, Reduction Technique, Mason's Gain Formula, Effect of feedback on control systems.

Unit – II: Time and Frequency Domain Analysis (Lectures - 10)

Time Domain Performance Criteria, Transient Response of First, Second and Higher Order Systems, Steady state errors and static error constants, Correlation between Time and Frequency Response, Frequency Domain Specifications.

Unit-III: Concept of Stability **(Lectures - 15)**

Asymptotic Stability and Conditional Stability, Routh-Hurwitz Criterion, Relative Stability Analysis, Root Locus Plots and their Applications.

Frequency Domain Analysis: Correlation between time and frequency response, Polar plots, Frequency domain specifications, Logarithmic plots (Bode Plots), Gain and phase margins, Nyquist stability criterion.

Unit – IV: Controllers and Compensation Techniques **(Lectures - 10)**

Response with P, PI and PID Controllers, Concept of Compensation, Lag, Lead and Lag-Lead Networks.

Recommended books

1. Modern Control Engineering: K. Ogata, Pearson
2. Automatic control system: B. C. Kuo , PHI
3. Control System Engineering: Nise, Wiley
4. Control System: B.Manke, Khanna Publishers
5. Control System Engineering: J. Nagrath& M. Gopal, New Age International (P) Ltd.
6. Modern Control Engineering: D.Roychoudhury, PHI

Major-11 (Practical): Control System Lab: ELSDSC511P

Credit: 2, Full Marks: 50, 60 Laboratory Hours)

(Hardware and Octave/Scilab/MATLAB/Other Mathematical Simulation software)

1. To study characteristics of: a. Synchro transmitter receiver, b. Synchro as an error detector
2. To study position control of DC motor
3. To study speed control of DC motor
4. To find characteristics of AC servo motor
5. To study time response of type 0, 1 and 2 systems
6. To study frequency response of first and second order systems
7. To study time response characteristics of a second order system.
8. To study effect of damping factor on performance of second order system
9. To study frequency response of Lead and Lag networks.
10. Study of P, PI and PID controller.

Simulation Experiments using Virtual Lab

I. Pole-zero plot
II. First order unity feedback
III. Second order unity feedback system
IV. Type zero-one-two System
V. Study the effect of addition of zeros to the forward path transfer function of a closed loop system
VI. Study the effect of addition of poles to the forward path transfer function of a control system
VII. To obtain root locus for a given transfer function of the system
VIII. To obtain bode plot for a given transfer function of the system

IX. Nyquist plot of a second order system
X. To study the effect of PI, PD and PID controller on a control system

Minor-5 (Theory): Instrumentation: ELSCOR505T/ELSMIN505T (Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit -I: Quality and Standard of Measurement **(Lectures - 02)**

Static and dynamic characteristics of instruments, Error in measurement (Gross Error, Systematic Error, Absolute Error and Relative Error), Classification of standards, Electrical Standards, Time and frequency standards, IEEE standards.

Unit – II: Basic Measurement Instruments **(Lectures - 08)**

Instrumentation Amplifier, PMMC Instrument, Galvanometer, Ammeter, Voltmeter (DC and AC-True RMS), 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.

Unit – III: Measurement of Resistance, Impedance, Capacitance and Frequency **(Lectures -04)**

Maxwell's Bridge, Anderson's Bridge, Schering's Bridge, DeSauty's Bridge.

Unit – IV: Oscilloscope **(Lectures – 08)**

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 – V: Signal Generator **(Lectures - 08)**

Phase shift oscillator, Wein bridge oscillator, Square wave generator, Triangle wave generator, Audio Frequency Oscillator, Pulse Generator, Function Generators,

Unit- VI: Transducers and Sensors **(Lectures - 07)**

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).

Unit – VII: Introduction to Biomedical Instrumentation **(Lectures - 08)**

Origin of Bioelectric Signals, Recording Electrodes, Electrodes for ECG, EMG and EEG, Biomedical Recorders, ECG, EEG and EMG, MEMS Based Biosensors, Measurement of Heart Rate, Blood Pressure, Temperature, Respiration Rate.

Recommended Books

1. Modern Electronic Instrumentation & Measurement Techniques: Helfrick & Cooper, Pearson
2. A Course in Electrical and Electronic Measurements and Instrumentation: Sahwney, Dhanpat Rai
3. Instrumentation, Kalsi, McGraw Hill
4. Biomedical Instrumentation and Measurements: Cromwell, Pearson
5. Biomedical Electronics and Instrumentation Made Easy: Sawhney , Techsar

Minor–5 (Practical): Instrumentation Lab:ELSCOR505P/ELSMIN505P
(Credit:2, Full marks: 50, 60 Laboratory-Hour)

1. To calibrate the given ammeter and voltmeter by potentiometer. (Virtual Lab Simulation available)
2. Measurement of resistance by Wheatstone bridge and measurement of bridge sensitivity.
3. Measurement of inductance using Anderson's Bridge. (Virtual Lab Simulation available)
4. Measurement of inductance using Maxwell's Bridge. (Virtual Lab Simulation available)
5. Measurement of Capacitance by De Sauty's Bridge (Virtual Lab Simulation available)
6. To determine the Characteristics of resistance transducer - Strain Gauge (Measurement of Strain using half and full bridge.) (Virtual Lab Simulation available)
7. To determine the Characteristics of LVDT. (Virtual Lab Simulation available)
8. To determine the Characteristics of Thermistors and RTD. (Virtual Lab Simulation available)
9. Measurement of temperature by Thermocouples. (Virtual Lab Simulation available)
10. Design a regulated power supply of given rating (5 V or 9V).
11. To design and study the Sample and Hold Circuit.
12. To plot the frequency response of a microphone.
13. To study the performance of Biosensor (Virtual Lab Simulation available)
14. Study of Various Leads for Monitoring of Electrocardiogram (ECG). (Virtual Lab Simulation available)
15. Study of various leads and electrode position for Electroencephalogram (EEG). (Virtual Lab Simulation available)

Semester - VI

Major-12 (Theory): Electronic Communication: ELSDSC612T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit-I: Electronic communication (Lectures - 05)

Block diagram of an electronic communication system, Electromagnetic spectrum-band designations and applications, Need for modulation, Concept of channels and base-band signals. Concept of Noise, Types of Noise, Signal to noise ratio, Noise Figure, Noise Temperature, Friss formula.

Unit – II: AM and FM (Lectures -18)

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, Single side band suppressed carrier (Chopper, Balanced Modulation), Basic idea of other forms of AM (Pilot Carrier Modulation, Vestigial Side Band modulation, Independent Side Band Modulation), Block diagram of AM Transmitter and Receiver (Super heterodyne receiver – advantages over TRF, Utility of heterodyning, different stages).

Unit – III: Angle modulation (Lectures - 09)

Frequency and Phase modulation, Modulation index and frequency spectrum, Equivalence between FM and PM, Generation of FM (direct and indirect methods), FM detector (PLL), Block diagram of FM Transmitter and Receiver.

Unit – IV: Pulse Modulation (Lectures - 08)

Pulse Analog Modulation: Channel capacity, Sampling theorem, PAM, PDM, PPM modulation and detection techniques, Multiplexing, TDM and FDM.
Comparison between AM, FM and PM.
Pulse Code Modulation: Need for digital transmission, Quantizing, Uniform and Non-uniform Quantization, Quantization Noise, Companding, Coding, Decoding, Regeneration.

Unit – V: Digital Carrier Modulation Techniques (Lectures - 05)

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

Recommended Books

1. An introduction to Analog and Digital Communication Systems: S. Haykin, Wiley
2. Modern Digital and Analog Communication Systems: B.P.Lathi , Oxford
3. Communication Systems: Analog and Digital S. Kundu, Pearson
4. Communication Systems: Analog and Digital: R.P. Singh, S.D. Sapre, McGrawHill
5. Digital & Analog Communication Systems: Couch, Pearson

Major-12 (Practical): Electronic Communication Lab: ELSDSC612P
Credit: 2, Full Marks: 50, 60 Laboratory Hours)

1. Amplitude modulator and Amplitude Demodulator.
2. Study of FM modulator.
3. Study of VCO using IC 566.
4. Study of Time Division Multiplexing and Demultiplexing.
5. Study of AM Transmitter/Receiver.
6. Study of FM Transmitter/Receiver.
7. ASK modulator and Demodulator.
8. Study of FSK Modulation.
9. Study of PWM and PPM.
10. Study of PAM Modulator and Demodulator

Major-13 (Theory): Instrumentation and Power Electronic Devices: ELSDSC613T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit -I: Quality and Standard of Measurement (Lectures - 02)

Static and dynamic characteristics of instruments, Error in measurement (Gross Error, Systematic Error, Absolute Error and Relative Error), Classification of standards, Electrical Standards, Time and frequency standards, IEEE standards.

Unit – II: Basic Measurement Instruments (Lectures - 04)

Instrumentation Amplifier, PMMC Instrument, Galvanometer, Ammeter, Voltmeter (DC and AC-True RMS), Digital Voltmeter (Integrating and Nonintegrating type), Digital Multimeter, Digital Frequency Meter.

Unit – III: Measurement of Resistance, Impedance, Capacitance and Frequency (Lectures -02)

Maxwell's Bridge, Anderson's Bridge.

Unit – IV: Oscilloscope (Lectures - 08)

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 – V: Signal Generator (Lectures - 03)

Wein bridge oscillator, Square wave generator, Triangle wave generator, Pulse and Function Generator.

Unit- VI: Transducers and Sensors (Lectures - 05)

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).

Unit – VII: Introduction to Biomedical Instrumentation (Lectures - 06)

Origin of Bioelectric Signals, Recording Electrodes, Electrodes for ECG, EMG and EEG, Biomedical Recorders, ECG, EEG and EMG, MEMS Based Biosensors, Measurement of Heart Rate, Blood Pressure, Temperature, Respiration Rate.

Unit – VIII: Power Devices (Lectures - 12)

Need for Semiconductor Power Devices, Power Diodes, Introduction to Family of Thyristors.
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.
Diac and Triac: Basic Structure, Working and V-I Characteristics, Application of Diac as Triggering Device for Triac.
Application of Thyristors: SCR as Static Switch, Phase Controlled Rectification, Single Phase Half Wave, Full Wave and Bridge Rectifiers with Non-Inductive Loads, AC Voltage Control using SCR and Triac as Switch.

Unit – IX: Insulated Gate Bipolar Transistors (IGBT) (Lectures - 03)

Basic Structure, I-V Characteristics, Switching Characteristics, Device Limitations and Safe Operating Area (SOA) etc.

Recommended Books

1. Modern Electronic Instrumentation & Measurement Techniques: Helfrick & Cooper, Pearson
2. A Course in Electrical And Electronic Measurements And Instrumentation: Sahwney, Dhanpat Rai
3. Instrumentation, Kalsi, McGraw Hill
4. Power Electronics Circuits, Devices and Applications: 3rd Edition, M.H. Rashid, Pearson
5. Biomedical Instrumentation And Measurements: Cromwell, Pearson
6. Biomedical Electronics And Instrumentation Made Easy: Sawhney , Techsar

Major-13 (Practical): Instrumentation and Power Electronic Devices Lab: ELSDSC613P Credit: 2, Full Marks: 50, 60 Laboratory Hours)

1. Design of Multi Range Ammeter and Voltmeter using Galvanometer.
2. Measurement of Resistance by Wheatstone Bridge and Measurement of Bridge Sensitivity.
3. Measurement of inductance using Anderson's Bridge
4. To Determine the Characteristics of Resistance Transducer - Strain Gauge (Measurement of Strain using Half and Full Bridge).
5. To Determine the Characteristics of LVDT.
6. To Determine the Characteristics of Thermistors and RTD.
7. Measurement of Temperature by Thermocouples and Study of Transducers like AD590 (Two Terminal Temperature Sensor), PT-100, J- type, K-type. (any one)

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. Study of I-V Characteristics of DIAC.
11. Study of I-V Characteristics of a TRIAC.
12. Study of I-V Characteristics of a SCR.
13. Study of SCR as a Half Wave and Full Wave Rectifiers with R and R-L Loads.

Simulation Experiments using Virtual Lab

I. Thermocouple-Seebeck Effect
II. Characteristics of controlled switching power devices. (a) SCR (b) MOSFET (c) IGBT
III. Characteristics of high frequency IGBT switching power device
IV. Voltage Current Characteristics of Insulated Gate Bipolar Transistor (IGBT)
V. Single Phase Half Wave Silicon Controlled Rectifier with R Load, RL Load & RLE Load
VI. Single Phase Full Wave Silicon Controlled Rectifier with R Load, RL Load & RLE Load
VII. Three Phase Half Wave Silicon Controlled Rectifier with R Load & RL Load
VIII. Three Phase Full Wave Silicon Controlled Rectifier with R Load & RL Load
IX. Single Phase Full Wave Mid-Point Converter with R Load & RL Load
X. Step-up Chopper with R Load
XI. Step-down Chopper with R Load
XII. Unipolar PWM Single Phase Inverter with RL Load
XIII. Three-Phase Voltage Source Inverter With 120° & 180° Conduction Mode

Major-14 (Theory): Photonics: ELSDSC614T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit – I: Light as an Electromagnetic Wave (Lectures - 03)

Plane waves in homogeneous media, Concept of spherical waves, Reflection and transmission at an interface, Total internal reflection, Brewster's Law, Interaction of electromagnetic waves with dielectrics: Origin of refractive index, Dispersion, Coherence- temporal and spatial.

Unit – II: Interference and Diffraction (Lectures - 12)

Superposition of waves, Concept of coherence, Interference by division of wavefront, Young's double slit, Division of Amplitude, Thin film interference, Newton's rings; Diffraction: Fresnel and Fraunhoffer approximations, Fraunhoffer Diffraction by a single slit, Double slit, Diffraction grating (qualitative discussion only).

Unit – III: Polarization (Lectures - 02)

Concept of Linear and circular polarization, Polarizer-analyzer and Malus' law; Faraday rotation and electro-optic effect. `

Unit – IV: Optical communication System **(Lectures - 01)**

Introduction to optical communication System and its Block diagram, Concept of Different Sections of Optical Communication systems, Optical sources, Transmission media and Detectors used in Communication.

Unit – V: Optical Sources **(Lectures - 09)**

Light Emitting Diodes: Construction, Materials and operation.
Lasers: Interaction of radiation and matter, Necessary condition for lasing - Condition for amplification, Laser cavity, Threshold for laser oscillation, Optical resonator, Line shape function, Working principle of common lasers; He-Ni Laser, Semiconductor Lasers, Qualitative discussion on effects of quantum confinement in 1,2 and 3 dimensions.

Unit – VI: Photodetectors **(Lectures - 04)**

Photomultiplier tube, Charge Coupled Device, Photo transistors and Photodiodes (p-i-n, avalanche), Quantum efficiency and responsivity.

Unit – VII: Transmission Media **(Lectures - 08)**

Guided Waves and the Optical Fiber; Structure and classification of optical fiber. Different modes of signal transmission, Concept of different attenuation and Dispersion mechanisms in optical fibers with mathematical Expressions, Basic concept of different Optical Amplifiers and Dispersion Management Systems and Optical fiber Connectors, Working principle of Photonic Crystal Fibers (PCFs), Basic Idea of OEIC (Optical electronic Integrated Circuits).

Unit – VIII: Introduction to Solar Cells **(Lectures - 06)**

Photovoltaic (PV) effect and its applications, Semiconductor principles: How solar cells work.
Types of solar cells (e.g., crystalline silicon, thin-film, CPV, perovskite).
Solar Cell Characteristics: Voltage-current (I-V) and Power-current (P-I) characteristics, Fill factor and efficiency, Temperature and irradiance effects.
Types of Solar Power Systems: Inverter, Grid-connected, energy Storage solutions

Recommended Books

1. Optics: Ajoy Ghatak, McGraw Hill
2. Basic Optics: Lahiri, Elsevier
3. Semiconductor Optoelectronic Devices: Pallab Bhattacharya
4. Optoelectronics: An Introduction, J. Wilson and J. F. B. Hawkes, Pearson
5. Optoelectronics and Photonics: Principles and Practices, S. O. Kasap, Pearson
6. Introduction to fiber optics: Ghatak A. K. and Thyagarajan K., Cambridge Univ. Press.
7. Advanced Optical Fibre Communications: Kushal Roy, (HB) Scitech

Major-14 (Practical): Photonics Lab: ELSDSC614P
Credit: 2, Full Marks: 50, 60 Laboratory Hours)

1. Study of I-V Characteristics of LEDs
2. Study of Photo-Detector.
3. Study of I-V Characteristics of solar cell and find the fill factor.
4. Measure the Numerical Aperture of an optical fibers.
5. Study of attenuation characteristics in optical fibers.
6. Study of I-V Characteristics of solar cell and find the fill factor.

Simulation Experiments using Virtual Lab

i. Laser beam divergence and spot size
ii. Newton's Rings-Wavelength of light
iii. Brewsters Angle determination
iv. To measure specific rotation of cane sugar using Polarimeter
v. Numerical Aperture of Optical Fiber
vi. Characterization of LED
vii. Characterization of Laser diode
viii. Intensity modulation of laser output through an optical fiber
ix. Measurement of data rate for digital optical link
x. Measurement of numerical aperture
xi. Measurement of losses in plastic fiber
xii. Characteristics of APD
xiii. Optical Power Measurements
xiv. Diffraction Grating

Major-15 (Theory): Digital Signal & Bio-Medical Image Processing: ELSDSC615T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit-I: Discrete Time systems (Lectures - 03)

Discrete sequences, linear coefficient difference equation, Representation of DTS, LSI Systems, Stability and causality, frequency domain representations and Fourier transform of DT sequences.

Unit- II: Discrete Fourier Transform (Lectures - 09)

Sampling Theorem, Sampling in the frequency domain- Discrete Fourier Transform (DFT) and Inverse DFT, Matrix relations, Relationship with FT and its inverse, Circular convolution, DFT theorems, concept of DCT, Computation of DFT, FFT Algorithms and processing gain, Discrimination, interpolation and extrapolation. Gibbs phenomena.

Unit – III: Digital Filters: Analog filter (Lectures - 08)

Review-Concept of Filters in signal processing, filter parameters, Concept of LP, HP, BP, Notch Filter, types of filters – Butterworth, Chebyshev.

System function for IIR and FIR filters, network representation, Canonical and decomposition networks, IIR filter realization methods and their limitations.

Unit- IV: Fundamentals of Image Processing (Lectures - 07)

Definition of digital image, pixels, representation of digital image in spatial domain as well as in matrix form, Wavelet transformation (working principle)
Block diagram of fundamentals steps in digital image processing, application of digital image processing system, Elements of Digital Image Processing systems
Basic Concepts in Sampling and Quantization, Representing Digital Images, Spatial and Gray Level Resolution.

Unit – V: Biomedical image analysis (Lectures - 18)

Objectives - Computer aided diagnosis, Removal of artifacts – Image Enhancement – Gray level transforms – Histogram transformation.
Spatial domain filters – Frequency domain filters – Morphological image processing – Binary morphological operations and properties – Morphological algorithms – Medical Image Segmentation, Thresholding – Region growing – Region splitting and merging – Edge detection.
Analysis of shape and texture – Representation of shapes and contours – Shape factors – Models for generation of texture – Statistical analysis of texture – Fractal analysis – Fourier domain analysis of texture – Applications – Contrast enhancement of mammograms – Detection of calcifications by region growing – Shape and texture analysis of tumours.

Recommended Books

1. Signals and Systems: Lathi, Oxford
2. Digital Signal Processing: Anand Kumar, PHI
3. Digital Signal Processing: Proakis, Pearson
4. Digital Signal Processing: Ramesh Babu ,Scitech
5. Fundamentals of Digital Image Processing: Jain, Pearson
6. Biomedical Signal Processing: D.C.Reddy, McGraw Hill
7. Fundamentals Of Medical Image Processing Using Matlab: Dwijesh Dutta Majumdar, PHI
8. Digital Image Processing for Medical Applications: Geoff Dougherty, OXFORD

Major-15 (Practical): Digital Signal & Bio-Medical Image Processing Lab: ELSDSC615P Credit: 2, Full Marks: 50, 60 Laboratory Hours

(Python /Scilab/MATLAB/Other Mathematical Simulation software)

1. Generation of unit sample sequence, Unit step, Ramp function, Discrete time sequence, Real sinusoidal sequence.
2. Generate and plot sequences over an interval.
3. Given x[n], write program to find X[z].
4. Fourier Transform, Discrete Fourier Transform and Fast Fourier Transform

5. Design of a Butterworth analog filter for low pass and high pass.
6. Design of digital filters.
7. To perform image sampling and quantization using any programming language.
8. To perform intensity transformation of images using any programming language.
9. To apply Discrete Fourier Transform on image and study its properties using any programming language.
10. To study the histogram and histogram equalization.
11. To perform image enhancement by spatial filtering.
12. To obtain frequency domain filters from spatial domain.
13. To detect edges in the image.
14. To perform morphological operations on image using any programming language.
15. To perform region-based segmentation of image using any programming language.
16. To perform sharpening image using gradient mask.
17. To fill the region of interest for the image.
18. To perform wavelet transformation of an image.

Simulation Experiments using Virtual /Lab

Simulation Experiments using Virtual Lab

i. Study of sampling theorem, effect of undersampling
ii. Study of Quantization of Continuous-Amplitude, Discrete-Time Analog Signals
iii. Study of Different Types of Companding Techniques
i. Study of Discrete Fourier Transform (DFT) and its inverse
ii. Study of Transform domain properties and its use
iii. Study of FIR filter design using window method: Lowpass and highpass filter
iv. Study of FIR filter design using window method: Bandpass and Bandstop filter
v. Study of Infinite Impulse Response (IIR) filter
vi. Image Arithmetic
vii. Affine Transformation, Point Operations and Neighbourhood Operations
viii. Image Histogram
ix. Fourier Transform
x. Morphological Operations
xi. Image Segmentation
xii. Image Processing Test Bench
xiii. Introduction to Biological Image Analysis
To learn image processing software techniques to analyze and quantify image data from wet lab experiments such as those in cell biology, biochemistry, molecular biology and immunology laboratories.
xiv. Quantification of Lignin in Tissue Sections
To study image processing software techniques to quantify lignin in stained plant tissues.
xv. Analysis of Cell Morphology
To apply image processing techniques to analyze the morphology of the stained cells.
xvi. Counting of Total Fluorescence in a Cell
To apply image processing technique to find out the total fluorescence in a cell.
xvii. Analysis on Molecular Gels
To compare the density of bands on a polyacrylamide gel

xviii. Quantification of Stained Liver Cells
To study the quantification of the stained collagen in an image of a liver tissue section.

xix. Quantification of Bacterial Colonies on an Agar Plate

xx. Quantification of Amino Acids Present in a Mixture

xxi. Quantification of Protein Present in a Sample.

Minor-6 (Theory): Modern Communication System: ELSCOR606T/ELSMIN606T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit - I: Electronic communication: (Lectures - 05)

Introduction to communication – means and modes. Need for modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Concept of Noise, signal-to-noise (S/N) ratio and Noise Figure (qualitative only).

Unit - II: Analog Modulation: (Lectures - 25)

Amplitude Modulation, modulation index, frequency spectrum and efficiency. Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Concept of DSBSC, SSB and VSB modulation.

Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector),

Analog Pulse Modulation: Channel capacity, Sampling theorem, Basic Principles-PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing.

Unit - III: Digital Pulse Modulation: (Lectures - 07)

Need for digital transmission, Pulse Code Modulation, Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), and Binary Phase Shift Keying (BPSK).

Unit - IV: Mobile Communication System: (Lectures - 08)

Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitative only)

Recommended Books

1. Modern Digital and Analog Communication Systems: B.P.Lathi , Oxford
2. Communication Systems: Analog and Digital:S. Kundu, Pearson
3. Communication Systems: Analog and Digital: R.P. Singh &S. D. Sapre, McGrawHill
4. Wireless Communications Principles and Practice: Theodore S. Rappaport, Pearson

5. Mobile Communications Design Fundamentals: C.Y. Lee, Wiley
6. Wireless and Mobile Communication: Dalal and Shukla, Oxford

Minor–6 (Practical): Modern Communication System Lab: ELSCOR606P/ELSMIN606P (Credit:2, Full marks: 50, 60 Laboratory-Hour)

1. To design an Amplitude Modulator using Transistor
2. To study envelope detector for demodulation of AM signal
3. To study FM - Generator and Detector circuit
4. To study AM Transmitter and Receiver
5. To study FM Transmitter and Receiver
6. To study Time Division Multiplexing (TDM)
7. To study Pulse Amplitude Modulation (PAM)
8. To study Pulse Width Modulation (PWM)
9. To study Pulse Position Modulation (PPM)
10. To study ASK, PSK and FSK modulators
11. Understanding RF environment & study of GSM network by actually connecting to the GSM environment by any service provider.
12. Real Time study of GSM 07.05 & 07.07 Commands in various Categories :
13. (i)Modem & SIM card related ,(ii) Network registration (iii) Call control (iv) Call setting
14. Implementation of (i) Phone Book- Add/Delete contact (i) Call information (iii) Message setting (iv)- Serial link control.

Semester – VII

Major-16 (Theory): Computer Networks and Mobile Communication: ELSDSC716T (Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit- I: Networking (Lectures - 25)

Concepts of networking: Network layers, Network hardware components, Layered protocol architecture-OSI: TCP. Physical media-topology.
Switching: Circuit switching (space-division, time division and space-time division), Packet switching (virtual circuit and Datagram approach), Message switching.
Comparison of various transmission media, Transport layer-Connection less and connection-oriented protocols, Policies on flow control, Error control, MAC-Ethernet, CSMA. CD, ALOHA, FDDI Design issues, Routing algorithms, Congestion control algorithms.
LANS and WLAN, high-speed LANs, Token ring, Token Bus, FDDI based LAN, Network Devices-repeaters, hubs, switches bridges.

Unit – II: Mobile communication (Lectures - 20)

Evolution from PSTN, Cellular concept, Frequency reuse, Channel assignment strategies, System capacity, Trucking and grade of service, GSM-architecture, Protocols, Handover, Security

Physical layer-Wireless media-characteristics, Modes of propagation, Various loss mechanisms

Multiplexing and multiple access techniques-FDM, TDM, FDMA, TDMA, CDMA, WCDMA Networking-Mobile IP, dynamic host configuration protocol, Wireless LAN technology standards.

Command Level Study

Real Time study of GSM 07.05 & 07.07 commands in various categories: Command concerning modem & sim card hardware, Network registration, Call control, Call setting, Call information, Phone Book, Serial link control, Message setting, Storing/restoring, Error message handling & survey

Recommended Books

1. Computer Networks: S. Tannenbum, D. Wetherall, , Prentice Hall, Pearson, 5th Edition
2. Data Communications and Networking: Forouzan, McGraw-Hill
3. Computer Networks: Kurose, Pearson
4. Telecommunication Switching Systems and Networks: ThiagarajanVishwanathan, PHI
5. Wireless Communications Principles and Practice: Theodore S. Rappaport, Pearson
6. Mobile Communications Design Fundamentals: C.Y.Lee, Wiley
7. Wireless and Mobile Communication: Dalal and Shukla, Oxford
8. Mobile Communications: Jochen Schiller, Pearson

Major-16 (Practical): Computer Networks and Mobile Communication Lab: ELSDSC716P (Credit: 2, Full Marks: 50, 60 Laboratory Hours)

1. Understanding RF environment & study of GSM network by actually connecting to the GSM environment by any service provider.
2. Real Time study of GSM 07.05 & 07.07 Commands in various Categories:
   (i)Modem & SIM card related, (ii) Network registration (iii) Call control (iv) Call setting
3. Implementation of (i) Phone Book- Add/Delete contact (i) Call information (iii) Message setting (iv)- Serial link control.
4. SIM identification for getting self-number, network name etc.
5. Execution of AT commands via PC
6. Voice communication using AT commands
7. Study of text or PDU data formats & interface with modem. SMS
8. Network status intimation via AT commands.
9. SMS interface for Transmit, Receive & manage inbox.
10. Call Records a. View missed calls b. View dialed numbers c. View records on
11. Study and measure PWM signal of circuit such as Vibrator, LED, Buzzer.
12. Setting of MIC gain & Speaker gain via. AT commands.
13. Indication of battery temperature via AT commands.
14. Battery Charging -start, stop battery charging via AT commands
15. Send and receive email facility through AT commands.
16. Control of Relay output over SMS.
17. Simulation experiments on Networking based on Cisco platform-

i. Configure a simple network using Cisco Packet Tracer, which consists of two PCs connected to a switch. Assign IP addresses, verify connectivity, and ensure communication between the two PCs.
ii. Create subnets from a given IP range and configure routers to route between different subnets.
iii. Test the different sections of mobile phone and perform the process of call connection and call release of cellular Mobile System.
iv. Study of different types of Network cables and practically implement the cross-wired cable and straight through cable using clamping tool.
v. Connect the computers in Local Area Network using Cisco Packet Tracer.
vi. Performing an Initial Switch Configuration
vii. Performing an Initial Router Configuration

Major-17 (Theory): Basics of VLSI and Nanotechnology: ELSDSC717T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit – I: Introduction -Semiconductor Process Technology (Lectures - 04)

Semiconductor materials, Single crystal, Polycrystalline and amorphous, Crystal growth techniques: Si from the Czochralski technique, Starting material, Distribution of dopants, Effective Segregation Coefficient, Wafer preparation.

Unit – II: Epitaxy Deposition (Lectures - 05)

Epitaxial growth by vapor phase epitaxy (VPE) and molecular beam epitaxy (MBE).

Characterization: Various characterization methods for structural analysis, Electrical and optical properties, Basic idea of X-ray diffractometer, Scanning electron microscope, Transmission electron microscope and UV-VIS-NIR spectrophotometer, Photo luminescence.

Unit- III: Oxidation and Diffusion (Lectures - 05)

Oxidation: Thermal Oxidation Process: Dry and Wet oxidation, Impurity Redistribution during Oxidation, Masking property of Silicon Oxide, Oxide Quality.

Diffusion: Basic Diffusion Process: Diffusion Equation, Diffusion Profiles, Doping through Ion Implantation and its comparison with diffusion**.**

Unit – IV: Lithographic Processes and Etching (Lectures - 04)

Lithographic Processes: Clean room, Optical lithography, Exposure tools, Masks, Photoresist, Pattern Transfer, Overview Comparison between various lithographic techniques.

Etching: Wet Chemical Etching-basic process and few examples of etchants for semiconductors, Insulators and conductors; Dry etching using plasma etching technique**.**

Unit – V: Process Integration (Lectures - 05)

Basic fabrication process, Isolation techniques. MOSFET Technology: Basic fabrication process of NMOS, PMOS and CMOS technology**.**

Unit – VI: Review of MOS (Lectures- 05)

MOS Capacitor- Band-diagram, threshold voltage, MOSFET I-V characteristics (gradual channel approximation) Short Channel Effects in MOSFET, lambda rule, scaling rules.

Unit – VII: Quantum Effect Devices (Lectures -15)

Introduction to nanoelectronics, Systems confined to one, two or three dimension and their effect on physical property and density of States for Quantum Wells, Wires and Dots: Coulomb Blockade
Structure and working Principle of Quantum effect devices: Nanowire FETs, Quantum wire FETs, Carbon nanotube**s.**

Unit – VIII: Application of Nano electronics **(Lectures - 02)**

Use of nano particles for biological application, Drug delivery and bio-imaging, Impact of nanotechnology on the environment.

Recommended Books

1. VLSI Fabrication Principles: Gandhi, Wiley
2. VLSI Technology: Sze, Wiley
3. Silicon VLSI Technology: Plummer, Pearson
4. Fundamentals of Nonoelectronics: Hanson, Pearson
5. Introduction to Nanoscience and Nanotechnology: K.K.Chattopadhyay, PHI
6. Nanoscience and Nanotechnology: Fundamentals of Frontiers: Singh and Rao,Wiley
7. Nano Materials: A.K. Bandyopadhyay New Age International (P) Ltd.

Major-17 (Practical): Basics of VLSI and Nanotechnology Lab: ELSDSC717P

(Credit: 2, Full Marks: 50, 60 Laboratory Hours)

1. VLSI Process Simulation: Oxidation.
   https://toolbox.nanofab.ualberta.ca/sithox/index.php#calculator
2. VLSI Process Simulation: Ion Implantation (https://cleanroom.byu.edu/implantcal)
3. VLSI Process Simulation: Diffusion
   Simulation studies using Virtual Lab
4. PMOS Capacitor Band Diagram
5. BJT Characterization (Gummel Plot)
6. Variation of Fermi Energy Level and Carrier Concentration with Temperature
7. C-V characterization of PMOS capacitors
8. Output characteristics of an n-channel MOSFET
9. Simulate dopant distribution and impurity profiles using MATLAB's PDE toolbox to solve diffusion equations during the Czochralski growth process.
10. Plot and analyze oxide thickness vs. time curves for dry and wet oxidation processes.
11. Simulate mask exposure patterns and analyze voltage-controlled photoresist curing behaviour.
12. Implement a simulation of etch depth versus time using MATLAB's curve fitting and visualization tools.
13. Design a CMOS inverter circuit, analyze the switching characteristics, and visualize voltage transfer characteristics (VTC).
14. Model the doping process using diffusion profiles, electric field analysis, and potential distribution.
15. Develop a simulation for energy band structure and carrier mobility in a quantum wire FET.
16. Plot I-V characteristics and Coulomb blockade effects for a Single Electron Transistor (SET) using experimental or simulated data.
17. PSPICE/Multisim for electronic circuit behaviour and potential distribution analysis and practical CMOS circuit design and switching characteristic visualization.

Semester – VIII

Major-18 (Theory): AIOT: ELSDSC818T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit- I: Overview of IoT (Lectures - 08)

Introduction to the Concept of IoT Devices – IoT Devices Versus Computers – IoT Configurations – Basic Components – Real time systems and Real-time scheduling – Processor basics and System-On Chip – IOT-Definition and characteristics of IoT - Technical Building Blocks, Physical design of IoT– IoT Protocols, IoT communication models, IoT Communication APIs, IoT enabled Technologies – Wireless Sensor Networks, Cloud Computing, Embedded Systems, IoT Levels and Templates.

Unit -II: Overview of Artificial Intelligence (AI) (Lectures - 10)

Types of AI (Weak AI, Strong AI, Reactive Machines, Limited Memory, Theory of Mind, Self Awareness); Different Machine learning Algorithms, Techniques of Knowledge representation in AI. its applications across various industries. Ethics and transparency in AI systems.

Unit- III: AIOT (Lectures - 03)

Introduction to the Artificial Internet of Things (IoT); Functional overview of AI and IOT technology integration. Applications of AIOT, benefits and challenges.

Unit -IV: IoT Communication Models and APIs (Lectures - 06)

IoT Communication Protocols- Basics of Wireless Networking, IoT Protocols, and Cloud Platforms for IOT – Bluetooth – WiFi – ZigBee
– GPS – GSM modules – Open Platform (like Raspberry Pi) – Architecture – Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

Unit – V: IoT Physical Devices and Endpoints (Lectures - 10)

Introduction to Arduino – Types of Arduino- Arduino Uno Architecture,– Arduino Toolchain – Arduino Programming Structure.

Controlling Hardware- Connecting LED, Buzzer, Switching High Power devices with transistors, Controlling AC Power devices with Relays, Controlling servo motor, Speed control of DC Motor, Unipolar and bipolar Stepper motors.

Sensors- Light sensor, Temperature sensor with thermistor, Voltage sensor, ADC and DAC, Temperature and Humidity Sensor DHT11, Motion Detection Sensors, Wireless Bluetooth Sensors, Level Sensors, USB Sensors, Embedded Sensors, Distance Measurement with ultrasound.

Unit – VI: IoT Communication Models and APIs (Lectures - 08)

IoT Communication Protocols- Basics of Wireless Networking, IoT Protocols, and Cloud Platforms for IOT – Bluetooth – WiFi – ZigBee
– GPS – GSM modules – Open Platform (like Raspberry Pi) – Architecture – Programming –

Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

Recommended books

1. IoT Fundamentals: David Hanes, Cisco Press(Pearson)
2. Embedded Systems: Dave, Pearson
3. Internet of Things (IoT): Raj Kamal, Mcgraw Hill
4. Internet of Things (IoT) Experiments: Kanetkar, Korde, BPB
5. Internet of Things with Arduino& Bolt: Ashwin Pajankar, BPB
6. Pythonic AI: Arindam Banerjee, BPB
7. Arduino Programming for beginners: Pal etc, TECHNO WORLD
8. MAKE: Getting Started with Sensors - Measure the World with Electronics, Arduino, and Raspberry Pi Kimmo Karvinen, SPD

Major-18 (Practical): AIOT LAB: ELSDSC818P
(Credit: 2, Full Marks: 50, 60 Laboratory Hours)

To understand how to install Arduino software integrated development environment and connecting the Arduino to the computer.

1. Interfacing of temperature and humidity sensor (DHT11) with Arduino.
2. Interfacing of high voltage device with Arduino.
3. Interfacing of LDR, relay and bulb with Arduino.
4. Interfacing of Optical sensor, relay and bulb with Arduino.
5. Experiments on digital input and digital output on Arduino Mega board and using LED and Buzzer.
6. Experiments on analog input and analog output on Arduino Mega board using PWM. Different outputs on LED.
7. Serial Communication between Arduino board and PC: -character send and received, Read and display voltage
8. DC Motor Control
9. Servo Motor Control

   Simulation exercises using Virtual Lab

   i. Characterize the temperature sensor (RTD)
   ii. Simulate the performance of a bio-sensor
   iii. Measurement of level in a tank using capacitive type level probe
   iv. Simulate the performance of a chemical sensor
   v. Characterize the strain gauge sensor
   vi. Characterize the temperature sensor (Thermocouple)

Major-19 (Theory): Microwave Electronics: ELSDSC819T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit – I: Introduction **(Lectures - 02)**

Microwave and millimeter wave frequency spectrum, need for microwave devices, microwave networks, Modes of Communication, microwave components, directional coupler.

Unit – II: Transmission Lines **(Lectures - 15)**

Typical Transmission lines- Co-axial, Two Wire, Microstrip, Coplanar and Slot Lines, Transmission Line Parameters, Transmission Line Equations, Wave propagation in Transmission lines- Characteristics of lowloss, lossless line, Distortionless line, Input Impedance, Standing Wave Ratio, Power. and lossy lines, Shorted Line, Open-Circuited Line, Matched Line, Smith Chart, Transmission Line as a circuit element.

Unit – III: Waveguides and Waveguide Devices **(Lectures - 10)**

Wave propagation in waveguides, Parallel plate waveguides, TEM, TM and TE modes, Rectangular waveguides, Power transmission and attenuation, Rectangular cavity resonators.

Unit – IV: Microwave tubes **(Lectures - 06)**

Linear beam (O-Type)- Klystron, Reflex Klystron; Microwave crossed field tubes (M-Type)- Magnetron, TWT.

Unit – V: Microwave Semiconductor devices **(Lectures - 08)**

Transferred electron devices, Avalanche transit time devices - Gunn, IMPATT, TUNNEL diode, Monolithic microwave integrated circuits and fabrication.

Unit – VI: Review of Antenna **(Lectures - 04)**

Friis Transmission Equation and Radar Range Equation
Hertzian dipole, Half wave dipole, Quarter-wave dipole, Yagi-Uda, microstrip, Helical, Pyramidal horn Parabolic antenna.

Recommended books

1. Microwave Devices and Circuits: Samuel Y Liao, Pearson
2. Microwave Engineering: David M. Pozar, Wiley
3. Microwave Engineering: Monojit Mitra, Dhanpat Rai
4. Microwave Engineering: G.S. Raghuvanshi, Cengage
5. Microwave Semiconductor Devices: Roy S.K ,PHI
6. Antennas and Wave Propagation: RAJU, Pearson

Major-19 (Practical): Microwave Electronics Lab: ELSDSC819P
(Credit: 2, Full Marks: 50, 60 Laboratory Hours)

Simulation experiments using Virtual Lab/other Simulation Software

1. Program to determine the phasor of forward propagating field
2. Program to determine the instantaneous field of a 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 a function of time and position in a loss less transmission line
6. Program to find the characteristic impedance, the phase constant and the phase velocity
7. Program to find the output power and attenuation coefficient
8. Program to find the power dissipated in the lossless transmission line
9. Program to determine the operating range of frequency for TE10 mode of air-filled rectangular waveguide
10. Program to determine Directivity, Bandwidth, Beamwidth of an antenna
11. Program to determine diameter of parabolic reflector.
12. Program to find out minimum distance between primary and secondary antenna
13. To Study the Characteristics of Reflex Klystron
14. To Plot the V-I Characteristics of Gunn Diode
15. To Study the Basic Properties of E-plane Tee, H-plane Tee and Magic Tee
16. To Measure the Scattering Parameters of Circulator
17. To study the characteristics of multi-hole directional coupler by measuring the following parameters: coupling factor and directivity of coupler
18. To Study the Properties of Magic Tee and Determining the Scattering Parameters of Magic Tee
19. To plot the Radiation pattern and Determining Gain of a Pyramidal Horn Antenna

Major-20 (Theory): Advanced Communication: ELSDSC820T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit – I **(Lectures - 11)**

Base Band Modulation Base band system, Sampling theorem, Sampling and signal reconstruction, Aliasing, Types of sampling, Quantization, PCM, Companding, DPCM, ADPCM, Delta modulation, Adaptive delta modulation, T1 carrier system.

Unit – II **(Lectures - 04)**

Digital Data Transmission Components of digital communication system, Line coding, Pulse shaping, Scrambling, Regenerative Repeater, Eye Diagram, Timing Extraction, Detection Error Probability, M-ary communication, Digital Carrier Systems.

Unit – III **(Lectures - 04)**

Digital Modulation Techniques Modulation techniques for ASK, QASK, FSK, M-ary FSK, BPSK, DPSK, DEPSK, QPSK, M-ary PSK, QAM.

Unit – IV **(Lectures - 06)**

Digital Carrier Demodulation Techniques Coherent and non-coherent detection of ASK, QASK, FSK, PSK, QPSK, M-ary PSK, DPSK, Noise temperature, Noise bandwidth, Noise figure.

Unit – V **(Lectures - 10)**

Information theory: Measure of information, Entropy, Source encoding, Error free communication over noisy channel, Channel capacity of discrete memory less channel, Channel capacity of continuous channel, Practical communication system in lights of Shannon theorem.

Unit – VI **(Lectures - 10)**

Error Correcting Codes Introduction, Linear Block Code, Cyclic Code, Burst error detecting and correcting codes, Interlace codes for burst and random error correction, Convolution Code, Comparison of coded and uncoded system.

Recommended Books

7. Digital Communications: Fundamentals & Applications, Sklar & Ray,Pearson
8. Digital Communication Systems: S. Haykin, Wiley
9. Modern Digital and Analog Communication Systems: B.P.Lathi , Oxford
10. Communication Systems: Analog and Digital Kundu, Singh & Sapre, McgrawHill
11. Digital Communication: Amitabha Bhattacharya, McGraw Hill
12. Digital & Analog Communication Systems: Couch, Pearson

Major-20 (Practical): Advanced Communication Lab: ELSDSC820P (Credit: 2, Full Marks: 50, 60 Laboratory Hours)

1. Generate- a) Unipolar-NRZ, RZ b) Bipolar- NRZ(AMI), Manchester Code
2. for given data
3. Implementation of various line coding scheme using suitable simulation tool.
4. Generation of natural and flat top sampling signal
5. Performance of pulse width modulation and demodulation circuit.
6. Performance of pulse position modulation and demodulation circuit
7. Transmit and receive digital signal using Amplitude shift keying
8. Transmit and receive digital signal using Frequency Shift Keying
9. Multiplexing of signals in TDM using kit.

Major-21 (Theory): VLSI Circuit Design: ELSDSC821T
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit -I: VLSI Design Methodologies (Lectures - 13)

Introduction: Moore's law, ASIC design, Full custom ASICs, Standard cell-based ASICs, Gate array-based ASICs, SoCs, FPGA devices, ASIC and FPGA Design flows, Top-Down and Bottom-Up design methodologies. Logical and Physical design. Speed power and area considerations in VLSI design.

Unit- II: Static CMOS Logic Design (Lectures - 12)

MOSFET Logic Design - NMOS Inverter (Static analysis only), Basic logic gates, CMOS logic, Static and transient analysis of CMOS inverter, Switching power dissipation and delays.
Logic design using CMOS -Realization of logic functions with static CMOS logic, Pass transistor logic, and transmission gate logic.

Unit- III: Dynamic logic Design and Storage Cells (Lectures - 14)

Dynamic Logic Design-Pre charge- Evaluate logic, Domino Logic, NP domino logic.
Read Only Memory-4x4 MOS ROM Cell Arrays (OR, NOR, NAND)
Random Access Memory –SRAM-Six transistor CMOS SRAM cell, DRAM –Three transistor and One transistor Dynamic Memory Cell.
Switched Capacitor Circuits-Switched capacitor amplifiers, Switched capacitor integrators, First and Second Order Switched Capacitor, Switched Capacitor Filters.

Unit- IV: Design rules (Lectures - 06)

Interconnect Modelling: RC Delay Model: Effective Resistance, Gate and Diffusion Capacitance, Equivalent RC Circuits, Elmore Delay Model Capacitive Parasitics, Resistive Parasitics, Inductive Parasitics.

Scaling Issues: - Constant Voltage vs Constant Field

Layout Design and Design rules, Stick Diagram and Design rules-micron rules and Lambda rules. (definitions only).

Recommended Books

1. CMOS Digital Integrated Circuits Analysis and Design: Sung Mo Kang, McGraw Hill
2. CMOS VLSI Design: Neil H.E. Weste, Pearson.
3. Basic VLSI Design: Pucknell & Eshragian,PHI
4. Digital Integrated Circuits: Rabaey & Chandrakasan, Pearson
5. A VHDL Primer: Bhasker , PHI
6. VHDL: Programming By Examples, PERRY, Mcgraw Hill

Major-21 (Practical): VLSI Circuit Design Lab: ELSDSC821P
(Credit: 2, Full Marks: 50, 60 Laboratory Hours)

Hardware modelling of Combinational and Sequential circuits using Verilog/VHDL

Experiments in Verilog/VHDL

1. Write code to realize basic and derived logic gates.

2. Half adder, 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 (4x1, 8x1) and Demultiplexer using logic gates.

6. Decoder (2x4, 3x8), Encoders and Priority Encoders.

7. Design and simulation of a 4-bit Adder.

8. Code converters (Binary to Gray and vice versa).

9. 2-bit Magnitude comparator.

10. 3-bit Ripple counter.

11. Device characterization, Spice analysis of CS, CG and CD amplifier

Semester–I/II/III

MDC–1/2/3 (Theory): Interdisciplinary Electronics:
ELSHMD101M/ELSHMD202M/ELSHMD301M
(Credit: 3, Full Marks: 50, 45 Lecture-Hour)

Unit–I: Basic Circuit Components (Lectures -20)

Energy Source- Concept of A.C. and DC signal, RMS and average value of AC sinusoidal signal, Its need in electronics, Concept of voltage and current sources.
Circuit Elements- Resistors, Inductors, Capacitors. Kirchhoff's current and voltage laws as an extension of laws of conservation of charge and energy.
Behaviour of circuit components under DC and AC excitation concept of reactance and impedance of R, L and C, Qualitative explanation of frequency selective circuits - tuning circuits and filters based on reactance curve, Power in electric circuits – True power, Active power and wattless component, Use of resistors, inductors and capacitors in everyday life, viz tube-light, fans etc, Working principle of transformer and its significance in everyday life.

Unit–II: Semiconductor Devices and Circuits (Lectures - 15)

Material classification on the basis of electrical conductivity- Insulator, Semiconductor and Conductor, Importance of semiconductor in Electronics, Mechanism of current conduction in semiconductors – electron and hole transport mechanism, Intrinsic and extrinsic semiconductors, Basic Concept of P-N Junction, P-N junction diode as a switching element using piece-wise linear model as an approximation of their I-V characteristics.
Rectifier- Its need in electronic circuits, Use of diode as Half-Wave and Full-Wave Rectifier using switching model, Working Principle of Solar Cell, LED, Lithium-ion batteries, Mobile charger.

Unit–III Digital Logic Circuits (Lectures - 10)

Difference between digital and Analog Electronic circuits, Significance of binary logic in Digital Electronics - Basic Idea of Boolean Algebra, Logic Symbol and Truth Tables of Basic Logic Gates (AND, OR, NOT), Switching equivalent of Logic gates, Derived Logic Gates (NAND, NOR, XOR and XNOR).

Recommended books:

1. Electronics for Dummies: Gordon McComb, Earl Boysen, Wiley Publishing Inc.
2. Electronics Fundamentals and Applications: Chattopadhyay and Rakshit, New Age International (P) Ltd.
3. Electronics: Analog and Digital, I.J. Nagrath, PHI.
4. Basic Electronics: Principles and Applications, Saha, Halder, Ganguly, Cambridge Press.
5. Introduction to Circuit and Network: Gargi Basu, Platinum Publishers.

Evaluation Note

1. Theory Paper: (a) Full Marks 50, to be evaluated by University End Semester Examination

   (b) Question Pattern:

   Group – A, 10 Marks (5x2=10), Answer any 5 out of 8 questions.
   Group – B, 40 Marks (5x8=40), Answer any 5 out of 8 questions.

2. Practical paper: (a) 20 Marks Internal Assessment (to be evaluated by College).
   5 Marks for Attendance:
   75% & above – 5 Marks
   65% to less than 75% – 03 Marks
   55% to less than 65% – 02 Marks*
   *to be allowed for examination with condonation fee
   Less than 55% – Barred from appearing in the University exam
   (b) End-Semester Evaluation
   As per Regulation
   (c) Production of LNB in the final examination is compulsory.

3. MDC paper: (a) To be evaluated by College
   (b) 10 Marks Internal Assessment (modality is to be decided by College)
   (c) Question Pattern:
   Group – A, 20 Marks MCQ (20×1=20, Answer 20 out of 20 questions).
   Group – B, 20 Marks (5×4=20, Answer any 4 questions out of 7 questions).

4. SEC paper: (a) To be evaluated by college
   (b) 10 Marks Internal Assessment
   (c) 20 Marks Practical – Examination
   (d) 20 Marks Theory – Examination