

DHANAMANJURI UNIVERSITY

Master of Science in Electronics

COURSE STRUCTURE OF 2-YR PG PROGRAMME (FOUR-SEMESTERS PG PROGRAMME)

AND

1-YR PG PROGRAMME (TWO-SEMESTERS PG COURSE)



2026

**Department of Electronics
School of Mathematical and Physical Sciences
Dhanamanjuri University
Imphal-795001
Manipur**

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23-6-2024

SYLLABUS OF M.Sc. (ELECTRONICS)

COURSE STRUCTURE OF M.Sc. (ELECTRONICS)

M.Sc. 1st Semester (2 year P.G.)

Paper Code	Paper Title	Internal Assessment Marks	University Examination Marks	Total Marks	No. of Credit
ELE-501	Network Analysis	20	80	100	04
ELE-502	Mathematical Methods	20	80	100	04
ELE-503	Digital Signal Processing	20	80	100	04
ELE-504	Microprocessor and Microcontroller Systems	20	80	100	04
ELE-505	Practical – I	--	--	100	04
ELE-506	Practical – II	--	--	100	04
				Total marks = 600	Total Credits = 24

M.Sc. 2nd Semester (2 year P.G.)

Paper Code	Paper Title	Internal Assessment Marks	University Examination Marks	Total Marks	No. of Credit
ELE-507	Fundamentals of Semiconductor	20	80	100	04
ELE-508	Antenna Theory and Microwave	20	80	100	04
ELE-509	CMOS Analog IC Design	20	80	100	04
ELE-510	Practical – III	20	80	100	04
ELE-511	VAC/AEC Introduction to MATLAB	--	--	50	02
				Total marks = 450	Total Credits = 18

DEPARTMENT OF ELECTRONICS
DHANAMANJURI UNIVERSITY , MANIPUR

M.Sc. 3rd Semester (2 year P.G.)

Paper Code	Paper Title	Internal Assessment Marks	University Examination Marks	Total Marks	No. of Credit
ELE-612	Nanoelectronics	20	80	100	04
ELE-613	Signal and System	20	80	100	04
ELE-614	VLSI Technology	20	80	100	04
ELE-615	Power and Industrial Electronics	20	80	100	04
ELE-616	Practical - IV	--	--	100	04
				Total marks = 500	Total Credits = 20

M.Sc. 4th Semester (2 year P.G.)

Paper Code	Paper Title	Internal Assessment Marks	University Examination Marks	Total Marks	No. of Credit
ELE-617	Digital VLSI Design	20	80	100	04
ELE-618	Introduction to Machine Learning	20	80	100	04
ELE-619	Practical - V	--	--	100	04
ELE-620	Research Methodology	10	40	50	02
ELE-621	Research (Thesis)	--	--	150	06
				Total marks = 500	Total Credits = 20

Semester-I

ELE-501: Network Analysis

100 Marks (4 Credits)

- Study circuits in a systematic manner suitable for analysis and design.
- Understands how to formulate circuit analysis problems in a mathematically tractable way with an emphasis on solving linear systems of equations.
- Analyze the electric circuit using network theorems.
- Determine Sinusoidal steady state response.
- Understand the two-port network parameters with an ability to find out two-port network parameters & overall response for interconnection of two-port networks.

Unit – I : Laplace Transformation

25 Marks

Basic theorems – examples of solution by Laplace transformation method – partial fraction expansion - examples - Analysis of LC, RC, RL and RLC circuits using Laplace transforms. Unit step, shifted unit step, Ramp and Impulse functions –Waveform synthesis – convolution integral.

Unit- II : Concept of complex frequency

25 Marks

Transform impedance and transform circuits – network functions for the one port and two port networks – poles and zeros of network functions – restrictions on pole-zero locations for driving point functions and transfer functions – time domain behavior from pole zero plot – examples.

Unit –III : Single and Multiport Networks

25 Marks

Introduction – Basic definitions – Matrix representation of Pi-network – Low-frequency hybrid network description of a BJT – Internal resistance and current gain of BJT based on h-parameters – Interconnecting networks – parallel connection of networks – cascading networks – ABCD representation – ABCD network representation of an impedance element – ABCD matrix computation of a T-network – ABCD-matrix coefficient computation of a transmission line section. Network properties and applications – Inter relations between Parameter Sets – Analysis of Microwave amplifier.

Unit –IV : Scattering Parameters

25 Marks

Definition – meaning of S-Parameters – Determination of a Tnetwork elements – Chain Scattering matrix – conversion between Z- and S-parameters. Signal flow chart modeling– flow chart analysis of a dual port network – Generalization of S- parameters – Input impedance computation of a Transmission line using signal flow chart – Practical measurement of S-parameters.

Suggested Books

1. **Network analysis** – G.K. Mittal, Khanna Publishers.
2. **Network Theory and filters Design** – V.K. Aatre, Wily Eastern Ltd.
3. **Engineering Circuit Analysis** – W.H. Hayt and J.E. Kemmerly, McGraw Hill, 1978.

4. **Network Analysis** – M.E. Van Valkenberg, Prentice Hall of India Pvt. Ltd,
5. **Network Analysis** – Ghosh, PHI
6. **Linear Circuit Analysis** – Liu, Oxford University Press;
7. **Network Analysis** – Stanlay, Pearson Education;
8. **Network Analysis** – (7th , 8th 9th and 10th chapters) Van Valkenberg)
9. **RF circuit Design** – Theory and Application by Reinhold Ludwig & Pavel Bretchko –
(Pearson Education Asia

- Understand and apply fundamental mathematical concepts such as linear algebra, differential equations, and complex analysis.
- Use mathematical software tools (e.g., MATLAB, Mathematica, Python) to implement numerical methods and visualize solutions.
- Apply techniques such as Fourier analysis or optimization to problems in signal processing, control systems, or data analysis.
- Emphasis on advanced topics like partial differential equations, complex analysis, or group theory, with applications in specialized fields like quantum mechanics or fluid dynamics.

Unit – I : Differential equations**30 Marks**

Power series solution for Legendre, Hermite and Laguerre differential equations – Legendre Hermite and Laguerre polynomials — Generating functions – Recurrence relations – Beta and Gamma functions and their properties – Bessel differential and its solutions- Bessel functions of first and second kind- generating functions,

Unit – II : Spectral Analysis**20 Marks**

Introduction to the concept of signals in time and frequency domains Fourier series, The sampling function, response of a linear system, normalized power, normalized power in a Fourier expansion, power spectral density, effect of transfer function on power spectral density.

Unit – III : The Fourier transform**20 Marks**

Properties of Fourier Transforms, examples of Fourier transforms, convolution and circuit response in time domain - Parseval's theorem power energy transfer through a network, band limiting of waveforms, power and cross correlation, auto correlation, auto correlation of a periodic waveform, auto correlation of a non-periodic waveform of finite energy, auto correlation of other waveforms - expansion in orthogonal functions, completeness of an orthogonal set. The Gram-Schmitt Procedure, correspondence between signals and vectors, distinguish ability of signals

Unit – IV : Numerical Analysis**30 Marks**

Principles of floating point computations and rounding errors; systems of linear equations, eigenvalue problems; interpolation, approximation by polynomials, data fitting and least squares approximation; Numerical Integration: integration by interpolation, adaptive quadratures and Gauss methods; Initial Value Problems for Ordinary Differential Equations: Runge-Kutta methods, multi-step methods, predictor and corrector scheme, stability and convergence analysis; Two Point Boundary Value Problems : finite difference methods with convergence results

1. **Engineering Mathematics** – Erwin Kreyszig, Wiley
2. **Linear Algebra and its Applications**- David Lay, published by Pearson/Addison Wesley
3. **Special Functions for Scientists and Engineers** –W. W. BELL
4. **An Introduction to Statistics, Vol-I &II** - L. Choudhury, Kitap Ghar, Guwahati-I
4. **Mathematical Statistics** – Kapoor and Gupta, Sultan Chand, New Delhi
5. **Probability, Random Process & Stochastic Process** – Populis, John wiley

Course Outcomes

At the end of this course, students will be able to

- CO1 Understand the basic concepts related to discrete time signals, systems, Z transform and Fourier transform
- CO2 Apply knowledge and demonstrate proficiency of analyzing signals in time as well as frequency domain using Fourier and Z transforms
- CO3 Design and analyze IIR/FIR filters with given specifications
- CO4 Apply transform methods for representing signals and systems in time and frequency domain

Credit-3**Unit- 1****25 Marks**

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

Unit- 2**25 Marks**

Z-Transform: Definition and properties, Inverse Z Transform and stability. Parsevals Theorem and applications.
System Function: signal flow graph, its use in representation and analysis of Discrete Time Systems. Techniques of representations. Matrix generation and solution for DTS evaluations.

Unit- 3**25 Marks**

Discrete Fourier Transform: DFT assumptions and Inverse DFT. Matrix relations, relationship with FT and its inverse, circular convolution, DFT theorems, DCT. Computation of DFT. FFT Algorithms and processing gain, Discrimination, interpolation and extrapolation. Gibbs phenomena. FFT of real functions interleaving and resolution improvement. Word length effects.

Unit- 4**25 Marks**

Digital Filters: Analog filter review. System function for IIR and FIR filters, network representation. Canonical and decomposition networks. IIR filter realization methods and their limitations. FIR filter realization techniques. Discrete correlation and convolution; Properties and limitations.

Suggested Books:

1. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989.
2. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall, 1997.

Course Outcomes

At the end of this course, students will be able to

- CO1 Understand the basic blocks of microcomputers i.e CPU, Memory, I/O and architecture of microprocessor's and Microcontroller's
- CO2 Apply knowledge and demonstrate proficiency of designing hardware interfaces for memory and I/O as well as write assembly language programs for target microprocessor and microcontroller.
- CO3 Derive specifications of a system based on the requirements of the application and select the appropriate Microprocessor or Microcontroller.

Unit-1

25 Marks

Introduction to Microprocessor: Introduction, applications, basic block diagram, speed, word size, memory capacity, classification of microprocessors (mention different microprocessors being used)

Microprocessor 8085: Features, architecture -block diagram, internal registers, register pairs, flags, stack pointer, program counter, types of buses. Multiplexed address and data bus, generation of control signals, pin description of microprocessor 8085.

Unit-2

25 Marks

8085 Instructions: Operation code, Operand & Mnemonics.

Instruction set of 8085, instruction classification, addressing modes, instruction format. Data transfer instructions, arithmetic instructions, increment & decrement instructions, logical instructions, branch instructions and machine control instructions.

Stack operations, subroutine calls and return operations. Delay loops, use of counters, timing diagrams-instruction cycle, machine cycle, T- states, time delay

Interrupt structure of 8085A microprocessor, processing of vectored and non-vectored Interrupts.

Unit- 3

25 Marks

Introduction to Microcontrollers: Basic block diagram, comparison of microcontroller with microprocessors, comparison of 8 bit, 16 bit and 32 bit microcontrollers.

MICROCONTROLLER 8051- architecture -internal block diagram, key features of 8051, pin diagram, memory organization, Internal RAM memory, Internal ROM. General purpose data memory, special purpose/function registers, external memory.

Counters and timers: 8051 oscillator and clock, program counter, TCON, TMOD, timer counter interrupts, timer modes of operation. Input / output ports and circuits/ configurations, serial data input / output – SCON, PCON, serial data transmission modes

Unit-4

25 Marks

8051 Interrupts, Addressing modes and Instruction set: Interrupts – IE, IP, time flag interrupts, serial port interrupt, external interrupts, reset, interrupt control, interrupt priority, interrupt destinations & software generated interrupts.

Addressing modes, immediate addressing, register addressing, direct and indirect addressing, Data transfer instructions, internal data move, external data move, code memory read-only data move, Push and Pop and data exchange instructions.

Logical Instructions, byte level logical operations, bit level logical operations, rotate and swap operations.

Arithmetic Instructions, flags, incrementing and decrementing, addition, subtraction, multiplication and division, decimal arithmetic, simple programs in assembly language.

Timer / Counter Programming in 8051: Programming 8051 timers, counter programming, programming timers 0 and 1 in 8051 C

Suggested Books:

1. Microprocessor Architecture, Programming and Applications with 8085, Ramesh S.Gaonkar - Wiley Eastern Limited- IV Edition.
2. Fundamentals of Microprocessor & Microcomputer: B. Ram—Danpat Rai Publications.
3. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. MCKinlay “The 8051 Microcontroller and Embedded Systems”, 2nd Edition, Pearson Education 2008.
4. Muhammad Ali Mazidi, “Microprocessors and Microcontrollers”, Pearson, 2006

ELE-505 Practical – I (Practical based on ELE-501 & ELE-504)

100 Marks (4 Credits)

- 1) To study the generation of Lissazous figures.
- 2) To measure the Z-Parameters of a two port network.
- 3) To study inverter circuit (SCR biased) for different configurations.
- 4) To study Hall effect.
- 5) To study photodevices.
- 6) To design Clipper, Clamper circuits and voltage doubler using Diode.
- 7) Frequency to voltage converter.
- 8) Voltage to frequency Converter.
- 9) Design of circuits using multiplexers.

Microprocessor

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.
10. To study interfacing of IC 8255.
11. Program to verify the truth table of logic gates.

8051 Microcontroller Programming

1. Program to find the sum of N 8-bit numbers.
2. Program to find largest of N numbers.
3. Program to find smallest of N numbers
4. Program to find whether the given data is palindrome.
5. Program to arrange the numbers in ascending order.
6. Interfacing of stepper motor and Rotating stepper motor by N steps clockwise/ anticlockwise with speed control.
7. LCD interfacing.
8. Speed control of DC motor using PWM (pulse delay to be implemented using timers).
9. Generation of unit sample sequence, unit step, ramp function, discrete time sequence, real sinusoidal sequence.
10. Generate and plot sequences over an interval.
11. Given $x[n]$, write program to find $X[z]$.
12. Fourier Transform, Discrete Fourier Transform and Fast Fourier Transform
13. Design of a Butterworth analog filter for low pass and high pass.
14. Design of digital filters.
15. Study of Amplitude Modulation
16. Study of Amplitude Demodulation
17. Study of Frequency Modulation
19. Study of Frequency Demodulation
20. Study of Pulse Amplitude Modulation
21. AM Transmitter/Receiver
22. FM Transmitter/Receiver

- 23. Study of Pulse Width Modulation
- 24. Study of Pulse Position Modulation
- 25. Study of Pulse Code Modulation

ELE-506 Practical – II (Practical based on ELE-503)

100 Marks (4 Credits)

- 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.

Semester –II
ELE-507: FUNDAMENTALS OF SEMICONDUCTOR DEVICES

100 Marks (4 credits)

Course Outcomes

At the end of this course, students will be able to

1. To introduce students about basic concepts of different materials.
2. To study the Band-Structure of Semiconducting Materials.
3. To make learners know about Types of contacts and various properties of materials.
4. To get aware about the applications of semiconducting materials for Electronics Devices.

UNIT-I

20 Marks

Band Theory of solids

Review of free electron theory and its draw backs, Energy bands in solids – Bloch theorem, Effect of lattice periodicity on the allowed states and the Kronig-Penney model, Origin of energy gap, Brillouin zones, Possible wave functions per band, Velocity of electrons according to band theory, Effective mass and concept of hole.

UNIT-II

30 Marks

Semiconductors

Distinction between metals, insulators and intrinsic semiconductors, Hall effect in semiconductors, Band shapes of real semiconductors, Density of states in the energy band, Distribution function, Fermi level in intrinsic case, Fermi level in extrinsic case, Low and high doping cases, Amorphous semiconductors. Metal – Semiconductor contacts, Rectifying and Ohmic contacts, Heterojunction, Metal –insulator-semiconductor structure, Accumulation, Depletion, Inversion, Surface space charge region, Interface traps and charges, Photonic devices, Optical Absorption in a semiconductor, Photoconduction in semiconductors.

UNIT-III

30 Marks

Compound Semiconductors

Compound semiconductors – binary, ternary and quaternary types and their properties; carrier generation and recombination, carrier scattering in semiconductors. Electronic properties and application of semiconductor – semiconductor junction, metal – semiconductor junction, metal – insulator junction, insulator – semiconductor junction in electronic device fabrication. Low-dimensional semiconductor structures: super lattice, quantum wells, wires and dots and their application in electronics; organic and polymer materials for electronics.

UNIT-IV

20 Marks

Semiconductor Devices

Photoelectric phenomena in a P-N junction, Solar cell, Hetero junction and other types of solar cells. Display devices, AC and DC electroluminescent devices, Injection luminescence, Radiative recombination processes, Light Emitting Diode (LED), Semiconductor LASER, Plasma display, Liquid crystal displays (LCD).

REFERENCE BOOKS:

1. Semiconductor Devices: Basic Principles
Jasprit Singh, (John Wiley & Sons Inc.N.Y,USA)
2. Physics of Semiconductor Devices
S. M. Sze, (Wiley Eastern Limited, New Delhi, INDIA)
3. Semiconductor Optoelectronics Devices
P.Bhattacharya, (Prentice Hall Int. Inc. N.J, USA)

4. Optoelectronics: An Introduction
J.Wilson and J.F.B. Hawkes, (Prentice Hall of India, New Delhi, INDIA)
5. Fundamentals of Solid State Physics
B. S. Saxena, R.C. Gupta and P. N. Saxena, (Pragati Prakashan, Meerut, INDIA)
6. Solid State Physics –
A J Dekker, McMillan Publisher, India
7. An Introduction to Solid State Physics –
Charles Kittel, Wiley Publishers
8. Semiconductor Devices –
Physics and Technology - S.M.Sze, Wiley
9. Electrical properties of materials –
L.Solymar and D Walsh

ELE-508: Antenna Theory and Microwave

100 Marks (4 credits)

Course Outcomes

At the end of this course, students will be able to

- CO1 Describe the principals of electromagnetic wave propagation and various effects involved in it
- CO2 Explain the phenomenon of transmission line and its types.
- CO3 Perform calculation for finding out performance parameters of transmission lines like losses SWR
- CO4 Understand the modes of transmission in waveguides and other components involved in microwave communications.

Module – 1

15 marks

Antenna radiation mechanisms: Electromagnetic radiation, retarded potentials, radiation from an oscillating dipole, linear antenna, Lienard – Wiechart potentials, potential for charge in uniform motion (Lorentz formula), field of an accelerated charge, radiation from an accelerated charged particle a low velocity, radiation from charged particle moving in circular orbit, electric quadruple radiation.

Module– 2

30 marks

Antenna and Microwave devices : Elementary doublet, Resonant & non- resonant antenna, Antenna gain and directivity, Antenna impedance and efficiency, Dipole arrays, Folded Dipole and Yagi-Uda antenna(VHF), Microwave Antennas: Antenna with parabolic reflectors, Horn antenna, Loop antenna and logic periodic antenna. Microwave tubes – Klystron, Reflex Klystron and magnetron, Travelling wave tubes, Tunnel diode and Gunn devices, Modes of Gunn diodes, Microwave detectors – PIN and Schottky diodes.

Module-3

25 marks

Introduction to Microwaves: History of Microwaves, Microwave Frequency bands; Applications of Microwaves, Microwave Tubes: Limitation of Conventional devices at high frequency, Construction & working principle with supportive expressions of Two cavity, Reflex klystron, Cylindrical Cavity Magnetron & TWT.

Modele-4

30 marks

Semiconductor Microwave Devices and waveguide system: Construction & working of Gunn Diodes, IMPATT diodes, TRAPAT diodes & Parametric amplifiers and MASERs.
Waveguides: Introduction, TE & TM Modes of propagation through rectangular wave guide & circular waveguide, Microstrip line: Introduction, characteristic impedance & losses in parallel microstrip line.

Basic Text & Reference Books:- (Antenna Theory)

1. Advanced Electronic Communication System
Wayne Tomasi, Prentice Hall International
2. Electronic Communication
Dennis Roddy & John Coolen, Prentice Hall India
3. Electronic Communication System
George Kennedy, Mcgraw Hill Book Co.

RECOMMENDED BOOKS: (Microwave)

1. Classical Electrodynamics
S.P.Puri (Tata McGraw Hill Publishing Co.Ltd., New Delhi, INDIA)
2. Classical electrodynamics
J.D.Jackson (Willey Eastern Ltd., New Delhi, INDIA)
3. Introduction to Electrodynamics
David J. Griffith (Prentice Hall of India Pvt. Ltd., New Delhi, INDIA)
4. Electronics Communications Systems
George Kennedy (McGraw Hill International Edition.,N.Y., USA)
5. Modern Microwave technology
Victor F. Velley (Prentice Hall Inc. N.Y., USA)
6. Microwave Engineering and Applications
O.P.Gandhi (Maxwell Macmillan International Edition.)
7. Electromagnetism (Theory and Applications)
Ashutosh Pramanik (Prentice Hall of India Pvt. Ltd. ,New Delhi, INDIA)

ELE-509: CMOS Analog IC Design

100 Marks (4 credits)

Course Description:

This course explores CMOS analog integrated circuit design, emphasizing MOSFET device behavior, amplifier architectures, current mirrors, feedback, stability, frequency response, and operational amplifier design. Students will gain practical experience through simulations and design projects using open-source EDA tools such as NGSPICE, Xschem, and Magic.

Course Objectives

- To introduce the fundamental principles of MOSFET operation and modeling.
- To explore various amplifier topologies and their applications in analog circuit design.
- To study current mirrors and feedback mechanisms essential for analog circuits.
- To develop skills in designing CMOS operational amplifiers and related circuits.

Course Outcomes

Upon successful completion of this course, students will be able to:

- Analyze and design basic MOSFET circuits and understand their characteristics.
 - Implement and evaluate different amplifier configurations.
 - Design current mirrors and analyze their performance under various conditions.
 - Understand feedback topologies and their impact on circuit stability.
 - Design and simulate CMOS operational amplifiers using open-source EDA tools.
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Course Syllabus:

UNIT I: MOSFET Fundamentals

25 marks

Overview of MOSFETs and their basic circuit applications; Threshold voltage and capacitance modelling; MOSFET structure, operation, and I/V characteristics; Transconductance and output resistance in saturation; Second-order effects: body effect, channel length modulation, subthreshold conduction; Small-signal MOSFET models and simulation using open-source tools; Short-channel effects: drain-induced barrier lowering (DIBL), velocity saturation, hot carrier effects, impact ionization, surface scattering

UNIT II: Amplifiers and Differential Circuits

25 marks

Fundamentals of amplifier design; Single-stage amplifiers: common-source (CS) configuration with various loads (resistive load, diode-connected load, current source load, triode load, source degeneration), source follower, common-gate (CG) amplifier, cascode amplifier, folded cascode; Differential amplifiers: single-ended and differential operation, basic differential pair, common-mode response, MOS load differential pairs, Gilbert cell mixer design

UNIT III: Current Mirrors, Feedback, and Frequency Response

25 marks

Current mirrors: basic, cascode, and active current mirrors (large and small signal analysis); Feedback

topologies: voltage-voltage, current-voltage, voltage-current, current-current; Analysis of loading effects, negative feedback, stability considerations; Frequency response of amplifiers: transfer function formulation, Miller effect, CS and CG stages, source followers; Techniques for frequency compensation.

UNIT IV: CMOS Operational Amplifier Design

25 marks

CMOS operational amplifier design: single-stage and two-stage op-amps; Gain enhancement techniques, folded cascode, telescopic op-amps; Common-mode feedback (CMFB) circuits; Design considerations: input range limitations, slew rate, power supply rejection; Voltage-controlled oscillator (VCO) circuit design; Operational transconductance amplifier (OTA) implementation.

Textbooks & References:

1. Behzad Razavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill.
2. Phillip E. Allen and Douglas R. Holberg, CMOS Analog Circuit Design, Oxford University Press.
3. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, and Robert G. Meyer, Analysis and Design of Analog Integrated Circuits, Wiley.
4. R. Jacob Baker, CMOS Circuit Design, Layout, and Simulation, IEEE Press.
5. David A. Johns and Ken Martin, Analog Integrated Circuit Design, Wiley.

ELE-510: Practical – III**100 Marks (4 credits)**

1. To study the I-V characteristics of an NMOS and PMOS transistor.
2. To design and simulate a common-source amplifier with different load configurations.
3. To design and analyze a source follower (common-drain) amplifier.
4. To implement and evaluate the performance of a common-gate amplifier.
5. To implement and evaluate the performance of a cascode amplifier.
6. To design and simulate a folded cascode amplifier.
7. To design and analyze a differential amplifier with an active load.
8. To evaluate the performance of various MOS current mirror configurations.
9. To perform frequency response analysis of common-source, common-gate, and source follower stages.
10. To design and simulate a single-stage CMOS operational amplifier.
11. To design and simulate a two-stage CMOS operational amplifier with Miller compensation.
12. To design and simulate a CMOS operational transconductance amplifier (OTA).
13. To design and simulate a voltage-controlled oscillator (VCO) using CMOS inverters.
14. To study Hall Effect and find Hall Voltage (V_h), carrier mobility, carrier concentration (n), Hall coefficient (R_h), resistivity (R_b) and carrier conductivity.
15. To determine the bandgap of semiconductor (a). Germanium (b) Silicon
16. To study the I-V characteristics of a metal-semiconductor contact (Schottky diode).
17. To study the I-V characteristics of a solar cell and hence determine the fill factor..
18. To study the resistivity of semiconductor using four probe arrangement.
19. To Characterize the optical characteristics using UV-VIS Spectrometer.
20. To find out the chemical bond present in deposited thin films using FTIR.
21. To Synthesize the Thin Films using Sol-Gel Spin Coating system.
22. To study and design yagi antenna having reflector, dipole and one element and find the gain .
23. To study and design yagi antenna having reflector, dipole and 3 elements and find the gain .
24. To study and design antenna having reflector, dipole and 7 elements and find the gain .
25. Parabolic Reflector Antenna or Dish antenna

ELE- 511: VAC/AEC Introduction to MATLAB**50 Marks (2 credits)****UNIT-I :MATLAB Environment****25 Marks**

MATLAB as a calculator – variables – Functions – Display formats – Complex numbers – Matrices and Vectors – Strings – Input and Output statements – Simple plotting in MATLAB – MATLAB package environments. MATLAB operators and Control flow: Relation operations – Logical operations – Elementary math functions – Matrix functions - Characters and strings – IF-END, IF-ELSE-END, ELSE-IF, SWITCHCASE, FOR Loops, WHILE Loops.

UNIT-II: Interactive Computations**25 Marks**

Matrices and Vectors, Matrices and Array operations, Vectorization, Command line functions, Using Built – in functions. Scripts and Functions: Scripts Files, Function files, General Structure of files, Scope of Variables, Passing parameters, Global Variables, Recursive functions.

References:

- 1. Programming in MATLAB**, Marc E. Hermitter, Thomson Brooks
- 2. MATLAB programming**, Rudrapratap.

M.Sc. III-Semester Electronics

ELE-612 : Nanoelectronics

100 Marks (4 Credits)

- Explain the fundamental principles governing electron behavior at the nanoscale, including quantum confinement, tunneling, ballistic transport, and Coulomb blockade.
- Identify key nanoelectronic devices, such as single-electron transistors, quantum dots, carbon nanotube transistors, graphene-based devices, and tunnel field-effect transistors (TFETs).
- Solve quantum mechanical problems relevant to nanoelectronics, such as the Schrödinger equation for quantum wells, wires, or dots, to predict electronic behavior.
- Use computational tools (e.g., TCAD, COMSOL, or Quantum ESPRESSO) to simulate nanoelectronic device performance and analyze quantum effects.

Unit-I : Single Electron and Few Electron Phenomena

25 Marks

Tunneling through a potential Barrier, Application of Tunneling : Field Emission, Gate -Oxide Tunneling and Hot Electron Effects in MOSFETs, Double Barrier Tunneling and Resonant Tunneling Diode, Coulomb Blockade in a Nanocapacitor, Tunnel Junction, Tunnel Junction Excited by a Current Source, Coulomb Blockade in a Quantum Dot Circuit, Single Electron Transistor (SET) and its Logic, Carbon Nanotube Transistor (FETs and SETs), Semiconductor Nanowire FETs and SETs, Molecular SETs and Molecular Electronics

Unit-II : Many Electron Phenomena

25 Marks

Density of States, Density of States in Lower Dimension and Semiconductor, Semiconductor Heterostructures and Quantum Well, Confinement Models and Two Dimensional Electron Gas, Energy Band Transition in Quantum Wells, Quantum Wires and Nanowires, Quantum Dots and Nanoparticles, Application of Semiconducting Quantum Dots, Plasmon Resonance and Metallic Nanoparticles, Functionalized Metallic Nanoparticles, Conductivity of Metallic Nanowires : The influence of Wire Radius, Ballistic Transport : Electron Collision and Length Scales, Ballistic Transport Model, Quantum Resistance and Conductance, Origin of Quantum Resistance, Graphene, Carbon Nanotubes, Transport of Spin, Spintronic Devices and Applications.

Unit-III : Fiber Optic Sensors (FOSs)

25 Marks

Basic Concepts, Architecture of Fiber Optics Sensors (FOSs), Applications- Temperature, Liquid Level, Fluid Flow and Microbend Sensor. Seismic Sensors, Micro Electro Mechanical Sensors (MEMs) Resonating Quartz Sensors, Piezoelectricity, Resonance and Quartz properties, Electronic equipments for Quartz Sensors, Surface Acoustic Wave Sensors (SAW), SAW Sensors Operation- Chemical and Physical Sensors, Magnetic Field Sensors, Gas sensor.

Unit-IV : Biosensors

25 Marks

SYLLABUS OF M.Sc. (ELECTRONICS)

Introduction and Definition, Receptor : Molecular Recognition Element, Immobilization methods, Electrochemical Sensing principles, Ion-Selective membrane electrode, Ion Selective field effect transistors, Optical biosensors, Introduction & sensing applications in environmental, food and clinical analysis, defense.

Suggested Books.

1. Fundamentals of Nanoelectronics, George W. Hanson, Pearson Education, New Delhi, India
2. Nanoelectronics, A.S. Bhatia, NuTech Books, New Delhi, India
3. Low Dimensional Semiconductors: Materials, Physics, Technology & Devices, M.J.Kelly, Clarendon Press Oxford, N.Y., USA
4. Nanoelectronics: Principles and Devices, Mircea Dragoman and Daniele, Artech House Publication, N.Y. USA
5. Semiconductor Heterojunctions and Nanostructures, Omar Manasreh, McGraw Hill, N.Y., USA
6. Quantum Wells, Wires and Dots, P.Harrison, Wiley, N.Y., USA
7. Silicon Nanoelectronics, Shunri Oda and David Ferry, Taylor & Francis, N.Y., USA
8. Sensors for Domestic Applications Alnaldo D'Amico and Giorgio Sbeveglieri, World Scientific Co. (USA) Advance in Biosensors A.P.F. Turner, Jai Press Ltd., N.Delhi (INDIA)
9. Sensors and Transducers(Second Edition) D. Patranabis, Prentice/Hall of India Private Limited, N.Delhi
10. Biosensors - An Introduction Beian Eggins Wiley Teuinee
11. Biosensors Principles & Applications Loic J. Blum and Pierre R. Coulet, Marcel Dekker, Inc. (USA)

SYLLABUS OF M.Sc. (ELECTRONICS)

ELE-613 : Signal and System

100 Marks (4Credits)

- **Design, implementation, analysis and comparison of digital filters for processing of discrete time signals**
- **Integrate computer-based tools for engineering applications**
- **Employ signal processing strategies at multidisciplinary team activities.**

Unit-I : Introduction to Signals and Systems

25 Marks

Signals and systems everyday life, biomedical, instrumentation domestic and industries. Representations of Signals, Classifications of Signals – Continuous time, Discrete time, comparison among Analog, Digital and Discrete Signals, Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, and the complex exponential. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. Examples.

Unit-II : Mathematical operations on Signals and Systems

25 Marks

Addition, subtraction, multiplication and division of the signals, parallel and series combinations of the systems, cascading of the systems, impulse response characterization and convolution integral for CT- LTI system, signal responses to CT LTI system, properties of convolution, LTI system response properties from impulse response, Examples. Impulse response characterization and convolution sum, Causal signal response to DT-LTI systems. Properties of convolution summation, Impulse response of DT-LTI system. DT-LTI system properties from Impulse response. System analysis from difference equation model, examples.

Unit-III : Fourier, Laplace and z-transforms

25 Marks

Representation of periodic functions, Fourier series, Frequency spectrum of aperiodic signals, Fourier Transform, Relation between Laplace Transform and Fourier Transform and its properties. Parseval's Theorem. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

Unit-IV : Sampling & reconstruction

25 Marks

The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system

SYLLABUS OF M.Sc. (ELECTRONICS)

theory: modulation for communication, filtering, feedback control systems.

Suggested Books.

1. Signals and Systems, Alan V. Oppenheim, Alan S. Willsky and Nawab, Prentice Hall
2. Signals and Systems, K. Gopalan, Cengage Learning (India Edition)
3. Signals and Systems, Michal J. Roberts and Govind Sharma, Tata Mc-Graw Hill Publications
4. Signals and Systems, Simon Haykin and Bary Van Veen, Wiley- India Publications
5. Linear Systems and Signals, B.P.Lathi, Oxford University Press
6. Signal, Systems and Transforms, Charles L. Philips, J. M. Parr and E. A. Riskin, Pearson Education
7. Signal and Systems, Anand Kumar, 3rd Edition, PHI
8. Internet of Things: Technologies, Applications, Challenges and Solutions, B. K. Tripathy & J. Anuradha, CRC Press, 2017.

SYLLABUS OF M.Sc. (ELECTRONICS)

ELE-614 : VLSI Technology

100 Marks (4 Credits)

- Discuss the differences and similarities between different vacuum based deposition techniques
- Evaluate and use models for nucleating and growth of thin films,
- Assess the relation between deposition technique, film structure, and film properties, discuss typical thin film applications.
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- Develop thin film based devices for various applications.

Unit-I: Semiconductor Materials

25 Marks

Crystal structures, Energy bands, Intrinsic Carrier concentration, Donors and Acceptors, Electron Mobility, Resistivity and conductivity, Crystal Growth, Electron Grade Silicon, Czochralski Crystal Growth, Float Process, Characterization, Wafer preparation, Epitaxy, Chemical Vapor Deposition(CVD), Growth model, Growth Chemistry, Doping and Autodoping, Reactors, Defects, Selective Epitaxial Growth, Low – temperature Epitaxy(LTE) and Molecular Beam Epitaxy(MBE) and Rapid Thermal Epitaxy(RTE)

Unit-II : Oxidation

25 Marks

Theory of Oxide growth, Experimental Fits – Orientation Dependence and Effects of Impurities, High Pressure Oxidation, Plasma Oxidation and Rapid thermal oxidation, Oxide properties, Dopant Redistribution at the Interface, Lithography, Clean Room, Optical Lithography, Masks, Photoresist, Pattern Transfer, Electron Lithography, X-Ray Lithography, Ion Lithography, Comparison of Lithographic Techniques

Unit-III: Etching

25 Marks

Wet chemical etching, Dry etching, Plasma excitation and plasma interaction, Simple plasma etching systems, Diffusion, Diffusion theory, Diffusion profiles, Constant-Surface concentration diffusion, Constant-Total-Dopant diffusion, Dual diffusion Process, Extrinsic diffusion, Diffusion in silicon, Oxide masking, Lateral diffusion, Fast diffusants, Diffusion in Polysilicon, Ion Implantation, Implant Uniformity, Contamination

Unit-IV: Annealing

25 Marks

Furnace annealing, Rapid thermal annealing, Metallization, Metallization choices, Metal Corrosion, Testing – assembly and Packaging of IC, Die bonding and wire bonding, Flip – Chip technique, Hermetic and plastic packages, Through – Hole and Surface-Mounts Packages, Tape Carrier Packages.

Suggested Books.

1. Introduction to VLSI circuits and systems, John P. Uyemura, John Wiley & Sons(Asia) Pvt Ltd NY(USA)
2. VLSI Technology, SM Sze (Mc Graw – Hill International Edition, NY, USA)

3. Modern Semiconductor Fabrication Technology, Peter Gise & Richard Blanchard (Reston Book – Prentice Hall, N.J, USA)

ELE-615 : Power and Industrial Electronics**100 Marks (4 Credits)**

- To implement the algorithms and draw flowcharts for solving simple problems.
- Demonstrate an understanding of computer programming language concepts.
- To be able to develop C programs. Micropro
- To define data types and use them in simple data processing applications also he/she must be able to use the concept of array of structures.
- To design and develop Computer programs, analyzes, and interprets the concept of pointers, declarations, initialization, operations on pointers and their usage.
- To Develop confidence for self-education and ability for life-long learning needed for Computer language

Unit-I : SPECIAL POWER DEVICES**25 Marks**

Thyristor families – SCR, triggering methods of SCR - dV/dt , triggering with single pulse and train of pulses, DIAC, TRIAC, power MOSFET, IGBT, Firing and Protecting Circuits: Necessity of isolation, pulse transformer, Power BJT, Over voltage, over current and gate protections; snubbers, Principles of Three phase half wave and full wave converter

Unit-II : SMPS**25 Marks**

Introduction of Basic Components - PWM principles, DC Choppers: Introductions – Principles of Step down Operation – Step down With RL load – Principle of Step up Operation, Switch Mode Regulators: Buck Regulator – Boost Regulator – Buck Boost Regulator – Cuk Regulator, Block Diagram of SMPS, Working principle of SMPS

Unit-III : Stabilized Power Supplies**25 Marks**

Uninterrupted power supplies, online UPS, offline UPS, high frequency online UPS, programmable logic controllers, Voltage stabilizers-servo mechanism, single phase & three phase servo voltage stabilizers.

Unit-IV : Introduction to motors**25 Marks**

DC Motors: Working principle of DC motor, shunt motor, series motor, starter, closed loop control of DC drive, PLL control of DC drive. AC Motors: Working principle of AC motor, typed of AC motors, torque speed characteristics of induction motor, induction motor drives, speed control of induction motor- stator voltage control and V/f control, synchronous motor, working principle of synchronous motor.

References:

1. **Modern Power Electronics and AC Drives**, Bimal K. Bose, Pearson Education Asia
2. **Power Electronics: Converters, Applications and Design**, Ned Mohan, Tore M. Undeland and William P. Robbins
3. **Wind and Solar Power System**, Mukund R. Patel
4. **Energy Technology – Non Conventional, Renewable and Conventional**, S. Rao and Parulekar, New Delhi, Khanna Publishers
5. **Power Electronics Circuits, Devices and Applications**, M.H. Rashid, New Delhi, Prentice Hall of India

ELE-616 Practical – IV 100 Marks (4 Credits)

1. Characteristics of D.C. and A.C. Servo motors
2. Study of I-V characteristics of DIAC
3. Study of I-V characteristics of a TRIAC
4. Study of I-V characteristics of a SCR
5. SCR as a half wave and full wave rectifiers with R and RL loads
6. DC motor control using SCR.
7. DC motor control using TRIAC.
8. AC voltage controller using TRIAC with UJT triggering.

M.Sc. IV-Semester Electronics

ELE-617 : VLSI Digital Design **100 Marks (4 Credits)**

- Design complex digital systems using VLSI design methodology.
- Design a digital system using given specifications and design constraints.
- Plan and choose digital system testing strategy
- Plan digital system verification strategy

Unit-I : An overview of VLSI **25 Marks**

VLSI Design Methodology, Design Flow, VLSI Road Map, Logic Design with MOSFET, Elements of Physical Design. System level physical design: Large scale physical design, Interconnectivity, Delay model, Cross talk, Floor Planning & Routing, I/O Circuits, Power Distribution & Consumption, Clock Distribution

Unit-II : Reliability & testing of VLSI Circuits **25 Marks**

Introduction to Testing of VLSI Circuits, Fault Models, Gate level testing, Boundary Scan testing, Ad-hoc Testing, Test Generation Methods, D-Algorithm, Introduction to ATPG.

Unit-III : System Specification using HDL **25 Marks**

Introduction to HDL, VHDL modeling concept, Scalar data type & operations in VHDL, Sequential statements, Composite data type, Basic Modeling Constructs.

Unit-IV : Subprogram in VHDL **25 Marks**

Packages & USE Clauses, VHDL standard package1164, Alias, Constants, Components and configurations, Files and Input/Output. Designing with Programmable Logic Devices, Digital Design with State Machine chart, Designing with FPGAs & CPLDs, VHDL model for memory buses.

Suggested Books.

- 1. Introduction to VLSI Circuits & Systems**, John P. Uyemura, John Willey & sons (Asia) Pvt Ltd. NY,(USA)
- 2. The Designer guide to VHDL**, Peter J Ashenden, Harcourt India Pvt. Ltd., N.Delhi (INDIA)
- 3. Digital logic design principles**, Norman Balabanian & Bradely Carlson, John Willey & Sons Pvt. Ltd. . NY,(USA)
- 4. Modern VLSI Design : System on Silicon**, Wayne Wolf, Pearson education - Prentice Hall ,New Delhi (INDIA)
- 5. Principles of CMOS VLSI Design : A system perspective Neil H.E.**, Weste and Kamran Eshraghian Pearson Education -Prentice Hall New Delhi (INDIA)

- 6. Digital Integrated Circuits : A Design Perspective** , Jan M. Rabeay, Anantha Chandrakasan and Borivoje Nikolic Prentice Hall of India (EEE), New Delhi (INDIA)
- 7. Digital Systems Design using VHDL**, Charles H. Roth Jr., Thomson Brooks/ Cole (USA)

ELE-618: Introduction to Machine Learning
100 Marks (4 Credits)

Course outcomes:

Upon successful completion of this course, students will be able to:

- Understand and distinguish between major types of machine learning paradigms.
- Apply supervised learning methods such as linear regression, logistic regression, SVM, and decision trees to solve regression and classification problems.
- Implement unsupervised learning techniques including k-means clustering and principal component analysis.
- Evaluate model performance using appropriate metrics like sensitivity, specificity, F1-score, and ROC curves.
- Design and execute machine learning experiments using Python and open-source libraries (e.g., scikit-learn, TensorFlow).
- Analyze data patterns and develop predictive models for practical applications in engineering and research domains.

Unit-I: Introduction to Machine Learning:

Basics of Machine Learning: Introduction and role of machine learning, General Problem in Machine Learning, What is Data and Model and Optimization Types of Machine Learning, Various Machine Learning Paradigm. Various Types of Machine Learning: Supervised, Unsupervised and Reinforcement Learning.

Unit-II: Basics of Supervised Learning:

Supervised Learning: regression and classification problems, simple linear regression, multiple linear regression, ridge regression, logistic regression, Least Square Error, Performance parameter: Sensitivity, Specificity, Accuracy, F1 Score, ROC Curve.

Unit-III: Basic Supervised Algorithm and approaches

k-nearest neighbour, naive Bayes classifier, linear discriminant analysis, support vector machine, decision trees, bias-variance trade-off, cross-validation methods such as leave-one-out (LOO) cross-validation, k-folds cross-validation, multi-layer perceptron, feed-forward neural network;

Unit-IV: Unsupervised Learning method

Unsupervised Learning: clustering algorithms, k-means/k-medoid, hierarchical clustering, top-down, bottom-up: single-linkage, multiple-linkage, dimensionality reduction, principal component analysis.

Suggested Books

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press (23 April 2020)
2. Tom M. Mitchell- Machine Learning- McGraw Hill Education, International Edition
3. Aurélien Géron Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, Inc. 2nd Edition
4. Saikat Dutt, Subramanian Chandramouli, and Amit Kumar Das, Machine Learning, Pearson Education India.
5. Nikhil R. Pal and Sankar K. Pal, Fundamentals of Machine Learning, PHI Learning.
6. T.V. Geetha and N. Sreenath, Machine Learning, Tata McGraw-Hill Education.

1. Study of Data Types and Preprocessing
 - a) Reading different data types (CSV, Excel) into MATLAB.
 - b) Handling missing data and basic normalization (min-max, z-score).
 - c) Label encoding of categorical data.
2. Study of Data Visualization
 - a) Scatter plots, histograms, and boxplots.
 - b) Correlation matrices using corrcoef.
3. Study of Simple Linear Regression
 - c) Implement simple linear regression on synthetic or real data.
 - d) Plotting regression line and calculating MSE, R^2 .
4. Study of Logistic Regression
 - e) Binary classification (e.g., tumor detection: benign vs. malignant).
 - f) ROC curve generation using perfcurve.
5. Study of k-Nearest Neighbors (k-NN) Classification
 - a) Classify Iris dataset using k-NN.
 - b) Analyze the impact of k on accuracy.
6. Study of Naive Bayes Classifier
 - a) Implement Gaussian Naive Bayes classifier from scratch or using MATLAB's fitcnb.
7. Study of Support Vector Machine (SVM)
 - a) Use MATLAB's fitsvm for binary classification.
 - b) Plot decision boundary for linearly separable data.
8. Study of Decision Trees
 - a) Create and visualize decision trees using fitctree.
 - b) View rules and leaf nodes.
8. Study of Cross-Validation Techniques
 - a) Implement k-fold and Leave-One-Out (LOO) validation for a chosen classifier.
10. Study of k-Means Clustering
 - a) Cluster synthetic data and visualize the results.
 - b) Compare cluster labels with actual classes using confusion matrix.
11. Study of Hierarchical Clustering
 - a) Use dendrograms to understand clustering linkage methods (single, complete).
12. Study of Principal Component Analysis (PCA)
 - a) Apply PCA on high-dimensional data (e.g., images or digit datasets).
 - b) Plot explained variance and reduce dimensionality for visualization.

ELE-620 Research Methodology**50 Marks (2 credits)**

Unit-1	Research aptitude: Meaning, characteristics, and types of research; Steps in research process; Research ethics and plagiarism; Publication of research papers and articles; Thesis writing-characteristics and standard format	25 Marks (1 credit)
	Scientific Communication & Presentation: Preparation of seminar presentations (slides, graphs, tables, images, references); Oral and poster presentation (A0 size format); Communication skills-eye contact, body language, audience engagement; Handling question-answer sessions	
	Scientific Writing Skills: Steps for effective scientific writing; Flow method and logical organization; Style and clarity in research writing; Preparation of figures, tables, graphs, footnotes, and references	
Unit-II	Internet and Research Tools: Use of internet in research; Searching scholarly databases and journals; Downloading and managing research papers; Introduction to repositories such as preprint archives; Compilation of relevant academic websites	25 marks (1 credit)
	ICT (Information and Communication Technology): Meaning and components of ICT; Advantages and limitations; Basics of internet usage and email communication in research	
	Intellectual Property Rights (IPR): Introduction to patent laws; Process of patent filing; Copyrights and ownership; Basics of cyber laws	

ELE-621: Research (Thesis) 150 marks (6 credits)