FIRST YEAR M.Sc.
ELECTRONIC SCIENCE

SEMESTER - II

Academic Year 2022-2023

M.Sc.I Electronic Science - Course structure & Credits Distribution

Semester	Course Code	Course Title	No. of credits
Sem-II	PSEL121	**Electromagnetics, Microwaves and Antennas**	04
	PSEL122	**Instrumentation and Measurement Techniques**	04
	PSEL123	**Embedded System Design with PIC microcontroller**	04
	PSEL124	**Foundation of Semiconductor Devices**	04
	PSEL125	**Electronics Science Practical Course III**	04
	PSEL126	**Electronics Science Practical Course IV**	04

Faculty of Science
Post Graduate Extra Credits

Semester	Course Code	Title of the Course	No. of Credits
II		Certificate Course-I	2
II	CYS-102	Introduction to Cyber Security - II	2

PSEL121- Electromagnetics, Microwaves and Antennas

[Credit-4]

Objectives:

1. To introduce to students the concepts of electromagnetics
2. To understand the theory of transmission lines and wave guides
3. To study various parameters of antennas
4. To study various methods of generation of microwaves

Outcomes:

1. Classify Maxwell's equation in different forms.
2. Analyses the nature of electromagnetic wave propagation in guided medium.
3. Test and examine the phenomena of wave propagation in different media and its interfaces.
4. Design different antennas based on their characteristics for different applications.

Prerequisite: Physical quantities as vectors, concept of gradient, curl, and divergence, concept of rotation operator, covariant and contra-variant vectors, line, surface and volume – integrals, Gauss and Stokes theorem complex plane, polar form of complex number, complex functions, Cauchy-Riemann conditions, orthogonal functions and relation with Laplace equation.

Unit-1: Electromagnetic Waves **(15L)**

Review of Maxwell's equations and their meaning, continuity equation, electric and magnetic wave equations in time domain and frequency domain, wave propagation in conducting and non-conducting media, skin depth and high frequency propagation, boundary conditions at the interface between two mediums, Poynting theorem and its applications.

Unit-2: Transmission Lines **(15L)**

Types of transmission lines, microstrip lines, two wire transmission line, transmission line equations for voltages and currents, inductance and capacitance per unit length of two wire and coaxial cable transmission line, characteristic impedance, propagation constants, attenuation and phase constants, phase velocity, reflection and transmission coefficients, SWR, line impedance, normalized impedance and admittance, Smith chart construction and applications, single stub and double stub matching, applications to reflection of EM-waves at interfaces for normal incidence.

Unit-3: Waveguides and Components **(15L)**

Concept of waveguides, frequency range, relation to transmission lines.

Rectangular Waveguides: TM and TE Modes, concept of cut-off frequency, guide impedance, phase velocity, guide wavelength for TE and TM modes, Applications to TE mode in rectangular waveguide, power losses in rectangular waveguide, introduction circular waveguide.

Optical Fiber: principles of operation and construction, difference between conducting circular waveguide and fiber Different methods of excitation of TE and TM modes in waveguides Cavity Resonators, Q factor of cavity resonators.

Unit-4: Electromagnetic Radiation **(15L)**

Potentials of electromagnetic fields, retarded potential, radiation from oscillating dipole, concept of near zone and radiation zone, radiation resistance, role of antenna in exciting different TE, TM modes in wave guides.

Antenna Parameters: gain, directivity, power, aperture, Friis equation, radiation pattern.

Application Areas: antenna temperature, Signal to Noise Ratio (SNR), remote sensing, RADAR equation.

Antennas Types: $\lambda/2$ antenna, antenna arrays, horn antennas, parabolic dish antennas, End fire antenna – Yagi Uda, patch antenna, microstrip antennas EMI and EMC.

Generation of Microwaves: principle, physical structure and working of - Gunn Effect diodes, magnetron oscillator, reflex Klystron oscillator.

Text / Reference Books:

1. Microwave Devices and Circuits, Samuel Y. Liao, PHI, 3rd Edition, 2002.
2. Principles of Electromagnetics, N. Sadiku, Oxford University Press.
3. Electromagnetics with Applications, Kraus and Fleiseh, McGraw Hill, 5th Edn, 1999.
4. Electromagnetics, J.D. Kraus, 4th Edn, McGraw Hill, 1992.

PSEL122:- Instrumentation and Measurement Techniques
[Credit -4]

Objectives:

1. To understand the configurations and functional descriptions of measuring instruments
2. To understand the basic performance characteristics of instruments
3. To understand the working principles of various types of sensors and transducers and their use in measuring systems
4. To study the techniques involved in various types of instruments
5. To understand the relevance of electronics with other disciplines

Outcome :

Working principles of various types of sensors and transducers, Instruments.

Unit1: Introduction to Instrument and Measurement Systems (10L)

Definition and significance of measurement, classification of instruments and types of measurement applications, elements of an instrument / measurement system
Static and dynamic characteristics: Accuracy, Precision, Resolution, Threshold, Sensitivity, Hysteresis, loading effect, linearity, dead zone.
Errors in measurement: Types of Errors - gross, systematic, environmental errors, Systematic errors, computational error, personal error etc.

Unit 2: Sensors and Transducers (20L)

Definition, Types of sensor, classification, Need of Sensors.
Transducer: Active and passive transducer, characteristics of sensors, static and dynamic characteristics, Methods of transduction, primary sensing elements and transducers, electrical transducers, classification of transducers
Motion and dimensional measurement: relative displacement- translational and rotational, resistive potentiometers, resistance strain gauge, differential transformers- LVDT & RVDT, piezoelectric transducers, digital displacement transducers (translational and rotary encoders), ultrasonic transducers, Hall effect sensor, LVDT and synchros.
Temperature Sensors: Thermocouples, Thermistors, RTD, PT 100, Semiconductor temperature transducers, AD590, LM35, LM135, LM235, LM335.
Actuators: Electromagnetic relay, Limit switch, Proximity sensor, Inductive, Capacitive, IR proximity sensor.

Unit 3: Process Parameter Measurement (15L)

Force, Torque and Shaft power: standards and calibration, basic methods of Strain gauge, digital system, load cell, torque measurement on rotating shafts
Pressure and Sound Measurement: dead weight gauges and manometers, low pressure measurement - Mcload gauge, Knudsen gauge, Sound level meter, microphone, and capacitor microphone
Flow measurement: Pitot-static tube, Yaw tube, hot wire and hot film anemometers, Flow Rate- rotameter, turbine, ultrasonic flow meter, electromagnetic flow meters

Temperature and Heat Measurement Transducers: standards and calibration, Bimetallic strips, thermometers, pressure thermometers, RTD, thermocouples, thermistors, application circuits, LM35

Radiation Fundamentals: detectors, optical pyrometers, IR imaging systems, heat Flux sensing- slug type sensors, Gorden gauge.

Unit4: Biomedical based instrumentation system (15L)

Fundamentals of medical Instruments: Role of Technology in medicine, Development in biomedical insterumentation medical devices.
Bioelectric signal : The origin of Biopotentials, measurement of Biopotentials, Electrical activity of excited cells, The concept of electrical impedance, impedance bridge circuits.
Sensors and Electrodes: Silver-silver Chloride electrode Electrodes for ECG, EEG & EMG.
Recording system : Electrocardiograph (ECG), Electroencephalograph (EEG)
Electromyograph (EMG): Basic principle, block diagram, ECG Leads

Reference books:

1. Measurement Systems, Applications and Design, Ernest O. Doeblin and Dhanesh N. Manik, 5th Edition, Tata McGraw Hill.
2. A Course in Electrical and Electronic Measurements and Instrumentation By A.K.Sawhney, Dhanpat Rai & Co.
3. Modern Electronic Instrumentation and Measurements Techniques, Cooper and Helfrick, PHI.
4. Biomedical instrumentation and measurement, R.Natrajani.
5. Biomedical Instrumemtation, R.S.Khandpur, 3 rd edition.

PSEL123: Embedded System Design with PIC microcontroller
[Credit -4]

Objectives:

1. To understand the basics of embedded system
2. To learn communication standards and protocols and RTOS
3. To understand the architecture of different 8-bitmicrocontrollers
4. To learn embedded C and assembly language programming
5. To learn real interfacing devices to microcontroller

Outcomes:

1. Understand the internal architecture and interfacing of different peripheral devices with Microcontrollers
2. Analyze and develop embedded hardware and software development cycles and tools.
3. Evaluate and understand different concepts of sensors, memory interface, and types of communication protocols.
4. Design and develop programming skills in embedded systems for various applications.

Unit-1: Introduction to Embedded System and Bus Standards (15L)

Embedded System: components, examples, development cycle of embedded system, embedded System
Development Environment - algorithm, flow chart, IDE, ICE, programmer
Communication Protocols: I2C bus- specification, general characteristics, bus signals, address mechanism
Serial Peripheral Interface (SPI): specifications, master slave configuration,
Controller Area Network (CAN): specifications, basic concepts, frame types, bus signals, error handling and addressing, Introduction to IoT.

Unit-2: Introduction to PIC Microcontroller (15L)

Architecture (PIC18F4550, 18F458), instruction set, addressing modes, memory organization, timers, I/O ports, ADC, interrupts.
Design of General Purpose Target Board: reset, oscillator circuit, derivatives of PIC
Basic C Programs: arithmetic, logical, code converter, block data transfer, I/O programming.

Unit -3: Interfacing programming (15L)

C programming of timers and counters, DAC, LED, SSD, dot matrix display, and LCD displays (text and graphic), keyboard and motors, EEPROM, DAC and ADC

Unit -4: Serial communication programming (15L)

Serial communication, Real world interfacing with the microcontrollers RTC, I2C, SPI, GPS, GSM.Concept of Real time, Characteristics, Hard and Soft real time system, Structure of RTOS.

Text / Reference Books:

1.Embedded/ Real Time System - Concept Design Programming, KVVK Prasad
2.PIC Microcontroller and Embedded Systems, Mazidi, Mckinlay and Causey, Pearson Education.
3.Programming PIC microcontrollers with PIC basic by Chuck Helebuyck
4.PIC microcontrollers-programming in basic by Milan Verle.
5.C Programming for Embedded Systems, Kirk Zurell, PearsonEducation.
6.Programming in C, Stephen Kochan, HaydenBooks/Macmilla

PSEL124:- Foundation of Semiconductor Devices
[Credit -4]

Objectives

1.To introduce crystal structure with reference to semiconductors
2.To introduce quantum and statistical mechanics
3. Operating principles of modern semiconductor devices
4.To understand the theory and characteristics of semiconductor devices

Outcomes

1. Understand the concept of Quantum and statistical mechanics.
2. Concept of Semiconductor.
3. Understand the characteristics of semiconductor devices.
4. Materials and its different properties.

Unit-1: Theory of solids, quantum and statistical mechanics (15L)

Crystal structure of solids: types of solids, Semiconductor materials, basics of crystallography, Space lattice, unit cell, Crystal structures, atomic bonding, Miller indices, imperfections and impurities in solids, methods for semiconductor crystal growth. Quantum Theory of solids: Principles of quantum mechanics, Schrodinger wave equation and Applications of Schrodinger's wave equation for bound state potential problems, Allowed & forbidden energy bands, electrical conduction in solids. Statistical mechanics: Statistical laws, Fermi-Dirac probability function, the distribution function and the Fermi energy.

Unit-2: Physics of semiconductors (15L)

Semiconductor in equilibrium: Dopant atoms and energy levels, extrinsic semiconductors, Statistics of donors and acceptors, charge neutrality, position of Fermi energy level. Carrier transport phenomena: charge, effective mass, drift current density, conductivity, carrier diffusion, graded impurity distribution, Hall effect. Non-equilibrium excess carriers in semiconductors: Carrier generation & recombination characteristics of excess carriers, quasi-Fermi energy levels, excess carrier lifetime, surface effects.

Unit-3: Basics of Semiconductor Devices (15L)

Diode: Fabrication process, Junction terminologies of PN junction diode, junction capacitance C-V characteristics, Qualitative and Quantitative analysis, diode equation, Reverse-bias breakdown, Transient response, Poisson's equation BJT: Fabrication process, Terminology, electrostatics and performance parameters, Eber-Moll model, Two port model, hybrid – pi model, Modern BJT structures – polysilicon emitter BJT, Hetero junction bipolar transistor(HBT)FETs: JFET and MESFET - Junction terminologies, characteristics MOSFET: Fundamentals, Capacitance- voltage characteristics, I-V characteristics, Special semiconductor devices-Optical devices, Solar cells, Photodetectors

Unit-4: Electronic Materials and properties (15L)

Electrical properties of metals: Conductivity, reflection and absorption, superconductivity, thermoelectric phenomena. Conduction in metals oxides .Dielectric Properties of materials :Macroscopic electric field, local electric field at an atom, dielectric constant and polarizability, ferroelectricity, antiferro electricity, phase transition, piezoelectricity, ferro elasticity,

electrostriction.Optical properties of materials: Optical constants and their physical significance, Relations, Electronic Intern bond and intra bond transitions Relations between Optical properties and band structure Magnetic Properties of Materials: Dimagnetism, paramagnetism, various contributions to par and diamagnetism, Defects in crystals and their effects on mechanical, electrical and optical properties.

Text / Reference Books:

1.Semiconductor Physics and Devices Basic Principles, Donald A. Neamen, TMH, 3rdEdition(2003)
2.Semiconductor Device fundamentals, Robert F. Pierret, PearsonEducation
3.Solid State Electronics Devices, Streetman, PHI, 5th Edition,(2006)
4.Principles of Electronic materials &dev, S.O. Kasap,Mcgraw Higher Ed Publication
5.Solid State Physics, Dekkar,Mcgraw Higher Ed publication
6.Introduction to Solid State Physics, C.Kittle,Wiley publication

PSEL125- Electronics Science Practical Course III
[Credit-04]

Group A (07) + Group B (03)= Total 10

Group A-Practical based on Instrumentation and Measurement System

1. Design build and test rms to dc converter for voltage measurement of ac signal
2. Displacement measurement using LVDT, signal conditioning and DPM
3. Temperature measurement using PT100, signal conditioning and DPM
4. Temperature measurement using thermocouple with cold junction compensation
5. Design build and test IR transmitter and receiver (TSOP1738 or similar) for object detection
6. To build and test current telemetry (4 to 20mA)
7. Ultrasonic transmitter and receiver, distance measurement
8. Pressure measurement using strain gauge
9. RPM measurement using various methods
10. Design light intensity meter using photodiode or LDR and the necessary signal conditioning and display.
11. Use of strain gauge to measure stress on a cantilever made of material known quantity
12. Hot wire anemometer
13. Design of signal conditioning circuit for Humidity Measurement.
14. Temperature measurement and control of using Thermistor.
15. Design and calibrate light intensity meter using photodiode or LDR using necessary signal conditioning.
16. Object Counter using reed switch.
17. Hall Effect measurement.

Group B -Practical based on Electromagnetics, Microwaves, Antennas

1. To study the characteristics of Klystron tube
2. To determine the standing wave ratio and reflection coefficient of a given waveguide
3. Microwave Test bench experiment
4. Microwave Test bench experiment
5. To measure an unknown impedance with smith chart
6. To determine the frequency and wavelength in rectangular waveguide
7. To study the characteristics of directional coupler
8. Design and test Yagi-Uda antenna with power reflectors
9. Measurement of primary-secondary coupling factor of a given transformer using LCR meter (calculation of transformer model parameters expected)

[C]Activity: Equivalent to TWO Experiments

OR

[C] Study Tour

PEL126- Electronics Science Practical Course IV
[Credit-04]

Group A (07) + Group B (03) = Total 10

Group A-Practical on PIC Interfacing

1. Interfacing of LED array to generate different sequences, use of timer for delay generation
2. Two-digit 7-segment display (multiplexed) interfacing
3. LCD / keyboard Interfacing
4. Bidirectional stepper motor interfacing
5. Real Time Clock display on LCD / HyperTerminal(I2C)
6. Use of internal EEPROM
7. DAC interfacing (square wave, staircase, triangular, sine) use of timer
8. Use of ADC
9. Two digit frequency counter or event counter using timer /interrupt
10. Matrix keyboard / Touch screen
11. Graphic LCD interfacing
12. Zigbee communication
13. DC motor control using PWM / intensity control of LED

Group B- Practical on Electromagnetics (C / MATLAB)

1. To plot Equipotential contours and field lines for given charge distribution
2. Use of Smith chart for transmission line pattern and verify using C
3. Use of MATLAB for potential distribution in a region bound by two conductors
4. Use of MATLAB for directivity pattern for simple antennas
5. Use of MATLAB to plot the contours of the voltage and the field lines for square coaxial cable
6. Use of MATLAB to plot magnetic field lines of solenoids.
7. Use of MATLAB to determine electric field at a point.

[C] Activity: Equivalent to TWO Experiments

OR

[C] Circuit Simulation Using Software