FIRST YEAR M.Sc.
ELECTRONIC SCIENCE

SEMESTER - II

Academic Year 2022-2023

2022 Pattern

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]

Course Objectives:

1. To introduce to students the concepts of electromagnetics
2. To understand the theory of transmission lines
3. To study various waveguide
4. To study various methods of generation of microwaves
5. To study OFC
6. To Study Different Antenna types.
7. To study various parameters of antennas

Course Outcomes:

CO1: Classify Maxwell's equation in different forms.
CO2: Analyses the nature of electromagnetic wave propagation in guided medium.
CO3. Test and examine the phenomena of wave propagation in different media and its interfaces.
CO4. Design different antennas based on their characteristics for different applications.
CO5. Working of OFC
CO6. Test and examine the phenomena of wave propagation in different media and its interface
CO7. 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.

Course Outcome	Program Outcomes								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	3	3	3	2	1	2	3	3
CO2	3	2	2	1	3	-	3	3	-
CO3	-	3	3	2	3	3	-	-	2
CO4	3	-	-	2	2	2	2	1	1
CO5	2	1	2	3	-	-	-	-	-
CO6	-	-	-	1	2	-	3	-	2
CO7	2	1	-	-	-	-	-	-	-

Justification for the mapping

P01: Disciplinary Knowledge

CO1: Classifying Maxwell's equations requires a deep understanding of electromagnetic theory, which is fundamental knowledge in the field of electrical engineering and physics.

CO2: Analyzing electromagnetic wave propagation in guided media involves understanding advanced concepts in wave theory and transmission line theory.

CO4: Designing antennas involves applying theoretical knowledge of electromagnetic waves to practical applications.

CO5: Understanding the working of OFC requires knowledge of optical and communication systems.

CO7: designing antennas for various applications emphasizes the application of theoretical knowledge in the field of antenna design, aligning with the program outcome.

PO2: Critical Thinking and Problem solving

CO1: he study of electromagnetic wave propagation in guided media and the design of antennas for different applications require critical thinking skills.

CO2: This outcome is essential for providing students with a deep understanding of how electromagnetic waves propagate in guided media

CO3: Testing and examining wave propagation phenomena in various media and interfaces require students to apply theoretical concepts to real-world situations

CO5: Understanding the working of Optical Fiber Communication involves analyzing the transmission of data through optical signals.

CO7: this outcome reinforces the application of knowledge in designing antennas.

PO3 :Social competence

CO1: Understanding Maxwell's equations is foundational for anyone working with electromagnetic phenomena**.**

CO2: Analyzing wave propagation involves the ability to communicate findings and insights to peers, fostering social competence in the exchange of technical information

CO3: Collaborative testing and examination of wave propagation phenomena in diverse media naturally require effective communication and teamwork

CO5: Understanding the working of Optical Fiber Communication systems is a collaborative effort that requires effective communication among team members.

PO4: Research-related Skills and Scientific Temper

CO1 to CO6:All include Research-related Skills and Scientific Temper.

P05: Trans-disciplinary knowledge

CO1: The classification of Maxwell's equations in different forms and the analysis of electromagnetic wave propagation This trans-disciplinary approach ensures that students gain a comprehensive knowledge.

CO2**:** require an understanding that spans multiple disciplines, including physics and mathematics. This trans-disciplinary approach ensures that students gain a comprehensive knowledge base that goes beyond the boundaries of a single field.

CO3: Collaborative testing and examination of wave propagation phenomena in diverse media naturally require Trans-disciplinary knowledge.

CO4: Designing antennas involves applying theoretical knowledge of electromagnetic waves to practical applications it include Trans-disciplinary knowledge.

CO6: Study of wave propagation include Trans-disciplinary knowledge

PO6: Personal and professional competence

CO1: Understanding Maxwell's equations is Personal and professional competence for anyone working with electromagnetic phenomena**.**

CO3: Collaborative testing and examination of wave propagation phenomena in diverse media naturally require Personal and professional competence.

CO4: Designing antennas involves applying theoretical knowledge of electromagnetic waves to practical applications it include Personal and professional competence.

PO7:Effective Citizenship and Ethics

CO1: Understanding the foundational equations of electromagnetism is critical for ethical engineering practices

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CO2: As students explore the nature of electromagnetic wave propagation, they must consider ethical implications related to signal privacy, security, and potential interference.

CO4: Ethical considerations in antenna design involve ensuring that the designed antennas comply with regulations

CO6: testing wave propagation in various media requires ethical considerations, especially when conducting experiments that involve radiation.

PO8: Environment and Sustainability

CO1: Understanding the fundamental equations that govern electromagnetism is crucial for developing technologies that are energy-efficient and have minimal environmental impact

CO2: As students explore electromagnetic wave propagation, they should consider the environmental impact of communication systems

CO4: Antenna design involves considerations of efficiency and resource utilization.

PO9: Self-directed and Life-long Learning

CO1,CO3,CO4,CO6: Each of these outcomes requires students to delve into foundational and advanced concepts related to electromagnetic waves, propagation, antenna design, and microwave generation. Engaging with these topics fosters a habit of continuous learning, as students are encouraged to explore beyond the classroom and keep abreast of advancements in the field.

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
6. To understand the application of Electronics in biomedical application.
7. Ability to bring out the important and modern methods of imaging techniques and their analysis.

Course Outcome:

By the end of the course, students will be able to:

CO1. To Know the various types instruments and measurement system.
CO2. Ability to find Instrument characteristics and error.
CO3. Working principles of various types of sensors and transducers, Actuators Instruments.
CO4. Ability to bring out the importance of Sensors for monitoring controlling applications.
CO5. Ability to interface sensors actuators for dedicated applications.
CO6. To know the role of technology in biomedical applications.
CO7. Students are able to know the bio potential, ECG, EEG & EMG.
CO8. Ability to bring out the important and modern methods of imaging techniques and their analysis.

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 shaftsPressure 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.

Course Outcome	Program Outcomes								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	-	2	-	-	-	-	-
CO2	2	1	2	-	1	-	-	-	-
CO3	2	2	2	-	3	-	-	-	3
CO4	3	2	2	3	-	3	-	2	3
CO5	2	2	-	3	2	2	-	3	2
CO6	3	2	2	2	2	-	-	-	2
CO7	2	3	-	2	-	-	-	-	-

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Students will able to demonstrate use instruments for measurement techniques precisely and use for various parameter measurements.

CO2: Students will develop deep understanding of instrument characteristics, handling and reducing errors in instruments.

CO3,4: Students will master in demonstrate the use of sensors, transducers, actuators and it applications.

CO5: Students will develop knowledge to demonstrate the interfacing of sensor to develop system for dedicated applications.

CO6,7: Students will demonstrate the use of modern technology in biomedical applications.

PO2: Critical Thinking and Problem Solving

CO1,2: Students will apply their knowledge for selecting instrument for reducing error, good performance.

CO3,4,5: Students will think to develop specific instrument using sensor, transducer and actuators for dedicated application for solving complex problem.

CO6,7: Students will increase thinking ability to develop experimental skill to design electronics system for biomedical applications.

PO3: Social competence

CO1 to 6: Students will able to use various instruments, sensors and transducers for industrial, agriculture, medical, automobile or any other relevant application.

CO7: Student will apply the idea to exhibit the hardware design for medical field solve real-world problems.

PO4: Research-related skills and Scientific temper

CO4: Student develops their ability to think need of sensor and transducers and design necessary circuit.

CO1,5: Students will able to use scientific instruments for result analysis and standardization.

CO6,7: Students apply their knowledge for biomedical application.

PO5: Trans-disciplinary knowledge

CO2,3: Student will use their knowledge for designing electronic system for solving practical problems in physics, chemistry, botany and other relevant subject.

CO5,6: It is useful for development of electronic system for biomedical application.

PO6: Personal and professional competence

CO4,5: Students to develop their ability to work independently or as a team to solve real-world problems.
Students develop their skills for starting own start-up in electronics design.
Students use their knowledge to develop suitable solution for interdisciplinary field.

PO8: Environment and Sustainability

CO4-5: Student will think to develop system for weather monitoring system which helps various applications, automation system for agriculture, automobile industry and energy conservation.

PO9: Self-directed and Life-long learning

CO3-6: Student will think the technical solution for real-world problems and start-up in electronics design for various applications. It is lifelong learning due to technology.

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 PIC microcontrollers.
4. To learn embedded C and assembly language programming.
5. To learn real interfacing devices to microcontroller.
6. To introduce real life modules.
7. To study interfacing of serial communication with PIC.

Course Outcomes:

By the end of the course, students will be able to:

CO1. Understand the internal architecture and interfacing of different peripheral devices with Microcontrollers
CO2: Analyze and develop embedded hardware and software development cycles and tools.
CO3: Evaluate and understand different concepts of sensors, memory interface, and types of communication protocols.
CO4: Design and develop programming skills in embedded systems for various applications.
CO5: Interface external devices to microcontroller.
CO6: Understand the concept of embedded system design.
CO7: Explain serial communication interfacing using PIC.

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, Pearson Education.
6.Programming in C, Stephen Kochan, Hayden Books/Macmilla

Course Outcome	Program Outcome								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	3	3	3	1	3	3
CO2	3	2	2	3	3	3	1	1	3
CO3	3	3	2	3	3	2	1	1	3
CO4	3	3	1	3	3	3	1	1	3
CO5	3	3	3	3	3	3	1	-	3
CO6	3	3	1	3	3	1	1	-	3
CO7	3	3	-	3	3	2	2	3	3

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Providing a solid foundation in understanding the core concepts and functionalities of embedded systems.
CO2: Delving into the comprehensive understanding of the tools and processes involved in embedded system development.
CO3:Ensuring a broad understanding of essential elements crucial in embedded systems design.
CO4: Empowering students with the practical skills required for implementing embedded solutions across diverse applications.
CO5: Providing hands-on experience in connecting and integrating external components into embedded systems.
CO6: Instilling a holistic understanding of the principles and methodologies involved in creating effective embedded systems.
CO7: Delving into the specifics of communication protocols and enhancing the understanding of data exchange mechanisms in embedded systems.

PO2: Critical Thinking and Problem solving

CO1: Involves critical thinking, requiring problem-solving skills to integrate components effectively into a microcontroller-based system.
CO2: Analyzing and developing embedded hardware and software cycles necessitates critical thinking to optimize development processes and solve challenges associated with designing embedded systems.
CO3: Chooses and implements the most suitable solutions, solving problems associated with data acquisition and communication in embedded systems.
CO4: Solve programming challenges and create efficient solutions for diverse applications.
CO5: The ability to interface external devices requires critical thinking to troubleshoot and solve issues related to compatibility, connectivity, and data transfer between the microcontroller and external components.
CO6: Grasping the concept of embedded system design involves critical thinking to solve complex problems associated with integrating hardware and software components seamlessly.
CO7: Explaining serial communication interfacing with PIC microcontrollers demands critical thinking to understand and address challenges related to data transmission, synchronization, and error handling.

PO3 : Social competence

CO1. Enabling effective communication and collaboration in the field of embedded systems.
CO2: Fostering teamwork and shared understanding among individuals working on embedded systems projects.
CO3: Facilitating effective communication with peers, stakeholders, and other professionals in the embedded systems domain.
CO4: Enabling individuals to contribute effectively to collaborative projects and share their expertise with others in the field.
CO5: Enabling effective collaboration and communication with team members and stakeholders involved in the development of embedded systems.
CO6: Grasping the concept of embedded system design enhances social competence by facilitating communication and collaboration among team members, fostering a shared understanding of design principles and objectives.

PO4 : Research-related skills and Scientific temper

CO1: Research-related skills are enhanced by delving into the intricate details of microcontroller architecture and peripheral interfacing, fostering a scientific temper essential for comprehensive understanding and exploration in embedded systems.
CO2: Cultivating research-related skills and a scientific temper to innovate and improve development methodologies.
CO3: Evaluation and understanding of sensor concepts, memory interfaces, and communication protocols involve research skills, contributing to a scientific temper necessary for critical assessment and improvement of these concepts.
CO4: The design and development of programming skills in embedded systems demand research-oriented exploration and innovation, aligning with the development of scientific temper and research-related skills.
CO5: It involves understanding, experimenting, and innovating to enhance the efficiency and applicability of these interfaces.
CO6: Comprehending the concept of embedded system design requires research-related skills for exploring various design methodologies and a scientific temper for critical analysis and improvement of existing practices.
CO7: Involves a research-oriented understanding of communication protocols and a scientific temper for effective explanation and potential enhancements.

PO5: Trans-disciplinary knowledge

CO1: Exploring the internal architecture and interfacing of peripheral devices requires knowledge that transcends traditional disciplinary boundaries, incorporating insights from multiple fields for a holistic understanding.
CO2: Involves integrating knowledge from diverse domains, emphasizing a trans-disciplinary approach to enhance the effectiveness of development cycles.
CO3: Necessitate knowledge that spans various disciplines, promoting a trans-disciplinary perspective in the exploration of these concepts.
CO4: Involves drawing upon knowledge from various domains, highlighting the trans-disciplinary nature of embedded systems.
CO5: Interfacing external devices to microcontrollers requires knowledge that spans different disciplines, showcasing the trans-disciplinary nature of integrating various devices into a cohesive system.
CO6: Grasping the concept of embedded system design entails incorporating knowledge from multiple disciplines, emphasizing the trans-disciplinary approach necessary for effective system design.
CO7: Involves merging knowledge from different areas, showcasing the trans-disciplinary aspect of communication protocols within the context of microcontrollers.

PO6: Personal and professional competence

CO1: Fosters personal and professional competence by enhancing technical expertise and problem-solving skills.

CO2: Honing skills related to system development and problem-solving within the embedded systems domain.
CO3: Providing a well-rounded skill set for designing and implementing embedded systems.
CO4: Enhances personal and professional competence by cultivating proficiency in creating solutions for various contexts.
CO5: Developing skills in integrating external components into embedded systems for specific functionalities.
CO6: Providing a comprehensive view of designing complex systems with embedded components.
CO7: Enhances personal and professional competence by demonstrating proficiency in communication protocols, a critical aspect of embedded system design.

PO7: Effective Citizenship and Ethics

CO1: Fosters effective citizenship by ensuring responsible and ethically sound use of technology for societal benefit.
CO2: Analyzing and developing embedded hardware and software cycles with ethical considerations contributes to effective citizenship by promoting responsible and ethical practices in technology development.
CO3: Ethical evaluation of sensor concepts, memory interfaces, and communication protocols ensures effective citizenship by considering the societal implications and ethical aspects of technology choices.
CO4: Promote effective citizenship by ensuring that the applications benefit society without causing harm or ethical concerns.
CO5: Demonstrates effective citizenship by prioritizing ethical considerations, ensuring that the interfaces align with societal values.
CO6: Instilling a sense of responsibility and ethical awareness in designing systems that align with societal values.
CO7: Ensuring that communication protocols adhere to ethical standards and societal expectations.

PO8: Environment and Sustainability

CO1: Optimizing resource usage and minimizing environmental impact in microcontroller applications.
CO2: Creating energy-efficient and environmentally friendly embedded systems.
CO3: Includes considerations for sustainability, ensuring responsible resource use and environmental impact.
CO4: Contributes to sustainability by creating eco-friendly embedded systems.
CO7: Explaining serial communication interfacing with a focus on energy efficiency and resource conservation promotes sustainability in microcontroller communication protocols.

PO9: Self-directed and Life-long learning

CO1: Fosters a self-directed and lifelong learning attitude, allowing continuous adaptation to emerging technologies.
CO2: Cultivates a mindset of self-directed learning, enabling the continuous improvement of hardware and software development skills throughout one's career.
CO3: Continuous evaluation and understanding of sensor concepts, memory interfaces, and communication protocols promote a self-directed and lifelong learning approach in adapting to evolving technologies.
CO4: Encourages a self-directed and lifelong learning attitude, crucial for staying relevant in the ever-evolving field.
CO5: Fosters a self-directed and lifelong learning mindset by adapting to diverse hardware requirements over time.
CO6: Enabling individuals to navigate and contribute to varied design challenges throughout their professional journey.
CO7: Explaining serial communication interfacing with PIC demonstrates the ability to continually learn and adapt to evolving communication technologies, aligning with a self-directed and lifelong learning approach.

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

Course Objectives:

1. To introduce crystal structure with reference to semiconductors
2. To introduce quantum and statistical mechanics
3. To provide students with a basic understanding of semiconductor materials and their properties, including concepts like energy bands, charge carriers, and doping.
4. Operating principles of modern semiconductor devices
5. To understand the theory and characteristics of semiconductor devices.
6. Determine the band structure of semiconductors when supplied with basic materials properties and applying their knowledge of quantum mechanics.
7. To understand the optical devices.

Course Outcomes:

By the end of the course, students will be able to:

CO1. Understand the concept of Quantum and statistical mechanics.
CO2. Students able to understand semiconductor fundamentals, including concepts related to energy bands,
charge carriers, and crystal structures.
CO3. Students should be able to explain the operating principles of key semiconductor devices, such as diodes, bipolar junction transistors, and field-effect transistors.
CO4. Students should understand the basic processes involved in semiconductor device.
CO5. Understand the characteristics of semiconductor devices.
CO6. Students should be familiar with the various applications of diode, transistor and FETs
CO7. Understand the function of solar cell.

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

Course Outcome	Program Outcomes								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	2	-	1	2	-	-	-	2
CO2	1	3	-	2	2	-	-	-	2
CO3	2	2	-	2	-	-	-	-	-
CO4	3	1	-	2	-	-	-	-	-
CO5	-	-	-	1	-	-	-	-	-
CO6	2	2	2	3	-	2	-	-	1
CO7	3	2	-	2	-	2	-	1	3

Justification for the mapping

PO1: Disciplinary Knowledge

The concepts covered in CO1 and CO3 contribute to building a strong foundation in the disciplinary knowledge of semiconductor physics and electronics. CO5, CO6 and CO7 Contribute to expand the disciplinary knowledge to cover communication and electromagnetic theory. Antennas are fundamental components in communication systems, and understanding their characteristics and radiation patterns is crucial in this disciplinary context.

PO2: Critical Thinking and Problem Solving

CO1, CO2, CO3, CO4, CO6, and CO7 require students to apply critical thinking skills to understand, analyze, and solve problems related to semiconductor devices, antenna, microwave and their applications.

PO3: Social competence

Co6 required to understanding the applications of semiconductor devices could involve considerations of social impact and relevance in various fields.

PO4: Research-related skills and Scientific temper

All Cos contribute the research related skill and scientific temper. CO1 to CO5 involve understanding fundamental concepts that are crucial for any scientific research in the field of semiconductors. CO6 and CO7 required developing system using semiconductor devices and solar cell.

PO5: Trans-disciplinary knowledge

CO1 required for quantum mechanics and CO2 for semiconductor fundamentals provide a trans-disciplinary perspective as they are foundational concepts applicable in various scientific and engineering disciplines.

PO6: Personal and professional competence

CO6 contribute the knowledge of applications is crucial for students' professional competence as engineers or professionals in the field of electronics. CO7 required for solar related system development

PO8: Environment and Sustainability

CO7 directly relates to the function of a solar cell, which has implications for environmental sustainability.

PO9: Self-directed and Life-long learning

The complex nature of semiconductor physics covered in CO1, CO2, CO6 and CO7 encourages self-directed and life-long learning as students delve into fundamental concepts that require continuous exploration and understanding.

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

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

Course Objectives:

1. To understand the basics operation of transducers.
2. To learn interfacing of transducers and sensors.
3. To understand the counter circuits.
4. To learn antenna parameters.
5. To learn microwave devices and source.
6. To learn RPM measurement techniques.
7. To study various instrumentation amplifier for sensor interfacing.

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Course Outcomes:

By the end of the course, students will be able to:

CO1. Learn the different types, working principle of active and passive transducers.
CO2. Perform experiment analog electronic circuits using different sensors and Transducers.
CO3. Evaluate different electronic circuits and review the analog and digital circuits.
CO4. Develop ability to design, build and test analog/digital application circuits.
CO5. To know operation of different instruments and antenna elements.
CO6. Ability to study antenna parameters and radiation pattern
CO7. To know operation of microwave test bench application

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

Course Outcome	Program Outcomes								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	3	2	-	-	-	-	-	-
CO2	3	2	2	3	2	2	-	2	3
CO3	-	2	1	2	-	-	-	-	-
CO4	-	2	2	1	2	-	3	2	2
CO5	3	2	-	1	-	-	-	-	-
CO6	1	2	-	1	-	-	-	3	1
CO7	3	2	-	3	-	2	-	-	-

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Students will able to demonstrate working and use of transducer, which helpful for development of application.

CO2: Students will able to develop analog design for sensor and transducer for dedicated application. This is a strong relation.

CO5: Students will develop knowledge to demonstrate the various instruments performance, use and antenna working.

CO6: Students will demonstrate the use of test bench and microwave application.

CO7: Students will be able to develop capability develop hardware and discussion result.

PO2: Critical Thinking and Problem Solving

CO1: Students will apply their knowledge for selecting transducer for specific application.

CO2: Students will think to develop specific analog design using sensor and transducer for dedicated application.

CO3: Student will think to develop system for observing the problem.

CO4: Students will use their knowledge for solving complex analog and digital hardware design.

CO5: Students will apply their knowledge for use of instruments for diverse application with reduced error.

CO6: Students will use their understanding to use of microwave frequency, microwave test bench for various applications.

CO7: Students will increase thinking ability to develop experimental skill to design electronics system for diverse field problem solving.

PO3: Social competence

CO1: Students will able to write idea or communicate the use of sensors and transducers for industrial, agriculture, medical, automobile or any other relevant application.
CO2: Student will apply the idea to exhibit the hardware design for required field.
CO3,4: Student will use their knowledge for design analog, digital or combination circuit for dedicated application to solve real-world problems.

PO4: Research-related skills and Scientific temper

CO1,2,3,4: Student develop their ability to think need of sensor and transducers and design necessary circuit.
CO5: Students will able to use scientific instruments for result analysis and standardisation.
CO6,7: Students apply their knowledge for antenna design.

PO5: Trans-disciplinary knowledge

CO2,4: Student will use their knowledge for designing electronic system for solving practical problems interdisciplinary field.

PO6: Personal and professional competence

CO2,7: Students to develop their ability to work independently or as a team to solve real-world problems.
Students develop their skills for starting own start-up in electronics design.
Students use their knowledge to develop suitable solution for interdisciplinary field such as physics, chemistry, agriculture, industrial, botany etc.

PO7: Effective Citizenship and Ethics

CO3: Student will demonstrate the use of technology for smart work and aware the need of technology.

PO8: Environment and Sustainability

CO2,4,6: Student will think to develop system for environmental parameter monitoring system which help various applications, energy conservation.

PO9: Self-directed and Life-long learning

CO2,4,6: Student will think the technical solution for real-world problems and start-up in electronics design for various application. It is lifelong learning due to technology up gradation.

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

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

Course Objectives:

1. To understand the basics of embedded C programming.
2. To learn communication standards and protocols.
3. To understand the interfacing of PIC microcontroller.
4. To learn real interfacing devices to PIC microcontroller.
5. To understand the configuration of ADC of PIC microcontroller.
6. To learn MATLAB for communication application.
7. To learn directivity pattern of antenna.

Course Outcomes:

By the end of the course, students will be able to:

1. Understand specifications of PIC microcontroller.
2. Understand architecture of PIC microcontroller.
3. Learn the skills for programming the PIC microcontroller.
4. Interface different devices to PIC microcontroller.
5. Study serial communication interface with PIC .
6. Interface different wireless devices to PIC microcontroller.
7. Learn the skills for programming the MATLAB for antenna radiation pattern analysis.

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

Course Outcome	Program Outcome								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	3	-	-	-	-	2
CO2	2	2	-	2	-	1	-	-	-
CO3	3	2	2	3	-	-	-	-	2
CO4	3	3	-	2	1	2	2	1	2
CO5	2	-	2	2	-	1	-	-	1
CO6	3	2	2	1	-	-	-	-	1
CO7	3	2	2	2	-	2	2	-	2

Justification for the mapping

PO1 Disciplinary Knowledge

CO1: Providing a foundational understanding of the core features and capabilities of PIC microcontrollers, essential for effective utilization in electronic applications.
CO2: Delving into the internal structure and organization of the microcontroller, forming the basis for informed decision-making in its application.
CO3: Imparting the essential skills required for effective utilization and control of PIC microcontrollers in electronic systems.
CO4: Providing hands-on experience in connecting and integrating external components with the microcontroller, an integral part of electronic system design.
CO5: Exploring the principles and methods of serial communication, essential for effective data exchange in electronic systems.
CO6: Introducing a versatile tool widely used in electronics for modeling, simulation, and analysis, enhancing students' capabilities in electronic system design.
CO7: Providing the necessary programming skills to effectively utilize MATLAB for electronic system simulation and analysis.
CO8: Applying simulation techniques to analyze and understand electronic systems, enhancing students' competence in the field.

PO2: Critical Thinking and Problem solving

CO1: To assess and apply technical specifications effectively in electronic system design.
CO2: Analyze and comprehend the intricate internal structure, facilitating informed decision-making in system design.

CO3: Addressing challenges in coding, debugging, and optimizing the program for efficient operation.
CO4: Effectively integrate diverse components and troubleshoot potential issues in the hardware interface.
CO6: Understand and apply MATLAB tools for modeling and simulation in electronic system analysis and design.
CO7: Address challenges in coding, debugging, and optimizing MATLAB programs for effective simulation in electronic system studies.
CO8: Apply simulation techniques effectively, enabling a deeper understanding of electronic systems.

PO3: Social competence:
CO1: It often requires collaboration and communication to gather and interpret technical information within a team or with peers.
CO3: Encourages collaboration and knowledge-sharing among peers, providing opportunities for mutual learning and skill development.
CO5: Encouraging collaborative learning and communication, as students share insights and problem-solving strategies related to communication protocols.
CO6: Facilitating collaborative exploration and discussion among students when tackling MATLAB-related challenges and sharing knowledge.
CO7: Fostering collaboration and collective problem-solving as students work together to enhance their programming capabilities in MATLAB.
CO8: Creating an environment where students can collaborate, share insights, and collectively solve challenges related to simulation and analysis.

PO4: Research-related skills and Scientific Temper
CO1: Encouraging students to critically analyze and explore the technical details, promoting a research-oriented approach to learning.
CO2: Delving into the internal structure, fostering a mindset for systematic analysis and inquiry into microcontroller design principles.
CO3: Students engage in systematic problem-solving and algorithmic thinking, contributing to a research-oriented mindset.
CO4: Encouraging students to explore and experiment with hardware integration, promoting a scientific approach to device interfacing.
CO5: Delving into communication protocols, fostering a systematic and analytical approach to understanding and implementing serial communication.
CO6: Students use MATLAB as a tool for scientific analysis, simulation, and modeling in electronic systems.
CO7: Encouraging students to apply systematic coding practices, fostering a research-oriented mindset in utilizing MATLAB for electronic system analysis.

CO8: Integrating a scientific approach to simulation, analysis, and modeling within the MATLAB environment.

PO5: Trans-disciplinary knowledge:
CO4: Integrating diverse components, connecting electronic hardware with various sensors and actuators, and creating a holistic understanding of system integration.

PO6: Personal and professional competence
CO2: Fostering a deep understanding of microcontroller design principles, facilitating effective problem-solving and decision-making in a professional context.
CO4: Encouraging teamwork, effective communication, and the ability to integrate diverse components, reflecting essential skills in a professional setting.
CO5: Enhancing communication skills and providing knowledge essential for effective collaboration in the field of electronics.

CO7: Providing practical programming skills applicable to professional contexts, ensuring individuals are well-prepared for real-world applications.
CO8: Applying simulation techniques to analyze and understand electronic systems, contributing to skills necessary for a successful career.

PO7: Effective Citizenship and Ethics:
CO4: Emphasizing ethical considerations and responsible practices in hardware integration, considering the societal impact of interconnected devices.
CO7: Providing students with the ethical foundation needed for responsible coding practices, aligning with ethical standards in software development.

PO8: Environment and Sustainability:
CO4: Encouraging efficient hardware integration, aligning with eco-friendly practices in electronic device connectivity.

PO9: Self-directed and Life-long learning:
CO1: Encouraging students to continuously update their knowledge about evolving microcontroller technologies throughout their professional careers.
CO3: Establishing a foundation for continuous skill development, empowering students to adapt to emerging programming paradigms in embedded systems.
CO4: Prompting students to stay informed about diverse electronic components and interface technologies, fostering a commitment to continuous learning.
CO5: Urging students to stay updated on communication protocols and adapt to new standards, aligning with a commitment to lifelong learning.
CO6: Introducing a versatile tool, encouraging students to explore its applications across various domains and adapt to evolving uses throughout their careers.
CO7: Providing students with a foundation in programming applicable across disciplines, enabling them to independently explore advanced MATLAB applications over time.
CO8: Empowering students to explore diverse simulation applications, fostering a commitment to continuous learning in electronic system simulation.