Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECET701T	VLSI Testing	3	0	0	3	40	60	100	3

Course Objective

The course is intended to enhance the skills for the most modern VLSI test principles, fault modeling and Design For Testability (DFT) architecture in an exertion to help in designing better quality products so as to boost the employability.

Course Outcomes

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

CO1	**Apply:** Interpret and apply the concepts of VLSI testing to detect the faults in digital circuits.
CO2	**Analysis:** Generate test patterns for analyzing faults in combinational and sequential circuits to know the consistency of systems.
CO3	**Evaluate:** Comprehend and evaluate the various testing techniques to conclude the functioning & reliability of device.
CO4	**Apply:** Interpret and apply the knowledge to locate the physical faults in a structural model of the unit under test with a highest degree of accuracy.

SYLLABUS

UNIT I: Overview of Testing

Introduction to Digital VLSI Testing, Functional and Structural testing, Faults & their detection, Fault Equivalence, Fault Simulation, Testability Measures (SCOAP).

UNIT II: Combinational Circuit Test Pattern Generation

Introduction to Automatic Test Pattern Generation (ATPG) and ATPG Algebras, D algorithm, PODEM, FAN, Weighted test pattern generation.

Simulation of Test pattern generation for combinational circuits using modern tool.

UNIT III: Sequential Circuit Test Pattern Generation
Test pattern generation for sequential circuits: Ad-hoc and structures techniques scan path, Level Sensitive Scan Design (LSSD), Boundary Scan.
Simulation of Test pattern generation for sequential circuits using modern tool.

UNIT IV: Design For Testability and Built in Self-Test (BIST)
Ad Hoc Techniques, Scan based design: Generic, Classical; Built in self-test, Test pattern generation for BIST, BIST architecture, Test generation for embedded RAM, Industry testing standards: IEEE 1149.1 (JTAG) and IEEE 1500.

UNIT V: Memory Testing
Memory fault models, Stuck at fault, Transition fault, Coupling fault, In version Coupling fault, Idempotent Coupling faults, Address Decoder faults, Neighborhood Pattern Sensitive fault, Memory testing algorithms.

UNIT VI: Fault Diagnosis Logic
Level Diagnosis, Diagnosis by UUT reduction, Fault diagnosis for combinational circuits, Self checking design, and System level diagnosis.

Text Books Recommended

1. "Essentials of Electronic Testing for Digital, Memory, and Mixed-Signal VLSI Circuits", Michael L. Bushnell and Vishwani D. Agrawal, 2015, B. S. Publications
2. "Digital Systems Testing and Testable Design", Miron Abramovici, Melvin Breuer and Arthur Friedman, 1st Edition, 1994, Wiley Publications.

Reference Books Recommended

1. "Principles of Testing Electronic Systems", Samiha Mourad, Yervant Zorian, 2009, Wiley-Inderscience Publication.
2. "VLSI Test Principles and Architectures", L. Wang, 1st Edition, 2006, Elsevier Science.
3. ATPG – An open source Automatic Test Pattern Generation tool from the University of Illinois for VLSI testing.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECET702T	Data Encryption and Decryption	3	0	0	3	40	60	100	3

Course Objective
The course is envisioned to provide in-depth knowledge of compression techniques, cryptography, encryption & decryption and system security in order to enhance skills, employability and explore entrepreneurship ideas.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	**Understand:** Interpret and describe various encryption techniques for text and video data in given application.
CO2	**Apply:** Comprehend and apply the concepts of cryptography and standard algorithms in data communication.
CO3	**Analyze:** Compare and analyze various encryption and decryption techniques to a given problem statement.
CO4	**Analyze:** Analyze relevant laws and regulations related to data privacy and security.
CO5	**Evaluate:** Interpret the need of system security and choose appropriate precautionary measures in data communication networks.

SYLLABUS

UNIT I: Introduction to Cryptography

Introduction, Types of attacks, Active Vs Passive attacks, Steganography, Classical encryption techniques: Substitution ciphers, Transposition ciphers, Cryptanalysis of classical encryption techniques.

UNIT II: Private Key Encryption

Private-Key (Symmetric) cryptography, Block ciphers, Stream ciphers, Data Encryption Standard (DES), Advanced Encryption Standard (AES) and Triple DES.

UNIT III: Number Theory & Public Key Encryption

Euler's theorem, Chinese Remainder theorem, Euclidean algorithm, Public Key (Asymmetric) cryptography: RSA algorithm, Diffie-Hellman key exchange, Elliptic curve cryptology, Message authentication and Hash functions, Hash and Mac algorithms, Digital signatures.

UNIT IV: Legal and Ethical Issues in Data Encryption

Introduction to legal and ethical Issues in data encryption, Data privacy laws and regulations, International data protection laws and standards, Ethical issues in Data Encryption, Surveillance and privacy, Freedom of speech and encryption, Legal and ethical implications of data breaches and hacking, Compliance with legal and ethical Standards.

UNIT V: Text and Video Encryption

Shannon Fano coding, Huffman coding, Arithmetic coding and dictionary techniques- LZW, Digital audio, μ-law and A-law companding, DPCM and ADPCM audio compression, Video compression and MPEG industry standards.

UNIT VI: System Security

Intruders, Intrusion detection, Worms, Viruses, Trojans, Virus countermeasures, Firewall design, Digital immune systems, Certificate based & biometric authentication, Secure electronic payment system.

Text Books Recommended

1. "Introduction to Data Compression", Khalid Sayood, 5th Edition, 2017, Morgan Kaufmann Publications.
2. "Cryptography & Network Security", Atul Kahate, 4th Edition, 2019, Tata McGraw Hill Publication.
3. "Cryptography and Network Security", Behrouz Forouzan, 1st Edition, 2007, McGraw Hill Publication.

Reference Books Recommended

1. "The Data Compression Book", Mark Nelson, 2nd Edition, 1996, BPB Publication.
2. "Cryptography and Network Security – Principles and Practice", William Stallings, 7th Edition, 2017, Pearson Education Asia Publication.
3. "Network Security & Cryptography", Bernard Menezes, 1st Edition, 2010, Cengage Learning.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECET703T	Robotics	3	0	0	3	40	60	100	3

Course Objective

The course empowers students to understand the basic components of robot configuration, kinematics of robot and develop analytical skills to design robotic applications.

Course Outcomes

After successful completion of this course. students will be able to:

CO1	**Understand:** Demonstrate the working principle of robots and classify various types of joints.
CO2	**Apply:** Interpret and apply end effectors and sensors for a given robotic application.
CO3	**Analyze:** Examine direct and inverse kinematic equations for end effector positions.
CO4	**Apply:** Make use of appropriate algorithm and operating system for realization of robots.
CO5	**Create:** Design and develop robotic systems considering economic aspect for various applications.

SYLLABUS

UNIT I: Robot Elements

Introduction, Robot configurations: Cartesian, Cylindrical, polar and articulate; Robot wrist mechanism, End effectors classification, Types of mechanical actuation, Gripper design, Robot drive system, Position and velocity feedback devices, Robot joints and links, Motion interpolation, Battery management system.

UNIT II: Sensors & Actuators

Touch sensors, Tactile sensor, Proximity sensors, Force sensor, Light sensors, Pressure sensors, Types of Actuators, DC motors, Synchronous motors, Stepper motors, BLDC servo motors, Interfacing with ARM Processor.

UNIT III: Kinematics & Control

Robot kinematics: Direct, Inverse kinematics; Robot trajectories, 2D and 3D Transformation, Scaling, Rotation, Translation, Homogeneous transformation, Control of robot manipulators: Point to point, Continuous path control.

UNIT IV: Algorithms in Robotics

Robot Algorithms: D*, PRM, Zero moment point; SWARM Algorithms: Ant Colony Optimization, Particle Swarm Optimization, Artificial Bee Colony, Bacterial Foraging Optimization and Firefly.

UNIT V: Robot Operating System (ROS)

ROS Core, Nodes, publish-subscribe messaging system, Services, request-response, Configuration Parameters, Packages, Tools, ROS Libraries.

UNIT VI: Applications of Robotics

Industrial, Medical, Household, Entertainment, Underwater, Defense, Disaster management.

Case study on Computer Vision and Artificial Intelligence in robotics.

Text Books Recommended

1. "Industrial Robotics Technology, Programming and Applications", Mikell P. Groover, Mitchell Weiss, Roger N Nagel, Nicholas G. Odrey, Ashish Dutta 2nd Edition, 2017, Tata – McGraw Hill Pub. Co.
2. "ROS Robotics Projects", Ramkumar Gandhinathan, Lentin Joseph, 2nd Edition 2017, Packt Publishing.

Reference Books Recommended

1. "Robot Engineering: An Integrated Approach", Klafter. R.D, Chmielewski. T. A, and Noggin's, 1995, Prentice Hall of India Pvt. Ltd.
2. "Robotics control, sensing, vision and intelligence", Fu.K.S, Gonzalez.R.C & Lee. C.S.G. 2008, Tata-McGraw Hill Pub. Co.
3. "Robotics Technology and Flexible Automation", Deb.S.R and Sankha Deb, 2nd Edition, 2010, Tata McGraw Hill Publishing Company Limited.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECET704T	Electronic System Design	3	0	0	3	40	60	100	3

Course Objective

The course is anticipated to provide the concepts and fundamentals for enhancing the electronic circuit designing skills so as to boost the employability and entrepreneurship.

Course Outcomes

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

CO1	**Create:** Design the voltage regulator circuit and evaluate the performance parameters.
CO2	**Create:** Design and analyze the performance of filter for the specified applications.
CO3	**Create:** Design Power amplifiers and analyze the performance parameters to judge its quality.
CO4	**Create:** Design and analyze the oscillator circuit for the given applications.
CO5	**Create:** Design isolation amplifier and data acquisition system for various applications.

SYLLABUS

UNIT I: Design of Regulated Power Supply

Principles of system design, Unregulated D.C. power supply system, Rectifiers and filters, Zener shunt regulator, Design of series voltage regulators, Design of regulators using IC 78×× and 79××, Protection circuits for regulators.

Design and simulate voltage regulator using modern tool.

UNIT II: Design of Switching Regulators

Design aspects of Switching regulators, Design of boost type SMPS, Buck Type SMPS, LM78S40, and DC-DC Converters.

UNIT III: Design of Filters & Drivers
Introduction to Active filters, Design of Active filters, Infinite Gain Multiple Feedback filter, Flat top filter, Ripple filter, Design of relay driver circuit, Design of stepper motor control circuit.
Design and simulate filters using modern tool.

UNIT IV: Design of Power Amplifier
Power Considerations: Thermal consideration, Thermal resistance; Design of power amplifier: Class A, Class B, Audio Power Amplifier, Integrated power amplifier TBA810.

UNIT V: Oscillator Design
Fundamentals of sinusoidal oscillators, Performance specification, Design aspects of VCO, PLL: Introduction, Concept of synchronization, Basic structure of PLL and Transfer function, PLL applications.

UNIT VI: Isolation Amplifier and Data acquisition system
Architecture of Isolation amplifier, Grounding and shielding, Architecture of DAC and ADC, Design aspects of Data Acquisition System.

Text Books Recommended

1. "A Monograph on Electronic Design Principles", N.C. Goyal, R.K. Khetan, 5th Edition, 2006, Khanna Publishers.

Reference Books Recommended

1. Texas Instruments - Design considerations for class D audio Power Amplifiers, Application report.
2. Texas Instruments - Op Amps for Everyone, Ron Mancini, Design reference, Ron Mancini.
3. Texas Instruments -Power Topologies Handbook, Markus Zehendner, Matthias Ulmann.
4. Handbook "Analog Isolation Amplifiers", Analog Devices, 2009.
5. Data Acquisition Handbook, Measurement Computing Corporation, 3rd Edition, 2012.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECET705T	Bio-Medical Electronics	3	0	0	3	40	60	100	3

Course Objective
The course is intended to provide in depth knowledge of bio-medical technology and signal acquisition techniques to develop skills and enhance employability.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	**Apply:** Illustrate and apply the knowledge of instrumentation system for medical applications.
CO2	**Analyze:** Interpret and compare electrodes & transducers for bio measurements.
CO3	**Evaluate:** Comprehend and select the medical imaging methods for accurate findings and interpretations.
CO4	**Evaluate:** Develop and evaluate non electrical and therapeutic measurements required for the diagnosis of ailment.
CO5	**Understand:** Explain the elements of risk for different instrumentation methods and basic electrical safety.

SYLLABUS
UNIT I: Medical Instrumentation System Role of technology in medicine, Basic medical instrumentation system, Static and dynamic characteristics of medical instruments, Sources of bio medical signals, Resting and action potentials.
UNIT II: Bio-Potential Electrodes & Physiological Transducers Electrode theory, Types of electrodes: Surface electrodes, Needle-electrodes, Macro electrodes, Micro electrodes; Transducers, Classification of transducers, Types of transducers: Displacement, Position, Motion, Pressure, Temperature, Optical; Biosensors.

UNIT III: Non-electrical Parameter Measurements

Temperature measurements, Respiration rate and pulse rate measurement, Blood pressure measurement: Direct and Indirect methods; Blood flow meter: Electromagnetic, Ultrasonic; Pulmonary function measurement: Spirometry, Photoplethysmography (PPG).

UNIT IV: Therapeutic Equipments

Cardiac pacemakers: Internal, External; Cardiac defibrillators, Ventilators, Nerve and muscle stimulators, Surgical diathermy machine, Haemo-dialysis machine, Anesthesia machine.

UNIT V: Medical Imaging

X–ray imaging, Computed tomography imaging, Magnetic resonance imaging, Ultrasonic imaging and Nuclear medical imaging systems, Thermal imaging systems.

UNIT VI: Patient Care and Safety

Electric shock hazards, Leakage currents, Safety for electro medical equipment, Electrical safety analyzer, Testing of biomedical equipment, Methods of accident prevention.

Case study on IoT Based Healthcare Monitoring Systems.

Text Books Recommended

1. "Biomedical Instrumentation and Measurements", Leslie Cromwell, F.J. Weibell, E.A. Pfeiffer, 2nd Edition, 2004, PHI.
2. "Medical Instrumentation Application and Design", John G. Webster, John Wiley,2009, 4th Edition, John Wiley & Sons,Inc.

Reference Books Recommended

1. "Handbook of Biomedical Instrumentation", Khandpur R.S, 2014, 3rd Edition, Tata McGraw-Hill New Delhi.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECET706T	Antennas and Wave Propagation	3	0	0	3	40	60	100	3

Course Objective
The course is intended to provide in depth knowledge of antenna system, wave guides and RADAR engineering for enhancing skills to develop reliable communication system.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	**Analyze**: Illustrate and analyze mechanism of dipole, antenna arrays and infer their significant usage in real time applications.
CO2	**Evaluate:** Estimate the parameters of high frequency antennas, wire antennas and antenna arrays to judge the performance.
CO3	**Analyze**: Explain and analyze the performance parameters of waves in ground wave, sky wave and space wave propagation.
CO4	**Evaluate:** Interpret and evaluate the parameters of microwave tubes for high frequency communication.
CO5	**Apply:** Identify, formulate and model RADAR engineering solutions based on a system approach.

SYLLABUS
UNIT I: Antenna Fundamentals Retarted potentials, Radiation resistance, Properties of antenna, Isotropic radiator, Antenna parameters, Wire Antennas: Short electric dipole, Half wave dipole, Quarter wave monopole. *Analysis of antenna parameters through modern simulation tools.*
UNIT II: Antenna Arrays Types of arrays, Arrays of two point sources, N element linear arrays: Broadside arrays, End fire arrays; Design of antenna, Pattern multiplication, Binomial arrays. *Study of different antenna radiation patterns using simulation tools.*

UNIT III: Travelling Wave and Broadband Antennas

Travelling wave radiators, Rhombic antennas, Small loop antennas, Folded dipole, Yagi-Uda arrays, Log periodic antennas, Reflector antennas: Huygens' principle, Flat sheet and Corner reflectors, Paraboloidal reflectors, Cassegrain feed, Horn antennas, Lens antennas, Patch and Microstrip antennas.

UNIT IV: Wave Propagation

Radio Wave Propagation: Earth atmosphere, Terrestrial propagation of electromagnetic waves; Obstacles in propagation: Noise, Interference; Ground wave propagation, Ionosphere propagation.

UNIT V: Wave Guides

Rectangular waveguide: Mode analysis, Cut-off frequency, propagation constant, Intrinsic wave impedance, phase and group velocity, Power transmission, Attenuation, Waveguide excitation, Wall current, Propagation constant.

UNIT VI: RADAR Engineering

Introduction, RADAR range equation, False alarm, Pulse and CW RADAR, Advantages of coherent radar, Doppler RADAR and MTI RADAR, delay-line cancellers, Blind speeds, Moving Target Detector.

Text Books Recommended

1. "Antennas and Wave Propagation", K. D. Prasad, 3rd Edition, 2003, Satya Prakasan.
2. "Microwave and Radar Engineering", Gottapu Sasi and Bhushana Rao, 2013, Pearson Education.
3. "Antenna Design for 5G Wireless Communication", Vivek Garg, Rupal Roy, Dinesh Sharma, 1st , 2019, Lambert Academic Publishing.

Reference Books Recommended

1. "Electromagnetic Waves and Radiating Systems", Jordan, E.C. and Balmain, K.G., 2ndEdition, 2006, Prentice Hall of India.
2. "Antennas and Radio Wave Propagation", Collin, R. E., 1985, McGraw Hill.
3. "Antennas and Wave Propagation", R.L. Yadava, 2nd Edition, 2011, PHI Learning Private Limited.
4. "Antenna Theory and Design", Balanis, C.A., 4th Edition, 2016, John Wiley and Sons.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECET707T	Micro-Electro Mechanical System (MEMS)	3	0	0	3	40	60	100	3

Course Objective

The course is intended to comprehend the multidisciplinary aspects of MEMS devices and applications with their fabrications and modeling methods to improve the skills in the field of modern electronics.

Course Outcomes

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

CO1	**Apply:** Demonstrate and apply concepts of microsensors, microactuators and microsystems.
CO2	**Apply:** Illustrate and apply a comprehensive knowledge of manufacturing techniques for designing micro sensors and micro actuators.
CO3	**Evaluate:** Evaluate the performance metrices of MEMS components and compare with the macroscale components.
CO4	**Analyze:** Analyze the key performance aspects of micromachined RF components.
CO5	**Analyze:** Interpret the packaging aspects and analyze the microsystem technology for technical feasibility and reliability in practical applications.

SYLLABUS

UNIT I: Introduction to MEMS

Evolution and emergence of Micromachines, Smart materials, Microstructures and microsystems, Electromechanical transducers, Microsensing for MEMS: Piezoerestive, Capacitive, Piezoelectric and Resonant sensing.

UNIT II: MEMS Materials and Fabrication Techniques

Metals and Semiconductors, Thin films, Materials for polymer MEMS, Bulk and surface micromachining for silicon-based MEMS, Evaporation, Sputtering, Growth and Deposition, Microstereolithography for polymer MEMS.

UNIT III: Micromachined Inductors & Capacitors

MEMS Inductors: Planar, Folded, Variable, Polymer based inductors; MEMS Capacitor: Gap Tuning, Area Tuning, Dielectric tunable capacitors.

UNIT IV: RF MEMS

RF MEMS Filters: Modelling, Filter using comb drives, SAW filters, BAW filters, Filters using millimeter frequencies; Micromachined phase shifters, Transmission lines and components, Micromachined antennas.

UNIT V: Micro Sensors and Actuators

Silicon capacitive accelerometer, Piezoresistive pressure sensor, Electrostatic comb-drive, Piezoelectric inkjet print head, Conductometric gas sensor, Fiber-Optic sensors, Magnetic micro relay.

UNIT VI: Integration of Micro and Smart Systems

Microsystem and CMOS interfacing, Microsystem packaging: Objective, Special issues, Types of microsystem packages, Packaging technology, Reliability and key failure.

Case studies of microsystem and smart structure in vibration control.

Text Books Recommended

1. "Micro and Smart Systems: Technology and Modeling", Ananthasuresh G. K., K JVinoy, and S. Gopalakrishnan, 1st Edition, 2019, Wiley Global Education.
2. "RF MEMS and their application", Vijay K Varadan., K JVinoy, and K. Abraham Jose, 1st Edition, 2003, John Wiley & Sons.

Reference Books Recommended

1. "Microsensors, MEMS, and smart devices",Gardner, Julian W., Vijay K. Varadan, and Osama O. Awadelkarim, 1st Edition, 2003, John Wiley & Sons.
2. "MEMS", Nitaigour P. Mahalik, 2009, Tata McGraw-Hill Education.
3. "Microsensors, MEMS, and smart devices", Gardner, Julian W., Vijay K. Varadan, and Osama O. Awadelkarim, 1st Edition, 2003, John Wiley & Sons.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECET708T	Machine Learning	3	0	0	3	40	60	100	3

Course Objective
Course is intended to understand the machine learning algorithms and methodologies of deep learning for solving industry based problems to boost employability and entrepreneurship.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	**Apply:** Interpret and apply various machine learning algorithms in data analytics.
CO2	**Analyze:** Apply various models of regression and classification for the analysis of real time data.
CO3	**Apply:** Apply clustering & dimensionality reduction techniques to provide optimized solution for industry problems.
CO4	**Evaluate:** Compare and select an appropriate technique of machine and deep learning for real world applications.

SYLLABUS
UNIT I: Fundamentals of Machine Learning Introduction, Types of Machine Learning algorithms: Supervised, Unsupervised, Reinforced; Machine intelligence, Perspective and issues in Machine Learning, Machine Learning applications.
UNIT II: Regression Data preprocessing, Simple Linear Regression, Multiple Linear Regression, Polynomial Regression, Support Vector Regression (SVR), Component regression, Regression evaluation matrix.
UNIT III: Classification K-Nearest Neighbor (K-NN), Support Vector Machine (SVM), Naive bayes, Decision tree, Random forest, Classification errors, Classification evaluation matrix. *Simulation of Machine* Learning *algorithms using modern tools.*

UNIT IV: Dimensionality Reduction Principle Component Analysis (PCA), Linear Discriminant Analysis (LDA), Generalized Discriminant Analysis (GDA), Nonlinear Latent variable models, Anomaly detection.
UNIT V: Clustering & Reinforcement Introduction, Mixture density, k-mean clustering, Expectation-Maximization Algorithm, Spectral clustering, Hierarchical clustering, Reinforcement Machine Learning (RFML), Elements of reinforcement learning.
UNIT VI: Deep Learning Introduction, Deep feed forward networks, Architecture design, Regularization for deep learning, Semi-supervised learning, Multi-task learning, Dropout, Adversarial training, Architecture of ConvNet, Convolution layer, Pooling layer, Applications of CNN.

Text Books Recommended
1. "Introduction to Machine Learning", Ethem Alpaydin, 3rd Edition, 2015, The MIT Press.
2. "Deep Learning", Ian Goodfellow and Yoshua Bengio and Aaron Courville, 2016, The MIT Press
3. "Pattern Recognition and Machine Learning", Christopher M. Bishop, 1st Edition, 2006, Springer.

Reference Books Recommended
1. "Machine Learning with SVM and Other Kernel Methods", K.P. Soman, R. Longonathan and V. Vijay, 2nd Edition, 2011, PHI
2. "Probabilistic Machine Learning: An Introduction", Kevin Murphy, 2022, MIT Press.
3. "Fundamentals of Neural Networks: Architectures, Algorithms and Applications", Laurene Fausett, 1st Edition, 2004, Pearson Education, Inc.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECET709T	Industrial Automation	3	0	0	3	40	60	100	3

Course Objective

The course is intended to provide fundamental concepts and techniques of Industrial Automation for enhancing technical skills and solving industry based problems to boost employability.

Course Outcomes

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

CO1	**Understand:** Explain the concepts of automation, variables and measurement systems for industrial applications.
CO2	**Apply**: Interpret and apply appropriate sensors and actuators for the realization of industrial automation.
CO3	**Apply:** Apply the knowledge of protocols, features and standardization to design and deploy IoT systems that meet performance, scalability and interoperability requirements.
CO4	**Apply:** Comprehend PLC architecture and apply the concepts to interface I/O devices for a given application.
CO5	**Create:** Design and develop systems using PLC and SCADA for industrial applications.

SYLLABUS

UNIT I: Automation and Measurement Systems

Introduction, Automation hierarchy, Components of automation system, Types of automation system: Fixed, Programmable, Flexible; Industrial variables.

UNIT II: Sensors & Actuators

Introduction, Pressure sensors, Displacement sensors, Position sensors, Proximity sensors, Flow sensors, Temperature sensors, Electrical drive system, Introduction to Pneumatics and Hydraulic systems.

Demonstration of sensors using modern simulation tools.

UNIT III: Industry Automation 4.0 Introduction, IoT architecture, Physical design of IoT, Various platforms for IoT, Overview of IoT component, IoT communication technologies, Challenges and issues in IoT, Network connectivity.
UNIT IV: IoT Protocols Protocol standardization, Design challenges, M2M and WSN Protocols, SCADA and RFID protocols, Unified data standards protocols: IEEE802.15.4, BACNet Protocol, Modbus, Zigbee, MQTT.
UNIT V: Programmable Logic Controller (PLC) Selection criterion, PLC architecture, Types of PLC, Relay logic fundamentals, Timers, Counters, Comparators, PLC programming, Applications of PLC.
UNIT VI: Supervisory Control and Data Acquisition (SCADA) Introduction, Architecture, Communication technologies, Monitoring and supervisory functions, Human Machine Interface (HMI), SCADA applications. *Demonstration of PLC and SCADA using modern simulation tools.*

Text Books Recommended
1. "A Course in Electrical & Electronic Measurements & Instrumentation", A. K. Sawhney, 2021, Dhanpat Rai and Co.
2. "Internet of Things - A Hands-on Approach", Arshdeep Bahga and Vijay Madisetti, 1st Edition, 2015, Universities Press.
3. "PLC and SCADA Theory and Practice", Rajesh Mehara, 1st Edition, 2019, Lakshmi Publication.

Reference Books Recommended
1. "Modern Electronic Instrumentation and Measurement Techniques", Cooper W.D and Helfrick A.D, 1st Edition, 2015, Pearson Education.
2. "Sensors and Signal Conditioning", Ramon Pallas Areny, John G. Webster, 2nd Edition, 2012, John Wiley and Sons Inc.
3. "Sensors and Actuators: Engineering System Instrumentation", Clarence W. de Silva, 2nd Edition, 2015, CRC Press.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECET710T	Optical Communication	3	0	0	3	40	60	100	3

Course Objective

The course is indented to inculcate the in-depth knowledge of optical communication systems and apply its operating principles to demonstrate basic fiber handling skills including connectors, splices, optical detectors, fiber optic measurements and various network parameters.

Course Outcomes

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

CO1	**Apply:** Explain and apply the concepts of optical fibers for solving problems in an optical communication system.
CO2	**Analyze:** Identify and analyze the various causes of signal degradation in an optical communication system and compare it with transmission characteristics.
CO3	**Analyze:** Interpret and analyze the various optical sources and detectors for transmitter and receiver.
CO4	**Evaluate:** Evaluate different measurements, parameters and properties of optical fiber.
CO5	**Apply:** Comprehend and choose suitable multiplexing-demultiplexing techniques for an optical communication application.

SYLLABUS

UNIT I: Overview of Optical Communication

Introduction, Nature of light, Light as an electromagnetic wave, Polarization, Interference, Transmitting light on fiber, Refractive index, Modes of propagation, Snell's law, Critical angle, Numerical aperture.

UNIT II: Fiber Manufacturing and Transmission Characteristics

Fiber Manufacturing: Materials and fabrication processes; Transmission characteristics, Attenuation due to absorption, Scattering & bending, Signal distortion in optical fibers: Intra modal dispersion, Material & waveguide dispersion, Intermodal dispersion, MMSI, MMGI.

UNIT III: Optical Sources and Transmitters

Introduction to optical sources: Wavelength and material, LED, LASER: working principle& characteristics; Optical transmitters: LED drive circuits for digital and analog transmission; Power launching & coupling: Fiber optic splices, Connectors & couplers, Coupling losses.

UNIT IV: Optical Detectors and Receivers

Material Considerations, P-i-N, Photo transistors, Avalanche photodiodes: Working principle & characteristics, relative merits and demerits; Receiver noise: Noise considerations in P-i-N & Avalanche photodiodes.

UNIT V: Optical Fiber Measurements

Measurements: Numerical aperture, Bending loss, Attenuation, Fiber optics cutoff wavelength, Field measurements.

UNIT VI: Advanced Multichannel Optical Systems

Overview of WDM: WDM Components, 2x2 Fiber coupler, Optical isolators and circulators, Multiplexers and De-multiplexers; Fiber Bragg Grating, FBG applications for multiplexing and de-multiplexing function, Diffraction gratings, Optical Amplifiers: OFA and SOA.

Text Books Recommended

1. "Optical Fiber Communications", Gerd Keiser, 5th Edition, 2017, Tata McGraw Hill.
2. "Optical Fiber Communications-Principles and Practice", John M. Senior, 3rd Edition, 2014, Pearson Education.

Reference Books Recommended

1. "Fiber Optic Communication Systems", Govind P. Agrawal, 5th Edition, 2021, John Wiley & Sons.
2. "Optical Fiber Communication", J. Gower, 2nd Edition, 2003, Prentice Hall of India.
3. "Fiber Optic Communications Technology", Djafar K. Mynbaev and Lowell L. Scheiner, 1st Edition, 2001, Pearson Education.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECET711T	Satellite Communication	3	0	0	3	40	60	100	3

Course Objective

The course is envisioned to endow the skills of satellite communication technologies to enhance the employability.

Course Outcomes

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

CO1	**Understand:** Outline the basic concepts, applications and future trends of satellite communication.
CO2	**Apply:** Explain and apply the concept of look angles, launches & launch vehicles and orbital effects in satellite communication.
CO3	**Apply:** Illustrate and identify the various satellite subsystems and its functionality.
CO4	**Evaluate:** Determine the satellite link parameters under various propagation conditions with the illustration of multiple access techniques.
CO5	**Apply:** Identify and choose the different satellite navigation systems for day to day applications.

SYLLABUS

UNIT I: Overview of Satellite Communication

Introduction, Architecture, General features, Frequency allocation for satellite services, Properties of satellite communication systems, Future trends of satellite communications.

UNIT II: Satellite Orbits

Introduction, Kepler's laws, Orbital dynamics, Orbital characteristics, Satellite spacing and orbital capacity, Angle of elevation, Eclipses, Launching and positioning, Satellite drift and Station keeping.

UNIT III: Satellite Subsystems
Introduction, Altitude and Orbit Control Systems (AOCS), Telemetry Tracking Command and Monitoring (TTC & M), Power subsystems, Communication subsystems, Antenna subsystems, Equipment reliability and Space qualification, Ground station technology.

UNIT IV: Satellite Links
General link design equation, System noise temperature, Uplink design, Downlink design, Complete link design, Effects of rain, Earth station: Introduction, Subsystem and types.

UNIT V: Space Segment Access and Utilization
Introduction, Space segment access methods, TDMA, FDMA, CDMA, SDMA, Assignment methods.
Simulation of a Satellite Network using modern tools.

UNIT VI: Satellite Navigation
Radio and Satellite Navigation, Global Positioning System (GPS): Position location principle, Receiver and Codes, Satellite signal acquisition, Navigation message, Signal level, Receiver operation, Code accuracy, Differential GPS; Introduction to Indian Regional Navigation Satellite System (IRNSS)-NAVIC, Nano satellite.

Text Books Recommended

1. "Satellite Communication", Timothy Pratt and Jeremy Allnutt, 3rd Edition, 2019, Wiley Publication.
2. "Global Navigation Satellite Systems with Essentials of Satellite Communications", G S Rao, 2nd Edition, 2010, Mc-Graw Hill Publication.

Reference Books Recommended

1. "Satellite Communications", Dennis Roddy, 4th Edition, 2006, Tata Mc-Graw Hill Publications.
2. "Satellite Communications Systems", G.Maral, M. Bousquet, 2nd Edition, 2002, John Wiley & Sons.
3. "Satellite Communication Systems Engineering", W. L. Pitchand, H. L. Suyderhoud, R. A. Nelson, 2nd Edition, 2007, Pearson Education.
4. "Handbook of Space Technology", Wilfried Ley, Klaus Wittmann and Willi Hallmann, 2009, Wiley Publication.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECET712T	Wireless and Mobile Communication	3	0	0	3	40	60	100	3

Course Objective
The course is intended to provide fundamental concepts of cellular system design, wireless standards & recent technologies to enhance skills and employability.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	**Analyze:** Interpret and apply frequency-reuse concept in mobile communications and analyze its effects on interference, system capacity, handoff techniques.
CO2	**Analyze:** Compare various wireless networking technologies & multiple-access techniques for mobile communications.
CO3	**Apply:** Apply concepts of mobile cellular systems in designing real time applications.
CO4	**Understand:** Demonstrate the concepts of MIMO and OFDM.
CO5	**Apply:** Comprehend and apply the concepts of recent technologies and networks for developing advanced wireless communication system.

SYLLABUS
UNIT I: Cellular Concept-System Design Fundamentals Cellular system design, Frequency reuse, Channel interference, Methods to improve cell coverage, Channel assignment techniques, Capacity improving methods.
UNIT II: Wireless System and Standard-GSM GSM Architecture and Interfaces: Introduction to GSM subsystems, Architecture, Interfaces, Channels; Mapping of GSM layers to OSI layers, Mobility management, Call flows in GSM.

UNIT III: Multiple Access Techniques
Introduction, TDMA, FDMA and CDMA, RAKE receiver, IS-95 system architecture, Air interface, Forward link, Reverse link, Physical and Logical channels of IS -95 CDMA, IS-95 CDMA call processing.

UNIT IV: MIMO in Wireless Communication
Introduction, Channel capacity, MIMO receiver, MIMO system model & Zero forcing receiver, SVD & Eigen modes of the MIMO, MIMO Spatial Multiplexing, MIMO-OFDM.

UNIT V: Wireless Networking
Networking concepts, Traffic routing, Mobile IP and wireless access protocol, Wireless LAN IEEE802: Protocol, Architecture and Services; Wireless Application Protocol.

UNIT VI: Introduction to 5G
Drivers, Roadmap and Vision, Data Speed, Latency, Bandwidth, Massive Machine-Type Communications (mMTC), Recent trends in Telecommunication industries.
Case study on 5G business value to industry.

Text Books Recommended

1. "Wireless Communications, Principles & Practice", Theodore S. Rappaport, 2nd Edition, 2002, Pearson.
2. "Wireless Communication and Networking", William Stallings, 2nd Edition, 2004,PHI.

Reference Books Recommended

1. "Mobile Cellular Telecommunications Analog and Digital Systems", William C.Y.Lee, 2nd edition, 1995, TMH.
2. "Mobile Communication", Jochen Schiller, 2nd Edition, 2003, Pearson Education.
3. "Fundamentals of 5G Mobile Networks", Jonathan Rodriguez, 1st Edition, 2015, John Wiley & Sons.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
OECET701T	Internet of Things	3	0	0	3	40	60	100	3

Course Objective
The course is intended to provide in-depth knowledge for interfacing physical devices, sensors and other elements to the internet and establish communication with each other, share data and perform tasks without human intervention so as to enhance skills, employability and entrepreneurship.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	**Understand**: Interpret the physical design, including sensors, actuators and other hardware components for the realization of basic IoT systems.
CO2	**Apply:** Apply the knowledge of protocols, features and standardization to design and deploy IoT systems that meet performance, scalability and interoperability requirements.
CO3	**Apply:** Make use of Wi-Fi module & web server with sensors and actuators to build IoT systems.
CO4	**Apply:** Apply the knowledge and skills in using Single Board Computers and its peripherals to interface with sensors & actuators to develop IoT applications.
CO5	**Apply:** Comprehend the virtualization, IoT cloud and computing with web services to develop IoT systems.

SYLLABUS
UNIT I: IoT Fundamentals Introduction, IOT Architecture, Physical design of IoT, Various platforms for IoT, Overview of IoT component, IoT communication technologies, Challenges and issues in IOT.
UNIT II: IoT Protocols Protocol standardization, Design challenges, M2M and WSN Protocols, SCADA and RFID protocols, Unified data standards protocols: IEEE802.15.4, BACNet Protocol, Modbus, Zigbee, MQTT.

UNIT III: IoT Development-I
Basics of Wireless Networks, Wi-Fi Module, Wi-Fi libraries, Web server: Installation, Configuration, Posting sensor data to web server; Interfacing of sensors and actuators with Wi-Fi Module.

UNIT IV: IoT Development-II
Introduction to Single Board Computer (SBC), Interfaces: Serial, SPI, I2C; Programming with Single Board Computer, Interfacing of sensor and actuators with SBC.
Hands-on with Single Board Computer.

UNIT V: IoT Cloud Platforms
Virtualization concepts and Cloud architecture, Cloud computing, Advantages, Cloud services: SaaS, PaaS, IaaS; Cloud providers, Study of IOT Cloud platforms, ThingSpeak API , Processor interfacing with Web services.

UNIT VI: IoT Applications
Home Automation, Smart Cities, Energy, Retail management, Logistics, Agriculture, Health and Lifestyle, industry, Environmental protection.

Text Books Recommended

1. "Internet of Things - A Hands-on Approach", Arshdeep Bahga and Vijay Madisetti, 1st Edition, 2015, Universities Press.
2. "Data Sheet: ESP8266 Technical Reference", 2020, Espressif IoT Team.
3. "Raspberry Pi Beginner's Guide", Gareth Halfacree, 2020, Raspberry Pi Trading Ltd.

Reference Books Recommended

1. "The Internet of Things: Key Applications and Protocols", Olivier Hersent, David Boswarthick, Omar Elloumi, 2011, 2nd Edition, Willy Publications
2. "Internet of Things – From Research and Innovation to Market Deployment Peter Friess", 2014, River Publishers.
3. "Learn-ESP32-with-Arduino-IDE", Rui-Santos, Sara Santos, 2nd Edition, Video Course & e-book.
4. "Data Sheet: ESP8266 Technical Reference", 2020, Espressif IoT Team.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PROJET701	Project-I	0	0	12	6	75	75	150	-

Course Objective
The objective of this course is to equip students with necessary tools and techniques to identify, analyze and propose solutions to real life problems that benefit the wider community.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	**Apply:** Identify and propose solutions to complex engineering problems of industry and society.
CO2	**Evaluate:** Critically evaluate alternate assumptions, approaches, procedures and tradeoffs to solve engineering problems.
CO3	**Apply:** Apply engineering knowledge for design and development of systems in an ethical and eco-friendly manner as an individual and as a member or leader in diverse team to manage project in multidisciplinary domain.
CO4	**Analyze:** Analyze the system and communicate the inferences with engineers and the community at large in written & oral forms.
CO5	**Create:** Innovate, design & develop systems to address real life problems and engage in life- long learning in continuing professional development.