Year: M. Tech. First Year, Semester-II

Course Code	Course Title	Hours / Week		Credits	Maximum Marks			ESE
		L	P		Continual Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PCCEN 201T	**Digital System Design and Modeling**	3	0	3	40	60	100	3

Course Objectives
The objectives of this course is to provide students with:
1. In-depth knowledge of digital systems design flow.
2. Skills to design various combinational and sequential systems using Verilog HDL.
3. Substantial knowledge to verify that a design meets its timing constraints, both manually and through the use of computer aided design tools.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	Make use of fundamental aspects of digital system design with Verilog HDL.
CO2	Design and model digital circuits with Verilog HDL at different levels of abstraction.
CO3	Design and develop combinational and sequential circuits.
CO4	Estimate different types of modeling techniques, timings & delays to meet the timing constraints.

SYLLABUS

UNIT I: OVERVIEW OF DIGITAL DESIGN WITH VERILOG HDL

Overview of digital design with Verilog HDL: Evolution of computer aided digital design, Emergence of HDLs, Typical HDL Design-flow, Importance of Verilog HDL, Trends in HDLs. Basic Concepts: Lexical conventions, data types, system tasks and compiler directives.

UNIT II: BASIC MODELING CONCEPTS

Hierarchical Modeling Concepts: Top-down and bottom-up design methodology, differences between modules and module instances, Components of a simulation: design block, stimulus block. Modules and Ports: Module definition, list of ports, port declaration, port connection rules, connecting ports, hierarchical name referencing.

UNIT III: GATE-LEVEL & DATA FLOW MODELING

Gate-Level Modeling: Modeling using basic Verilog gate primitives, description of AND, OR and NOT type gates, Gate Delays: rise, fall and turn-off delays, min, max, and typical delays. Data flow Modeling: Continuous assignment statements, delay specification, expressions, operators, operands, operator types and User defined primitives.

UNIT IV: BEHAVIORAL MODELING

Structured procedures, initial and always statement, blocking and non-blocking statements, delay control, generate statement, event control, conditional statements, Multi-way branching, loops, sequential and parallel blocks. Tasks & Functions.

UNIT V: MODELING TECHNIQUES, TIMINGS & DELAYS

Modeling Techniques: Procedural continuous assignments, overriding Parameters, conditional compilation & execution, useful system tasks. Timings & Delays: Types of delay models, path delay modeling, timing checks.

Text Books Recommended

1. Verilog HDL – A Guide to Digital Design and Synthesis, Samir Palnitkar, 2003, Second Edition, Pearson Publications
2. Modeling, Synthesis and Rapid Prototyping with the Verilog HDL, M. D. Ciletti, 1999 PHI Publications

Reference Books Recommended
1. A Verilog HDL Primer, J. Bhaskar, Kluwer, Third Edition, 2005, Star Galaxy Publishing
2. Verilog Digital Computer Design, M. G. Arnold, 1999, Prentice Hall (PTR)
3. Design through Verilog HDL, Padmanabhan, Tripura Sundari, 2016, Wiley
4. Advanced Digital Design with the Verilog HDL, Michael D. Ciletti, Second Edition, Pearson (Prentice Hall)
5. VHDL for Programmable Logic, Kevin Skahill, 2006, PHI/Pearson education

Course Code	Course Title	Hours / Week		Credits	Maximum Marks			ESE
		L	P		Continual Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PCCEN 201P	**Digital System Design and Modeling (Laboratory-I)**	0	2	1	25	25	50	-

Course Objectives
The objectives of this course is to provide students with:
1. The fundamental concepts of digital system modeling and hardware descriptive language.
2. Skills to Simulate and synthesize digital systems on FPGA.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	Design, simulate and test combinational and sequential circuits.
CO2	Design and implement digital system applications on FPGA.

Experiment List
1. Design 1 bit adder and implement on FPGA. 2. Design 3:8 decoder and implement on FPGA. 3. Design 4 bit magnitude comparator and implement on FPGA. 4. Design 4:1 Multiplexer and 1:4 de-multiplexer and implement on FPGA. 5. Design ALU and implement on FPGA. 6. Design decade counter and implement on FPGA. 7. Design BCD to seven segment decoder and implement on FPGA. 8. Design and simulate 4 X 4 keyboard scanner. 9. Design and simulate RAM (16 x 4). 10. Design and simulate function generator. 11. Design and simulate Mealy machine modeling for given sequence. 12. Design and simulate Moore's machine modeling for given sequence. • A minimum of 08 experiments to be performed based on the above list.

Suggested References
1. A Verilog HDL Primer, J. Bhaskar, Kluwer, Third Edition, 2005, Star Galaxy Publishing
2. Verilog Digital Computer Design, M. G. Arnold, 1999, Prentice Hall (PTR)
3. Design through Verilog HDL, Padmanabhan, Tripura Sundari, 2016, Wiley
4. Advanced Digital Design with the Verilog HDL, Michael D. Ciletti, Second Edition, Pearson (Prentice Hall)
5. VHDL for Programmable Logic, Kevin Skahill, 2006, PHI/Pearson education

Course Code	Course Title	Hours / Week		Credits	Maximum Marks			ESE
		L	P		Continual Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PCCEN 202T	**Advanced Embedded System Design**	3	0	3	40	60	100	3

Course Objectives
The objectives of this course is to provide students with:
1. Comprehensive understanding of fundamental concepts in embedded system design & its application.
2. An aptitude to compare and analyze different networking principles in embedded devices for communication.
3. An ability to get acquaint with Real Time Operating System in embedded systems.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	Apply the fundamentals of Embedded Systems and Real Time Operating Systems.
CO2	Apply the concepts of ARM processor to design various embedded system.
CO3	Compare and analyze different communication protocols for embedded applications.
CO4	Test and evaluate the real time characteristics of embedded systems to address problems associated with industry applications.
CO5	Design and develop various embedded system applications to solve the real world problems.

SYLLABUS
UNIT I: BASICS OF EMBEDDED SYSTEMS AND DESIGN PROCESS Embedded System, Design process in embedded system: concept used in design process, software design process, design metrics, abstraction of steps in design process. Challenges in embedded system design and optimization, Embedded system design technologies.
UNIT II: ARM PROCESSOR ARM Processor and its memory organization, ARM processor architecture and its organization, pipeline, instruction set & programming, instruction level parallelism, software interrupt, ARM memory interface, selection of processor and memory devices, I/O devices.
UNIT III: COMMUNICATION PROTOCOL Serial Bus Communication Protocol: I2C, SPI, CAN, USB. Parallel Bus Communication Protocol: PCI bus, ARM bus. Wireless and mobile system protocol: Bluetooth, IrDA, WLAN
UNIT IV: REALTIME OPERATING SYSTEM RTOS concepts, interrupts, interrupt Handling, ISR, context switching, process states, communication mechanism, scheduling algorithm, priority inversion, priority inheritance, inter-task communication, semaphores, deadlocks, starvation, clock driven approach, priority driven approach, priority inversion problem, dynamic versus static systems, EDF algorithm, off-line versus online scheduling, RTOS examples.
UNIT V: CASE STUDY OF PROGRAM MODELING Embedded Linux, Examples based on RasberryPi, Case study: Automation, Security, Communication, Automobile,
Text Books Recommended
1. Embedded systems-architecture, Programming & Design, Raj Kamal, Third Edition, 2014, McGraw Hill
2. Embedded System Design: A Unified Hardware/Software Introduction, Frank Vahid and Tony Givargis, 2001, John Wiley & Sons
3. Embedded and real time operating system, K. C. Wang, First Edition, 2017, Springer

Reference Books Recommended
1. Computers as Components: Principles of Embedded Computing System Design, Wayne Wolf, Fourth Edition, 2016, Morgan Kaufman Publishers
2. Real-Time Systems, C. M. Krishna and K. G. Shin, 1997, McGraw Hill
3. Real-Time systems, Jane. W.S. Liu, First Edition, 2002, Pearson Education Asia

Course Code	Course Title	Hours / Week		Credits	Maximum Marks			ESE
		L	P		Continual Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PCCEN 202P	**Advanced Embedded System Design**	0	2	1	25	25	50	-

Course Objectives
The objectives of this course is to provide students with:
1. In depth knowledge of embedded system to design and develop basic systems.
2. Design platforms used for designing an embedded systems application.
3. Skills to design an embedded system for various needs of society.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	Make use of General Purpose Input Output (GPIO) pins to read/ write the data.
CO2	Design and construct the program for various Input/ output devices.
CO3	Compile and analyze the outputs of various converters and RTC used in real time application.

List of Experiments
1. Study of ARM 7 LPC2148 Trainer Board. 2. Develop a program to write data on a GPIO pin. Verify the data using LED as an indicator. 3. Design and simulate a program to read data from GPIO pin. Use slide switch to send the data to GPIO pin and led as an indicator to verify the input data. 4. Design a counter which count from 0 to 9 continuously. Display it on seven segment display. 5. Create a program to display the status of LED ON/OFF as string on Liquid Crystal Display (LCD). 6. Design a program to scan 4x4 matrix keyboard and display the press key on LCD. 7. Develop a program to read analog signal using Analog to Digital Converter and display the equivalent digital value on LCD. 8. Design a program to generate analog signal (saw tooth wave) using Digital to Analog Converter. Analyze the analog signal using DSO/ CRO. 9. Interface a graphic LCD with LPC2148 and create a program to display the given string on graphic LCD Display. 10. Interface a RTCDS1307 with LPC2148 and create a program to display the current date and time on graphic LCD using real time clock RTCDS1307. • A minimum of 08 experiments to be performed based on the above list. **Rasbpery pi, version4,**

Suggested References
1. Embedded System Design: A Unified Hardware/Software Introduction, Frank Vahid and Tony Givargis, 2003, John Wiley & Sons.
2. ARM System developer's guide: designing and optimizing System Software, Andrew N. Sloss, Dominic Symes, Chris Wright, Morgan Kaufmann Publisher.

Course Code	Course Title	Hours per week		Credits	Maximum Marks			ESE
		L	P		Continual Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PCCE N203T	Research Methodology	4	0	4	40	60	100	3

Course Objectives
The objective of this course is to provide students with:
1. In-depth knowledge of research philosophy.
2. An ability to formulate research idea, planning of research, resource and different statistical analysis methods.
3. An aptitude to write reports and thesis.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Identify various kinds of research related queries.
CO2	Formulate research problems and develop appropriate research methods.
CO3	Assess the appropriateness using different kinds of research methodologies.
CO4	Demonstrate and compare various qualitative, quantitative and mixed methods of research.
CO5	Develop independent thinking for critically analyzing research reports.

SYLLABUS
Unit I: Research Foundation What is Research, objectives of research, types of research, scientific research, research and theory, conceptual and theoretical models, importance of research methodology in scientific research, use of LATEX indexing of journals, impact factor and social media for researchers, hypothetical research paper writting.
Unit II: Review of Literature Need for reviewing literature, what to review and for what purpose, literature search procedure, and sources of literature, planning of review work, note taking, library and documentation.
Unit III: Planning of Research The planning process, selection of a problem for research, formulation of the selected problems, hypothesis formation, measurement, research design/plan.
Unit IV: Processing of Data and Statistical Analysis of Data Introduction to statistical software, MINITAB, SPSS, measures of relationship, simple regression analysis, multiple correlation and regression, partial correlation, MATLAB and Neural Network based optimization, optimization of fuzzy systems, error analysis, results and their discussions.
Unit V: Report and Thesis writing Types of reports, planning of report writing, research report format, principles of writing, data analysis reporting in a thesis, use of endnote, bibliography, annexure, API , appendix, table, observations arrangement, preparation of type script and lay-out of thesis.

Text Books Recommended
1. Research Methodology: Methods and Techniques, C. R. Kothari, Third Edition, New Age International Publishers.
2. Statistical Methods for Research Workers, R. A. Fisher, 2017, Kalpaz Publications.

Reference Books Recommended
1. Design and Analysis of Experiments, D. Montogomery, Sixth Edition, John Wiley.
2. Methodology of Research in Social Sciences, O. R. Krishnaswamy and M Rangnatham, Himalaya Publication House.
3. MINITAB online manual.
4. SPSS online manual.

Course Code	Course Title	Hours / Week		Credits	Maximum Marks			ESE
		L	P		Continual Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECEN 201T	**Data Compression and Cryptography**	4	0	4	40	60	100	3

Course Objectives
The objectives of this course is to provide students with:
1. An insight of Lossless and Lossy compression techniques.
2. A Knowledge of different compression and encryption techniques.
3. Comprehensive understanding of the concepts of cryptography.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	Acquire the in depth knowledge of different compression techniques used for text, audio, image and video data.
CO2	Analyze and select appropriate compression technique for a system.
CO3	Choose appropriate encryption and decryption techniques for a system and analyze the impact.
CO4	Compare and apply appropriate cryptography algorithm for specific application.

SYLLABUS
UNIT I: TEXT COMPRESSION Shannon Fano coding, minimum variance Huffmann coding, extended Huffman coding, adaptive Huffman coding, arithmetic coding and dictionary techniques LZW, family algorithms, entropy measures of performance and quality measures.
UNIT II: AUDIO COMPRESSION Digital Audio, Lossy sound compression, μ-law and A-law companding, DPCM and ADPCM audio compression, MPEG audio standards, free lossless audio compression (FLAC), format of compressed data.
UNIT III: IMAGE AND VIDEO COMPRESSION Image Compression **:** Lossless and lossy techniques of image compression, two dimensional image transformation and energy compaction, JPEG, predictive techniques PCM and DPCM, Video Compression: analog & digital video, H.261 and MPEG industry standard, One open source and one proprietary, Case study: Audio and video compression technique.
UNIT IV: CONVENTIONAL ENCRYPTION Introduction, types of attacks, steganography, Data Encryption Standard (DES), block cipher principle, S-box design, Advanced Encryption Standard (AES).
UNIT V: NUMBER THEORY AND ASYMMETRIC KEY CRYPTOGRAPHY Euler's theorems, Chinese remainder theorem, principles of public key cryptography, RSA algorithm, Diffie-Hellman key exchange, Elliptic curve cryptology, message authentication, hash functions, hash and mac algorithms, digital signatures.

Text Books Recommended
1. Data Compression, David Salomon, Fourth Edition, Springer Publication.
2. Introduction to Data Compression, Khalid Sayood, Third Edition, Morgan Kaufmann Series.
3. Cryptography and Network Security, William Stallings, Fourth Edition, Pearson India.
4. Cryptography and Network Security, Behrouz Forouzan, First Edition, McGraw-Hill.

Reference Books Recommended
1. The Data Compression Book, Mark Nelson, Second Edition, 1996, BPB publication.
2. Applied Cryptography, Bruce Schnerer, Second Edition, John Willey & Sons Inc. Publication.
3. Cryptography & Network Security, Atul Kahate, Second Edition, 2006, Tata McGraw Hill.
4. Cryptography and Network Security, Behrouz A. Forouzan, First Edition, McGraw-Hill Education.
5. Network Security & Cryptography, Bernard Menezes, Ravinder Kumar, First Edition, Cenage Learning.

Course Code	Course Title	Hours / Week		Credits	Maximum Marks			ESE
		L	P		Continual Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECEN 202T	**Soft Computing**	4	-	4	40	60	100	3

Course Objectives
The objectives of this course is to provide students with:
1. An insight of fundamental concepts of soft computing.
2. An ability to apply the concepts of genetic algorithm and its applications to soft computing.
3. An aptitude to design hybrid systems using fuzzy logic & neural networks.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	Apply the concepts of fuzzy logic and neural network.
CO2	Make use of various soft computing techniques in order to solve problems effectively and efficiently.
CO3	Apply the concept of genetic algorithm to design an application for engineering optimization problems.
CO4	Identify and select a suitable soft computing technology to solve the realistic problem.
CO5	Build the hybrid system with knowledge of fuzzy logic, neural networks and genetic algorithm.

SYLLABUS

UNIT I: INTRODUCTION TO FUZZY LOGIC

Introduction of soft computing, soft computing vs. hard computing, crisp set and fuzzy set, basic concepts of fuzzy sets, membership functions, basic operations on fuzzy sets, and properties of fuzzy sets, fuzzy relations and fuzzy logic controller.

UNIT II: FUZZY LOGIC

Propositional logic and Predicate logic, fuzzy If – Then rules, fuzzy mapping rules and fuzzy implication functions, fuzzy inference system, applications.

UNIT III: NEURAL NETWORKS

Basic concepts of neural networks, neural network architectures, learning methods, architecture of a back propagation network, applications.

UNIT IV: GENETIC ALGORITHMS

Basic concepts of genetic algorithms, encoding, genetic modelling.

UNIT V: HYBRID SYSTEMS

Integration of neural networks, fuzzy logic and genetic algorithms, ANFIS.

Text Books Recommended

1. Principles of Soft Computing, S.N. Sivanandan and S.N. Deepa, Third Edition, 2007, Wiley India.
2. Fuzzy Logic in Engineering Applications, T. J. Ross, Fourth Edition, 2016, Wiley India.

Reference Books Recommended

1. Neural Networks, Fuzzy Logic and Genetic Algorithms, S. Rajasekaran and G. A. Vijaylakshmi Pai, Fifth Edition, Prentice Hall of India.
2. First Course on Fuzzy Theory and Applications, K. H. Lee, 2004, Springer.
3. Fuzzy Logic, Intelligence, Control and Information, J. Yen and R. Langari, First Edition, 1998, Pearson Education.

Course Code	Course Title	Hours / Week		Credits	Maximum Marks			ESE
		L	P		Continual Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECEN 203T	**VLSI Testing**	4	0	4	40	60	100	3

Course Objectives
The objectives of this course is to provide students with:
1. Broader understanding of fundamentals of VLSI Testing.
2. Substantial knowledge of fault modeling and simulation.
3. Knowledge of Boundary Scan and BIST for testing of CMOS ICs.
4. Techniques to generate test patterns for faults in a system and design a system for testability.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	Identify the need and importance of VLSI Testing.
CO2	Compare and select suitable fault modeling and simulation techniques.
CO3	Apply knowledge to generate test patterns for testing of various digital circuits and memory.
CO4	Analyze and estimate various test generation methods for static & dynamic CMOS circuits.
CO5	Apply Boundary Scan and BIST for the testing of various digital circuits.

SYLLABUS
UNIT I: FUNDAMENTALS OF VLSI TESTING Fundamentals of VLSI testing, verification in VLSI design process, issues in test and verification of complex chips, embedded cores and SOCs, VLSI Technology trends affecting testing.
UNIT II: FAULT MODELING AND SIMULATION Fault equivalence, fault collapsing, fault dominance, algorithms for fault simulation, serial fault simulation, parallel fault simulation, deductive faulty simulation, concurrent fault simulation, IDDQ testing, delay testing.
UNIT III: TEST PATTERN GENERATION AND MEMORY TESTING **C**ontrollability and observability SCOAP, D algorithm, PODEM algorithm, memory fault model, 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 IV: DESIGN FOR TESTABILITY Trade Offs, Adhoc design for testability techniques, scan design, LSSD, test interface and Boundary scan.
UNIT V: BUILT IN SELF-TEST (BIST) Test pattern generation for BIST, BIST architectures, MCM testing, Yield models. Case study: Boundary scan and BIST.

Text Books Recommended
1. Essentials of Electronic Testing for Digital, Memory and Mixed – Signal VLSI Circuits: M. Bushnell and V.D. Agrawal, 2000, Kluwer Academic Publisher.
2. Digital Systems Testing and Testable Design: M. Abramovici, M.A. Breuer and A. D. Friedman, 1990, IEEE Press.
3. Advanced VLSI Design and Testability Issues, Suman Lata Tripathi, Sobhit Saxena, S. Mohapatra, First Edition, CRC Press.

Reference Books Recommended
1. Introduction to Formal Hardware Verification: T. Kropf, Verlag, 2000, Springer.
2. System - on - a - Chip Verification Methodology and Techniques: P. Rashinkar, Paterson and L. Singh, 2001, Kluwer Academic Publisher.
3. VLSI Test Principles and Architectures, Laung-Terng Wang, Cheng-Wen Wu, Xiaoqing Wen, First Edition, Elsevier.

Course Code	Course Title	Hours / Week		Credits	Maximum Marks			ESE
		L	P		Continual Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECEN 204T	**Cloud Computing and Application**	4	0	4	40	60	100	3

Course Objectives
The objectives of this course is to provide students with:
1. An insight of the modern technology of cloud computing.
2. An ability to apply the concept of cloud infrastructure and security.
3. Broader understanding of different cloud computing tools.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	Understand the main concepts, key technologies, strengths and limitations of cloud computing.
CO2	Identify the architecture, infrastructure of cloud computing and select appropriate architecture as per the requirements of a cloud based application.
CO3	Compare and select appropriate cloud services to secure the data on cloud.
CO4	Choose appropriate web service provider and cloud computing tool for various cloud computing applications.
CO5	Propose solution for addressing data security issues in cloud computing.

SYLLABUS
UNIT I: CLOUD COMPUTING OVERVIEW Defining cloud computing and it's characteristics, benefits, cloud computing vs cluster computing vs grid computing, legal issues related to cloud model, challenges in cloud computing, cloud types: NIST model, cloud cube model, deployment model, service model **,** cloud computing stack, open stack.
UNIT II: CLOUD ARCHITECTURE Services and applications, defining Infrastructure as a Service (IAAS), Platform as a service (PAAS), Software as a service (SAAS), Compliance as a service, using virtualization technologies, load balancing and virtualization, understanding machine imaging, porting applications, SAAS vs PAAS.
UNIT III: CLOUD PLATFORMS & CLOUD MIGRATION Using google web services, Amazon web Services, Microsoft cloud services, Aneka Integration of private and public Cloud, broad approaches to migration, seven step model, mobbing applications to the cloud, application in cloud API.
UNIT IV: CLOUD SECURITY AND STORAGE Cloud security challenges, securing the cloud, securing the data, infrastructure security, network level security, host level security, application level security, virtual machine security, identity access management, authentication in cloud computing, commercial and business considerations.
UNIT V: CLOUD COMPUTING TOOLS AND APPLICATIONS Introduction to AWS cloud, AWS cloud concepts, AWS cloud security and compliance concepts, methods of deploying and operating in the AWS Cloud, AWS global infrastructure, core AWS services, resources for technology support, various pricing models for AWS, Introduction to OpenStack, Components of OpenStack, OpenStack powered Public & Private clouds.

Text Books Recommended
1. Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, McGraw Hill Education (India) Pvt. Ltd
2. Cloud Computing, Michael Miller, First Edition, Pearson Education.
3. Cloud Computing, A Hands on Approach, Arshdeep Bagha, Vijay Madisetti, 2013, University Press.

Reference Books Recommended
1. Cloud Computing, Implementation, Management, and Security, John W. Rittinghouse and James F. Ransome, First Edition, CRC Press.
2. Cloud Application Architectures, George Reese, First Edition, O'Reilly Media.
3. Cloud Computing using Windows Azure, B.M. Harwani, 2014, Arizona Business Alliance Publication.

Course Code	Course Title	Hours / Week		Credits	Maximum Marks			ESE
		L	P		Continual Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECEN 205T	**Human Machine Interface**	4	0	4	40	60	100	3

Course Objectives
The objectives of this course is to provide students with:
1. In-depth knowledge of human machine interface.
2. An insight of the various user friendly interfaces.
3. An ability to choose the various design process, supports and models used in HMI.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	Understand the fundamentals of HMI and apply it for various design process.
CO2	Make use of different models for human machine interface.
CO3	Analyze and implement effective user friendly interfaces and supports.
CO4	Design and develop interactive user interface for real life applications.

SYLLABUS

UNIT I: FOUNDATIONS OF HMI

The Human: history of user interface designing, I/O channels, hardware, software and operating environments, the Psychopathology of everyday things, Psychology of everyday actions, reasoning and problem solving. The computer: devices, memory, processing and networks. Interaction: models, frameworks, ergonomics, styles, elements, interactivity, paradigms.

UNIT II: GRAPHICAL USER INTERFACE

The Graphical User Interface: popularity of graphics, the concept of direct manipulation, graphical systems, characteristics. Web user Interface: interface popularity, characteristics. The merging of graphical business systems and the web, principles of user interface design.

UNIT III: SCREEN DESIGNING

Design goals, screen planning and purpose, organizing screen elements, ordering of screen data and content, screen navigation and flow, visually pleasing composition, amount of information, focus and emphasis, presentation information simply and meaningfully, information retrieval on web, statistical graphics, technological consideration in interface design.

UNIT IV: IMPLEMENTATION & USER SUPPORT

Implementation support–Windowing system elements, using tool kits–user interface management, Evaluation techniques–goals, multimodal interaction, user support, Approaches: adaptive help systems, designing user support system.

UNIT V: COGNITIVE MODELS

Goal & task hierarchies, linguistic models, physical & device models, architectures, communication & collaboration models, face-to-face communication, conversation–text based, brain computing interface concepts, brain signals-EEG, application of BCI.

Case study:Industry based HMI models.

Text Books Recommended

1. Human Computer Interaction, Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, Third Edition, 2004, Pearson Education.
2. The Essential Guide to User Interface Design, Wilbert O. Galitz, Third Edition, Wiley publication.

Reference Books Recommended
1. Interaction Design: Beyond Human Computer Interaction, Rogers, Sharp Preece, Fifth Edition, Wiley.
2. Human Machine Interaction, Kalbande, Kanade, Iyer, Galitzs Wiley Publications.
3. Designing the User Interface: Strategies for Effective Human-Computer Interaction, Ben Shneiderman and Catherine Plaisant, Fifth Edition, Pearson Addison-Wesley.
4. Brain–Computer Interfaces: Principles and Practice, Jonathan Wolpaw and Elizabeth Winter Wolpaw, First Edition, Oxford University Press.

Course Code	Course Title	Hours / Week		Credits	Maximum Marks			ESE
		L	P		Continual Evaluation	End Sem. Exam	Total	Duration (Hrs.)
PECEN 206T	Micro-Electromechanical System	4	0	4	40	60	100	3

Course Objectives
The objectives of this course is to provide students with:
1. Broader knowledge of semiconductors, solid mechanics to fabricate MEMS devices & understand its operation of major classes.
2. An ability to apply MEMS manufacturing concepts in sensors, actuators & other devices.
3. An exposure to current state of the art & the unique demands, environments and applications of MEMS devices.

Course Outcomes	
After successful completion of this course, students will be able to:	
CO1	Understand the operations and fabrication techniques of MEMS and Microsystems.
CO2	Acquire the working concepts of RF MEMS components.
CO3	Expertise the knowledge in design of micro sensors and actuators.
CO4	Compare and select various packaging techniques in the design of MEMS.
CO5	Interpret and apply the challenges in design and fabrication of recent advancements in the field of MEMS.

SYLLABUS
Unit I: Introduction to MEMS Overview of microelectronics and microsystems technology, MEMS materials, laws of scaling, multi-disciplinary nature of MEMS, micro-fabrication and micromachining, integrated circuit processes.
Unit II: Micro-Sensors and Micro-actuators Classification of physical sensors, Integrated, Intelligent, or Smart sensors, sensor principles and examples, micro actuation techniques, mechanical design of micro-actuators, micro-actuator examples.
Unit III: Micro System Manufacturing Bulk and surface micro machining, wafer bonding, high aspect-ratio processes (LIGA), Surface Micromachining: one or two sacrificial layer processes, surface micro machining requirements and examples. Modeling of MEMS: mechanics of solids in MEMS, brief overview of finite element method, modeling of coupled electromechanical systems.
Unit IV: RF MEMS RF MEMS components, RF MEMS for communications, space & defense applications.
Unit V: Microsystems Design and Packaging Micro system packaging materials, design considerations, mechanical design, process design, micro system packaging, packing technologies, assembly of microsystems, reliability in MEMS.

Text Books Recommended
1. Micro and Smart Systems, Ananthasuresh, G. K., Vinoy, K. J. Gopala Krishnan, S., Bhat, K. N., Aatre, V. K., First Edition, Wiley-India.
2. RF MEMS and Their Applications, Vijay, Varadan, K. J. Vinoy, K. A. Jose, First Edition, Wiley.

Reference Books Recommended
1. Microsensors, MEMS and Smart Devices, Julian W. Gardner, Vinay K. Varadan, Osama O. Awadelkarim, First Edition, Wiley.
2. VLSI Technology, Size S. M., Second Edition, McGraw Hill.
3. MEMS and Microsystems Design and Manufacture, Tai-Ran Hsu, Second Edition, Wiley.