R18

M.Tech. (EMBEDDED SYSTEMS)

M.Tech. R18 CBCS Curriculum

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

An Autonomous, ISO 9001:2015 & QS I-Gauge Diamond Rated Institute, Accredited by NAAC with 'A++' Grade
NBA Accreditation for B.Tech. CE, EEE, ME, ECE, CSE, EIE, IT Programmes
Approved by AICTE, New Delhi, Affiliated to JNTUH, NIRF 127 Rank in Engineering Category
Recognized as "College with Potential for Excellence" by UGC
Vignana Jyothi Nagar, Pragathi Nagar, Nizampet (S.O), Hyderabad – 500 090, TS, India.
Telephone No: 040-2304 2758/59/60, Fax: 040-23042761
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VISION OF THE INSTITUTE

To be a World Class University providing value-based education, conducting interdisciplinary research in cutting edge technologies leading to sustainable development of the nation

MISSION OF THE INSTITUTE

- To produce technically competent and socially responsible engineers, managers and entrepreneurs, who will be future ready.
- To involve students and faculty in innovative research projects linked with industry, academic and research institutions in India and abroad.
- To use modern pedagogy for improving the teaching-learning process.

DEPARTMENT OF

ELECTRONICS AND COMMUNICATION ENGINEERING

VISION OF THE DEPARTMENT

A resource centre of academic excellence for imparting technical education with high pattern of discipline through dedicated staff which shall set global standards, making National and International students technologically superior and ethically strong, who in turn shall improve the quality of life.

MISSION OF THE DEPARTMENT

- To provide quality education in the domain of Electronics and Communication Engineering through effective learner centric process.
- To provide industry specific best of breed laboratory facilities beyond curriculum to promote diverse collaborative research for meeting the changing industrial and societal needs.

M.TECH.
(EMBEDDED SYSTEMS)

M.TECH. (ES)

PROGRAM EDUCATIONAL OBJECTIVES

PEO-I: Apply the acquired knowledge to solve engineering problems to suit multidisciplinary situations.

PEO-II: Undertake research and development projects in the field of Embedded Systems.

PEO-III: Continue the personal development through professional study and self learning.

M.TECH. (ES)

PROGRAM OUTCOMES

PO-1: Demonstrate their professional, ethical and social responsibilities and contribute their part for addressing various global issues.

PO-2: Apply the acquired knowledge from undergraduate engineering and other disciplines to identify, formulate and present solutions to technical problems related to various areas of Embedded Systems.

PO-3: Learn advanced technologies and analyze complex problems in the fields of Embedded System design along with the fundamental concepts of engineering.

PO-4: Addressing specific problems in the field of Embedded System in the form of mini projects, analysis, and interpretation of data and synthesis of information to provide valid conclusions by considering societal and environmental factors in the core areas of expertise.

PO-5: Plan and conduct systematic study on a significant research topic effective to the societal, health, legal and environmental issues in the field of Embedded Systems.

PO-6: Use the techniques, skills, modern Integrated Development Environment (IDE) tools, Operating systems, software and equipment necessary to evaluate and analyze the systems in Real time environments.

PO-7: Ability to manage team effectively and become good leaders.

PO-8: Understand the scenario of global business.

PO-9: Demonstrate effective oral and written communication skills in accordance with technical standards.

PO-10: Develop confidence and motivation for self education and imbibe professional values for lifelong learning.

PO-11: Understand and commit to professional ethics, social responsibilities and norms of engineering practice.

PO-12: Become knowledgeable about contemporary developments by self learning.

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY, HYDERABAD
M.TECH. I YEAR COURSE STRUCTURE AND SYLLABUS

(EMBEDDED SYSTEMS)

I SEMESTER **R18**

Course Type	Course Code	Name of the Course	L	T	P	Credits
Professional Core-I	18PC1VS01	Simulation and Synthesis with PLDs	3	0	0	3
Professional Core-II	18PC1ES01	Processors for Embedded System Design	3	0	0	3
Professional Core-III	18PC1ES02	Programming Languages for Embedded Software	3	0	0	3
Professional Elective-I	18PE1ES01	Artificial Intelligence	3	0	0	3
	18PE1ES02	Internet of Things				
	18PE1ES03	Communication Buses and Interfaces				
Professional Elective-II	18PE1ES04	Parallel Processing	3	0	0	3
	18PE1ES05	Advanced Communication Networks				
	18PE1VS03	Advanced Digital Signal Processing				
Professional Core Lab-I	18PC2VS01	Simulation and Synthesis with PLDs Laboratory	0	0	3	1.5
Professional Core Lab-II	18PC2ES01	Processors for Embedded System Design Laboratory	0	0	3	1.5
Project	18PW4ES01	Technical Seminar	0	0	4	2
Audit	18AU5CS01	Research Methodology and IPR	2	0	0	0
Total			**17**	**0**	**10**	**20**

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY, HYDERABAD
M.TECH. I YEAR COURSE STRUCTURE AND SYLLABUS

(EMBEDDED SYSTEMS)

II SEMESTER **R18**

Course Type	Course Code	Name of the Course	L	T	P	Credits
Professional Core-IV	18PC1ES03	System Design with Embedded Linux	3	0	0	3
Professional Core-V	18PC1ES04	Wireless and Mobile Communications	3	0	0	3
Professional Core-VI	18PC1CP03	Machine Learning	3	0	0	3
Professional Elective-III	18PE1ES06	SOC and NOC Architecture	3	0	0	3
	18PE1ES07	Network Security and Cryptography				
	18PE1ES08	Advanced Computer Architecture				
Professional Elective-IV	18PE1VS08	Image and Video Processing	3	0	0	3
	18PE1ES09	Sensors and Actuators				
	18PE1ES10	High Performance Networks				
Professional Core Lab-III	18PC2ES02	System Design with Embedded Linux Laboratory	0	0	3	1.5
Professional Core Lab-IV	18PC2ES03	Machine Learning and Wireless Communication Laboratory	0	0	3	1.5
Project	18PW4ES02	Mini-Project	0	0	4	2
Audit	18AU5EN01	English for Academic and Research Writing	2	0	0	0
Total			**17**	**0**	**10**	**20**

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY, HYDERABAD
M.TECH. II YEAR COURSE STRUCTURE AND SYLLABUS

(EMBEDDED SYSTEMS)

III SEMESTER **R18**

Course Type	Course Code	Name of the Course	L	T	P	Credits
Professional Elective-V	18OE1MT01	Selected Topics in Mathematics	3	0	0	3
	18PE1ES11	Wireless Sensor Networks				
	18PE1VS09	Memory Technologies				
Open Elective	18OE1CN01	Business Analytics	3	0	0	3
	18OE1AM01	Industrial Safety				
	18OE1AM02	Operations Research				
	18OE1AM03	Composite Materials				
	18OE1PS01	Waste to Energy				
Project	18PW4ES03	Project Part - I	0	0	16	8
Total			**6**	**0**	**16**	**14**

IV SEMESTER **R18**

Course Type	Course Code	Name of the Course	L	T	P	Credits
Project	18PW4ES04	Project Part - II	0	0	28	14
Total			**0**	**0**	**28**	**14**

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

M.Tech. I Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PC1VS01) SIMULATION AND SYNTHESIS WITH PLDs

COURSE PRE-REQUISITES: Basic Concepts of Digital Systems

COURSE OBJECTIVES:
- To introduce Verilog HDL for the design and functionality verification of a digital circuit
- To understand the design of data path and control circuits for sequential machines
- To introduce the concept of realizing a digital circuit using PLDs

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Develop the Verilog HDL to design a digital circuit
CO-2: Appreciate the analysis of finite state machine of a controlling circuit
CO-3: Understand the Static Timing Analysis and clock issues in digital circuits
CO-4: Verify the functionality of the digital designs using PLDs

UNIT-I:
Verilog HDL: Importance of HDLs, Lexical Conventions of Verilog HDL
Gate Level Modeling: Built in primitive gates, switches, gate delays
Data Flow Modeling: Continuous and implicit continuous assignment, delays
Behavioral Modeling: Procedural constructs, Control and repetition Statements, delays, function and tasks.

UNIT-II:
Digital Design: Design of BCD Adder, State graphs for control circuits, shift and add multiplier, Binary divider.
FSM and SM Charts: Finite state diagram, Implementation of sequence detector using FSM, State machine charts, Derivation of SM Charts, Realization of SM Chart, Implementation of Binary Multiplier.

UNIT-III:
ASIC Design Flow: Simulation, simulation types, Synthesis, synthesis methodologies, translation, mapping, optimization, Floor planning, Placement, routing, Clock tree synthesis, Physical verification.

UNIT-IV:
Static Timing Analysis: Timing paths, Meta-stability, Clock issues, Need and design strategies for multi-clock domain designs, setup and hold time Violations, steps to remove Setup and hold time violations.

UNIT-V:
Digital Design using PLD's: ROM, PLA, PAL- Registered PAL's, Configurable PAL's, GAL. CPLDs: Features, programming and applications using complex programmable logic devices, Altera Max - 7000 series and Altera FLEX logic- 10000 series CPLD.

UNIT-VI:
FPGAs: Field Programmable gate arrays Logic blocks, routing architecture, design flow, technology mapping for FPGAs, Spartan3E, Spartan XC6SLX45, Spartan 6 LX45 FPGA, Zynq-7000, Architectures and their speed performance.

TEXT BOOKS:
1. Verilog HDL, A Guide to Digital Design and Synthesis, Samir Palnitkar, 2nd Edition, 2003
2. Fundamentals of Logic Design, Charles H. Roth, 5th Edition, Cengage Learning, 2010

3. Verilog HDL Synthesis-A Practical Primer, Bhasker J., 1st Edition, 1998

REFERENCES:

1. Modern Digital Electronics, P. Jain, 3rd Edition, TMH, 2003
2. Data Sheets for CPLD & FPGA Architectures, 1996
3. Digital Principles and Design, Donald D. Givone TMH, 2016
4. Designing with FPGAs & CPLDs, Bob Zeidman, CMP Books, 2002
5. Modern Digital Design, Richard S. Sandige, MGH International Edition, 1990

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M.Tech. I Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PC1ES01) PROCESSORS FOR EMBEDDED SYSTEM DESIGN

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To introduce modern embedded systems and their programming
- To introduce the concept of integrating hardware and software for microcontroller application systems
- To implement software approach on an embedded platform to solve the predefined problems

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Outline various building blocks of an embedded system and applications of embedded systems
CO-2: Compare and select the application specific ARM processor core based SoC for an embedded system
CO-3: Identify and characterize the architecture of Programmable DSP Processors
CO-4: Develop the task specific applications on ARM processor core and DSP processor-based platform

UNIT-I:
Overview of Embedded Systems: Embedded Systems-Core Components, Design challenges, Applications Embedded Processor Architecture and Organization, RISC vs CISC, Embedded Memory Technologies, I/O and Memory Maps, Modern Processor Instruction Set Features, Interrupts and Exceptions, Power saving modes, Embedded C and assembly language programming, Writing portable Embedded Software,

UNIT-II:
ARM Cortex-M3 Processor: Applications, Programming model – Registers, Operation modes, Exceptions and Interrupts, Reset Sequence, Instruction Set, Unified Assembler Language, Memory Maps, Memory Access Attributes, Permissions, Bit-Band Operations, Unaligned and Exclusive Transfers. Pipeline, Bus Interfaces

UNIT-III:
Exceptions, Types, Priority, Vector Tables, Interrupt Inputs and Pending behaviour, Fault Exceptions, Supervisor and Pendable Service Call, Nested Vectored Interrupt Controller, Basic Configuration, SYSTICK Timer, Interrupt Sequences, Exits, Tail Chaining, Interrupt Latency.

UNIT-IV:
LPC 17xx Microcontroller: Internal memory, GPIOs, Timers, ADC, UART and other serial interfaces, PWM, RTC, WDT

UNIT-V:
Programmable DSP (P-DSP) Processors: Multiplier and Multiplier Accumulator (MAC), Multi port memory, Modified bus structures and Memory Access Schemes in P-DSPS, VLIW architecture, Pipelining, On-chip Peripherals

UNIT-VI:
TMS320C6000 series, architecture study, Central processing UNIT and data paths, Functional UNITs and its operations, Addressing modes in C6X, memory architecture, Peripherals, Assembly Instructions for arithmetic, logical operations

TEXT BOOKS:

1. Real Time Concepts for Embedded Systems, Qing Li, Caroline Yao, CRC Press
2. The Definitive Guide to ARM Cortex-M3, Joseph Yiu, 2nd Edition, Elsevier
3. Digital Signal Processors: Architecture, Programming and Applications, Venkatramani B. and Bhaskar M., 2nd Edition, TMH

REFERENCES:

1. Designing Embedded Hardware, John Catsoulis, 2nd Edition, O'Reilly Media
2. ARM System Developer's Guide: Designing and Optimizing, Sloss Andrew N, Symes Dominic, Wright Chris, Morgan Kaufman Publication
3. ARM System-on-Chip Architecture, Steve Furber, Pearson Education
4. Embedded System Design, Frank Vahid and Tony Givargis, Wiley
5. Technical References and user manuals on www.arm.com, NXP Semiconductor www.nxp.com and Texas Instruments www.ti.com

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M.Tech. I Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PC1ES02) PROGRAMMING LANGUAGES FOR EMBEDDED SOFTWARE

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To develop skills in embedded system programming
- To provide the ability of identifying the choice of programming language for embedded systems
- To differentiate interpreted languages from compiled languages

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Develop an embedded C application of moderate complexity
CO-2: Appreciate the algorithms developed in C++ and their analysis
CO-3: Develop and test the programs using application specific scripting languages

UNIT-I:
Embedded 'C' Programming: Bitwise operations, Dynamic memory allocation, OS services, Linked stack and queue, Sparse matrices, Binary tree, Interrupt handling in C, Code optimization issues, Writing LCD drives, LED drivers, Drivers for serial port communication, Embedded Software Development Cycle and Methods (Waterfall, Agile)

UNIT-II:
Object Oriented Programming: Introduction to procedural, modular, object-oriented and generic programming techniques, Limitations of procedural programming, objects, classes, data members, methods, data encapsulation, data abstraction and information hiding, inheritance, polymorphism

UNIT-III:
CPP Programming: 'cin', 'cout', formatting and I/O manipulators, new and delete operators, Defining a class, data members and methods, 'this' pointer, constructors, destructors, friend function, dynamic memory allocation

UNIT-IV:
Overloading and Inheritance: Need of operator overloading, overloading the assignment, overloading using friends, type conversions, single inheritance, base and derived classes, friend classes, types of inheritance, hybrid inheritance, multiple inheritance, virtual base class, polymorphism, virtual functions,

UNIT-V:
Templates: Function template and class template, member function templates and template arguments, Exception Handling: syntax for exception handling code: try-catch-throw, Multiple Exceptions.

UNIT-VI:
Scripting Languages: Introduction to Scripting Languages – PERL, Python, TCL, Shell Scripting.
Python: PYTHON-syntax, statements, functions, Built-in-functions and Methods, Modules in PYTHON, Exception Handling.

TEXTBOOKS:
1. Embedded C, Michael J. Pont, 2nd Edition, Pearson Education, 2008
2. Learning Perl, Randal L. Schwartz, 6th Edition, O'Reilly Publications, 2011
3. Data Structures via C++, Michael Berman, Oxford University Press, 2002

REFERENCES:

1. Algorithms in C++, Robert Sedgewick, Addison Wesley Publishing Company, 1999
2. Operating System Concepts, Abraham Silberschatz, Peter B, Greg Gagne, John Willey & Sons, 2005
3. Programming PYTHON, M. Lutz, SPD
4. Core PYTHON Programming, Chun, Pearson Education
5. Guide to Programming with PYTHON, M. Dawson, Cengage Learning

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M.Tech. I Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PE1ES01) ARTIFICIAL INTELLIGENCE

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:

- To make students conversant with fundamentals of AI with the help of a running applications connecting all the covered topics

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Understand the difference between optimal reasoning versus human like reasoning
CO-2: Gain the in-depth knowledge of the notions of state space representation, exhaustive search, heuristic search along with the time and space complexities
CO-3: Understand different knowledge representation techniques and fuzzy logic for artificial intelligence
CO-4: Learn the applications of AI: namely Game Playing, Theorem Proving, Expert Systems, Machine Learning and Natural. Language Processing

UNIT-I:
Introduction to AI: AI Problems and Underlying Assumption, various AI Techniques, level of the model, criteria for success, some general REFERENCES:.

UNIT-II:
Problems, State Space Search & Heuristic Search Techniques - Defining the Problems as a State Space Search, Production Systems, Production Characteristics, Production System Characteristics, and issues in the Design of Search Programs, Additional Problems. Generate-and-Test, Hill Climbing, Best-First Search, Problem Reduction, Constraint Satisfaction, Means-Ends Analysis.

UNIT-III:
Knowledge Representation: Representations and Mappings, Approaches to Knowledge Representation. Using Predicate Logic: Representation Simple Facts in Logic, Representing Instance and ISA Relationships, Computable Functions and Predicates, Resolution. Representing Knowledge Using Rules: Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning.

UNIT-IV:
Symbolic Reasoning Under Uncertainty: Introduction to Non monotonic Reasoning, Logics for Non-monotonic Reasoning. Statistical Reasoning: Probability and Bays' Theorem, Certainty Factors and Rule-Base Systems, Bayesian Networks, Dempster Shafer Theory, Fuzzy Logic.

UNIT-V:
Game Playing Overview, And Example Domain: Overview, MiniMax, Alpha-Beta Cut-off, Refinements, Iterative deepening, The Blocks World, Components of a Planning System, Goal Stack Planning, Nonlinear Planning Using Constraint Posting, Hierarchical Planning, Reactive Systems, Other Planning Techniques. Understanding AI as constraint satisfaction.

UNIT-VI:
Natural Language Processing: Introduction, Syntactic Processing, Semantic Analysis, Semantic Analysis, Discourse and Pragmatic Processing, Spell Checking.
Connectionist Models: Introduction- Hopfield Network, Learning in Neural Network, Application of Neural Networks, Recurrent Networks, Distributed Representations, Connectionist AI and Symbolic AI.

TEXT BOOKS:

1. Artificial Intelligence, Saroj Kaushik, Cengage Learning, 2011
2. Artificial Intelligence: A Modern Approach, Stuart Russel and Peter Norvig, 3rd Edition, Prentice Hall, 2009

REFERENCES:

1. Artificial Intelligence, Elaine Rich and Kevin Knight, 2nd Edition, Tata McGraw-Hill, 2005

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M.Tech. I Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PE1ES02) INTERNET OF THINGS

COURSE PRE-REQUISITES: Concepts of Programming in Java, C/C++, Embedded C, Concepts of Wireless Communication and Networking

COURSE OBJECTIVES:
- To understand the new paradigm of objects interacting with people, information systems and with other objects
- To introduce various IoT protocols
- To understand the issues in developing specific real time systems on various IoT platforms.

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Identify and describe different kinds of internet-connected products developed on various IoT platforms
CO-2: Appreciate the challenges involved in establishing user-interaction with connected-objects
CO-3: Develop prototype IoT application using python

UNIT-I:
Introduction to Internet of Things: Definition and Characteristics of IoT, Physical Design of IoT – IoT Architecture, Smart Objects, Bits and Atoms, IoT enabled Technologies – Wireless Sensor Networks, Cloud Computing, Big data analytics, Communication protocols, Embedded Systems.

UNIT-II:
IoT Standards and Protocols: Infrastructure (ex: 6LowPAN, IPv4/IPv6, RPL); Identification (ex: EPC, uCode, IPv6, URIs); Comms / Transport (ex: Wifi, Bluetooth, LoRa); Discovery (ex: Physical Web, mDNS, DNS-SD); Data Protocols (ex: MQTT, CoAP, AMQP, Websocket, Node); Device Management (ex: TR-069, OMA-DM); Semantic (ex: JSON-LD, Web Thing Model); Multi-layer Frameworks (ex: Alljoyn, IoTivity, Weave, Homekit).

UNIT-III:
Introduction to Python: Language features of Python, Data types, data structures, Control of flow, functions, modules, packaging, file handling, data/time operations, classes, Exception handling Python packages - JSON, XML, HTTPLib, URLLib, SMTPLib

UNIT-IV:
IoT Physical Devices and Endpoints: Introduction to Raspberry PI-Interfaces (serial, SPI, I2C) Programming – Python program with Raspberry PI with focus of interfacing external gadgets, controlling output, and reading input from pins.

UNIT-V:
IoT Platforms: Introduction to IoT Platforms (AWS IoT, IBM Watson, ARM Mbed), Cloud Storage models and communication APIs, Python web application framework Designing a RESTful web API.

UNIT-VI:
Iot Applications and Issues: Combination scenarios, Breaking assumptions: - Home, City, Environment, Energy, Retail, Logistics, Agriculture, Industry, health and Lifestyle with Case Studies

TEXT BOOKS:

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
2. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers, 2007
3. Building the Internet of Things. Sara Cordoba, WimerHazenberg, Menno Huisman. BIS Publishers. 2011

REFERENCES:

1. Designing the Internet of Things, Adrian Mcewen, Hakin Cassimally, 2015
2. The Internet of Things: Key Applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi, 2012
3. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759
4. Securing the Internet of Things: A Standardization Perspective, Keoh, Sye Loong, Sahoo Subhendu Kumar, and Hannes Tschofenig, Internet of Things Journal, IEEE 1.3 (2014): 265-275

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M.Tech. I Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PE1ES03) COMMUNICATION BUSES AND INTERFACES

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To understand serial communication protocols
- To know about basic elements of a embedded network and building such networks
- To understand the principles of embedded networking design choices

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Select the application specific serial bus
CO-2: Develop APIs for configuration, reading and writing data onto serial bus
CO-3: Appreciate the principles of interfacing peripherals with the desired serial bus

UNIT-I:
Introduction: Serial/ Parallel Communication – Serial communication protocols - Physical interface, Data and Control signals, features of RS232 standard – RS485.

UNIT-II:
Synchronous Serial Protocols: Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C)- Fire wire. Limitations and Applications of RS232, RS485, I2C, SPI.

UNIT-III:
PC Parallel Port Programming: ISA/PCI Bus protocols- Block Diagrams, Latest Generations, Read and Write Operations , PCIe - Revisions, Configuration space, Hardware protocols, applications.

UNIT-IV:
CAN Bus: Introduction - Architecture, Data transmission, Layers, Frame formats, Bit stuffing – Types of errors –Nominal Bit Timing – applications with CAN.

UNIT-V:
USB Bus: Introduction – Speed Identification on the bus – USB States – USB bus communication- Packets –Data flow types –Transfer types, enumeration, Descriptor types and contents, Device driver.

UNIT-VI:
Data Streaming Serial Communication Protocol: Serial Front Panel Data Port (SFPDP) - Specifications- speeds – Communication Range-SFPDP using fiber optic and copper cable.

TEXT BOOKS:
1. Serial Port Complete - COM Ports, USB Virtual Com Ports, and Ports for Embedded Systems, Jan Axelson, 2nd Edition, Lakeview Research
2. Embedded Systems Design: A Unified Hardware/Software Introduction, Frank Vahid, Tony Givargis, John & Wiley Publications, 2002

REFERENCES:
1. Advanced PIC microcontroller Projects in C: From USB to RTOS with the PIC18F Series, Dogan Ibrahim, Elsevier 2008
2. USB Complete, Jan Axelson, Penram Publications
3. PCI Express Technology, Mike Jackson, Ravi Budruk, Mindshare Press

4. A Comprehensible Guide to Controller Area Network, Wilfried Voss, Copperhill Media Corporation, 2nd Edition, 2005
5. Serial Front Panel Draft Standard VITA 17.1 – 200x
www.can-cia.org, www.pcisig.com, www.usb.org

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M.Tech. I Semester (ES)	**L**	**T/P**	**C**
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(18PE1ES04) PARALLEL PROCESSING

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To provide an overview of concepts and issues of parallel architectures, models, algorithms and software
- To provide a foundation and context from which current research in Parallel Computation can be understood
- To introduce the principles of developing efficient parallel algorithms

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Identify limitations of different architectures of computer
CO-2: Analyze quantitatively the performance parameters for different computer architectures
CO-3: Investigate software issues related to different computer architectures

UNIT-I:
Overview of Parallel Processing and Pipelining, Performance analysis, Scalability.

UNIT-II:
Principles and implementation of Pipelining, Classification of pipelining processors, Advanced pipelining techniques, Software pipelining.

UNIT-III:
Parallel algorithms for multiprocessors- Classification and performance of parallel algorithms, operating systems for multiprocessors systems, Message passing libraries for parallel programming interface, PVM (in distributed memory system), Message Passing Interfaces (MPI).

UNIT-IV:
Multithreaded Architecture, Multithreaded processors, Latency hiding techniques, Principles of multithreading, Issues and solutions.

UNIT-V:
Parallel Programming Techniques: Message passing program development, Synchronous and asynchronous message passing, Shared Memory Programming, Data Parallel Programming, Parallel Software Issues.

UNIT-VI:
Operating systems for multiprocessors systems, customizing applications on parallel processing platforms.

TEXT BOOKS:
1. Computer Architecture and Parallel Processing, Kai Hwang, Faye A. Briggs, MGH International Edition, 2009
2. Advanced Computer Architecture, Kai Hwang, TMH, 2007
3. Computer Organization and Architecture, Designing for Performance, William Stallings, Sixth Edition, Prentice Hall, 2003

REFERENCES:
1. Scalable Parallel Computing, Kai Hwang, Zhiwei Xu

2. High-Performance Computer Architecture, MGH Harold S. Stone, Addison-Wesley, 1993

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M.Tech. I Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PE1ES05) ADVANCED COMMUNICATION NETWORKS

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To introduce the analyse of various advanced communication networks
- To introduce the principles of designing innovative network topologies and their simulation
- To provide the ability in designing and maintenance of communication networks

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Understand advanced concepts in Communication Networking
CO-2: Appreciate the designing and developing of protocols for Communication Networks
CO-3: Understand the mechanisms in Quality of Service in communication networking
CO-4: Explain the principles of Optimising the Network Design

UNIT–I:
Overview of Internet-Concepts, challenges and history. Overview of ATM. TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP.

UNIT-II:
Real Time Communications over Internet. Adaptive applications. Latency and throughput issues. Integrated Services Model (intServ). Resource reservation in Internet. RSVP.; Characterization of Traffic by Linearly Bounded Arrival Processes (LBAP). Leaky bucket algorithm and its properties.

UNIT-III:
Packet Scheduling Algorithms-requirements and choices. Scheduling guaranteed service connections. GPS, WFQ and Rate proportional algorithms. High speed scheduler design. Theory of Latency Rate servers and delay bounds in packet switched networks for LBAP traffic.; Active Queue Management - RED, WRED and Virtual clock. Control theoretic analysis of active queue management.

UNIT-IV:
IP address lookup-challenges, Packet classification algorithms and Flow Identification- Grid of Tries, Cross producting and controlled prefix expansion algorithms.

UNIT-V:
Admission control in Internet. Concept of Effective bandwidth. Measurement based admission control. Differentiated Services in Internet (DiffServ). DiffServ architecture and framework.

UNIT-VI:
IPV4, IPV6, IP tunneling, IP switching and MPLS, Overview of IP over ATM and its evolution to IP switching. MPLS architecture and framework. MPLS Protocols. Traffic engineering issues in MPLS.

TEXT BOOKS:
1. High Performance Communications Networks, Jean Wairand and PravinVaraiya, 2nd Edition, 2000

2. Communication Networking: An Analytical Approach, Morgan Kaufman Publishers, 2004
3. Computer Network Technology, D. S. Gaikwad and N. D. Lambe

REFERENCES:

1. Network Calculus A Theory of Deterministic Queueing Systems for the Internet, Jean Le Boudec and Patrick Thiran, Springer Veriag, 2001
2. Internet QoS, Zhang Wang, Morgan Kaufman, 2001
3. ATM Network Performance, George Kesidis, Kluwer Academic, Research Papers, 2005
4. Advance Computer Networks, Deepak Tyagi
5. Advance Computer Networks, Sona Kumar and G. Shobha

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

M.Tech. I Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PE1VS03) ADVANCED DIGITAL SIGNAL PROCESSING

COURSE PRE-REQUISITES: Knowledge of Digital Filter Design techniques, Digital Signal Processing techniques

COURSE OBJECTIVES:
- To introduce the principles of Multi-rate digital signal processing and its implementation
- To provide ability to compute the power spectrum of the given discrete signal
- To understand various sources of errors affecting the performance of a DSP system
- To understand the necessity of adaptive signal processing

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Appreciate the design of multi rate DSP systems
CO-2: Explain the methods of power spectrum estimation of the given signal
CO-3: Comprehend the effect of data word length on the performance of a DSP system
CO-4: Appreciate the applications of adaptive signal processing

UNIT-I:
Review of DFT, FFT, IIR Filters, FIR Filters: Multi-rate Signal Processing: Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, Multistage Implementation of Sampling Rate Conversion, Filter design &Implementation for sampling rate conversion, Applications of Multi-rate Signal Processing.

UNIT-II:
Non-Parametric Methods of Power Spectral Estimation: Estimation of spectra from finite duration observation of signals, Non-parametric Methods: Bartlett, Welch & Blackman & Tukey methods, Comparison of all Non-Parametric methods

UNIT-III:
Linear Prediction and Optimum Linear Filters: Forward and Backward Linear Prediction – Forward Linear Prediction, Backward Linear Prediction, Optimum reflection coefficients for the Lattice Forward and Backward Predictors. Solution of the Normal Equations: Levinson Durbin Algorithm, Schur Algorithm. Properties of Linear Prediction Filters. FIR Wiener Filter, Orthogonality Principle in Linear Mean -Square Estimation.

UNIT-IV:
Parametric Methods of Power Spectrum Estimation: Autocorrelation & Its Properties, Relation between auto correlation & model parameters, AR Models - Yule-Waker & Burg Methods, MA & ARMA models for power spectrum estimation.

UNIT-V:
Finite Word Length Effects: Analysis of finite word length effects in Fixed-point DSP systems – Fixed, Floating Point Arithmetic – ADC quantization noise & signal quality – Finite word length effect in IIR digital Filters – Finite word-length effects

UNIT-VI:
Adaptive Filters: Gradient search Approach, Least Mean Square Algorithm, Recursive Least Squares, Kalman Filters Innovations Process, Estimation of the State Using the Innovations Process, Kalman Filter as the Unifying Basis for RLS Filters, Variations of the Kalman Filter. Applications of Adaptive Filters- System Identification or System Modelling, Adaptive Channel Equalization, Echo Cancellation in Data Transmission over Telephone Channels, Adaptive Noise Cancelling.

TEXT BOOKS:

1. Digital Signal Processing: Principles, Algorithms & Applications, J. G. Proakis & D. G. Manolokis, 4th Ed., PHI, 2001
2. Adaptive Filter Theory, S. Haykin Pearson, 2003
3. DSP – A Practical Approach, Emmanuel C. I. Feacher, Barrie. W. Jervis, 2nd Ed., Pearson Education, 2008

REFERENCES:

1. Modern Spectral Estimation: Theory & Application, S. M. Kay, 1988, PHI
2. Multirate Systems and Filter Banks, P. P. Vaidyanathan, Pearson Education, 1993
3. Digital Signal Processing, S. Salivahanan, A. Vallavaraj, C. Gnanapriya, 2000, TMH

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

M.Tech. I Semester (ES)	**L**	**T/P**	**C**
	0	**3**	**1.5**

(18PC2VS01) SIMULATION AND SYNTHESIS WITH PLDs LABORATORY

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To provide familiarity with hardware description language Verilog HDL for modelling of combinational and sequential circuits
- To understand the role of functional simulator in the validating the functionality of designed circuits
- To understand the Synthesis of a designed digital circuits
- To introduce the process of implementation of digital circuits on FPGA kits

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Apply CAD tools for the design of digital circuits
CO-2: Appreciate the process of synthesizing a given digital circuits
CO-3: Implement the specified digital circuits using FPGA

LIST OF EXPERIMENTS:

Implementation of the following designs on FPGA using Verilog HDL:
1. 8:1 Mux/Demux, Full Adder, 8-bit Magnitude comparator, Encoder/decoder, Priority encoder, Parity generator
2. Code converters
3. D-FF,4-bitShiftregisters(SISO,SIPO,PISO,bidirectional),3-bitSynchronous Counters.
4. Sequence generator/detectors, Synchronous FSM – Mealy and Moore machines.
5. Vending machines - Traffic Light controller, ATM, elevator control.
6. PCI Bus & Arbiter.
7. Single and Dual portSRAM
8. Arithmetic circuits like serialadder/subtractor,paralleladder/subtractor, serial/parallel multiplier

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M.Tech. I Semester (ES)	**L**	**T/P**	**C**
	0	**3**	**1.5**

(18PC2ES01) PROCESSORS FOR EMBEDDED SYSTEM DESIGN LABORATORY

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To introduce the principles involved in the design and implementation of embedded systems
- To provide familiarity with the basic concepts and terminology of the target area, the embedded systems design flow
- To introduce the embedded system architecture
- To introduce the methods of executive device control and testing

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Install, configure and utilize tool sets for developing applications based on ARM processor core and DSP processor
CO-2: Develop prototype codes using commonly available on and off chip peripherals on the Cortex M3 and DSP development boards

LIST OF EXPERIMENTS:

Part A) Experiments to be carried out on Cortex-M3 development boards and using GNU tool-chain
1. Blink an LED with software delay, delay generated using the SysTick timer.
2. System clock real time alteration using the PLL modules.
3. Control intensity of an LED using PWM implemented in software and hardware.
4. Control an LED using switch by polling method, by interrupt method and flash the LED once every five switch presses.
5. UART Echo Test.
6. Take analog readings on rotation of rotary potentiometer connected to an ADC channel.
7. Temperature indication on an RGB LED.
8. Mimic light intensity sensed by the light sensor by varying the blinking rate of an LED.
9. Evaluate the various sleep modes by putting core in sleep and deep sleep modes.
10. System reset using watchdog timer in case something goes wrong.
11. Sample sound using a microphone and display sound levels on LEDs.

Part B) Experiments to be carried out on DSP C6713 evaluation kits and using Code Composer Studio (CCS)

1. To develop an assembly code and C code to compute Euclidian distance between any two points
2. To develop C code for generating waveforms like sine, square, triangular etc.
3. To develop assembly and C code for implementation of convolution operation
4. To design and implement filters in C to enhance the features of given input sequence/signal

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

M.Tech. I Semester (ES)	**L**	**T/P**	**C**
	0	**4**	**2**

(18PW4ES01) TECHNICAL SEMINAR

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Identify a research topic related to advanced/state-of-the-art technologies
CO-2: Collect the literature and comprehend/analyze critically the technological advancements
CO-3: Engage in effective oral communication through presentation of seminar
CO-4: Engage in effective written communication through report

COURSE OUTLINE:

- A student shall present a seminar on a technical topic during I semester of the M.Tech. programme.
- A student, under the supervision of a faculty member, shall collect literature on a technical topic of his / her choice, critically review the literature and submit it to the Seminar Review Committee (SRC) in a prescribed report form.
- The SRC shall consist of Head of the Department, faculty supervisor and a senior faculty member of the specialization / department.
- Student shall make an oral presentation before the SRC after clearing the plagiarism check.
- Prior to the submission of seminar report to the SRC, its soft copy shall be submitted to the PG Coordinator for PLAGIARISM check.
- The report shall be accepted for submission to the SRC only upon meeting the prescribed similarity index.

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M.Tech. I Semester (ES)	**L**	**T/P**	**C**
	2	**0**	**0**

(18AU5CS01) RESEARCH METHODOLOGY AND IPR

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To introduce the characteristics of a good research problem
- To choose appropriate approaches of investigation of solutions for research problem
- To familiarize with basic Intellectual Property Rights
- To understand different Patent Rights

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Understand research problem formulation, analyze research related information and follow research ethics
CO-2: Realize the importance of ideas, concept, and creativity in the present-day context
CO-3: Recognize that when IPR would take such important place in growth of individuals and nation, it is needless to emphasize the need of information about IPR to be promoted among students in general and engineering in particular
CO-4: Appreciate IPR protection which leads to creation of new and better products, and in turn brings about, economic growth and social benefits

UNIT-I:
Introduction: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.
Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations.

UNIT-II:
Literature Survey: Effective literature studies approaches, analysis. Plagiarism, Research ethics.

UNIT-III:
Effective Technical Writing: How to write report, Paper. Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT-IV:
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of
Patenting and Development: technological research, innovation, patenting, development.
International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-V:
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT-VI:
New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR.

TEXT BOOKS:
1. Research Methodology: An Introduction for Science & Engineering Students, Stuart Melville and Wayne Goddard

2. Research Methodology: An Introduction, Wayne Goddard and Stuart Melville
3. Resisting Intellectual Property, Halbert, Taylor & Francis Ltd ,2007

REFERENCES:

1. Research Methodology: A Step-by-Step Guide for Beginners, Ranjit Kumar, 2nd Edition
2. Research Methodology: Methods and Techniques, C. R. Kothari and Gaurav Garg, New Age International Publishers
3. Intellectual Property in New Technological Age, Robert P. Merges, Peter S. Menell, Mark A. Lemley, 2016
4. Intellectual Property Rights Under WTO, T. Ramappa, S. Chand, 2008

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

M.Tech. II Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PC1ES03) SYSTEM DESIGN WITH EMBEDDED LINUX

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To provide a basic understanding of the Linux OS and the Eclipse IDE framework
- To understand the complexities of Embedded Linux Distributions in embedded systems
- To understand the process of configuring, booting and testing the Embedded Linux distributions and applications running on Embedded Linux target systems

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Appreciate the principles of the embedded Linux development model
CO-2: Develop the code for profile applications and drivers in embedded Linux
CO-3: Appreciate and create Linux BSP for a hardware platform

UNIT-I:
Introduction to Real Time Operating Systems: Characteristics of RTOS, Tasks Specifications and types, Real-Time Scheduling Algorithms, Concurrency, Inter-process Communication and Synchronization mechanisms, Priority Inversion, Inheritance and Ceiling.
Embedded Linux Vs Desktop Linux, Embedded Linux Distributions, System calls, Static and dynamic libraries, Cross tool chains

UNIT-II:
Embedded Linux Architecture, Kernel Architecture – HAL, Memory manager, Scheduler, File System, I/O and Networking subsystem, IPC, User space, Start-up sequence

UNIT-III:
Board Support Package Embedded Storage: MTD, Architecture, Drivers, Embedded File System **Embedded Device Drivers:** Communication between user space and kernel space drivers, Character and Block Device Drivers, Interrupt handling, Kernel modules
Embedded Drivers: Serial, Ethernet, I2 C, USB, Timer, Kernel Modules

UNIT-IV:
Porting Applications Real-Time Linux: Linux and Real time, Programming, Hard Real-time Linux

UNIT-V:
Building and Debugging: Bootloaders, Kernel, Root file system, Device Tree

UNIT-VI:
Embedded Linux Application Development, POSIX Thread programming, Semaphores, Mutes, Shared Memory, Message Queues, Case study on bringing up U-Boot, Linux Kernel and Root FS for popular Embedded Linux boards such as Beaglebone, Raspberry Pi

TEXT BOOKS:
1. Mastering Embedded Linux Programming, Chris Simmonds, Second Edition, PACKT Publications Limited.
2. Building Embedded Linux Systems, Karim Yaghmour, O'Reilly & Associates
3. Embedded Linux System Design and Development, P. Raghavan, Amol Lad, Sriram Neelakandan, Auerbach Publications

REFERENCES:
1. Embedded Linux Primer: A Practical Real World Approach, Christopher Hallinan, 2nd

Edition, Prentice Hall, 2010
2. Exploring Beaglebone: Tools and Techniques for Building with Embedded Linux, Derek Molloy, 1st Edition, Wiley, 2014

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M.Tech. II Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PC1ES04) WIRELESS AND MOBILE COMMUNICATIONS

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To understand the principles of advanced multiple access techniques
- To provide the understanding of diversity reception techniques
- To provide an ability to understand principles of digital cellular systems
- To provide the ability to synthesize and analyze wireless communication systems over a stochastic fading channel

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Explain the frequency-reuse concept in mobile communications, and its effects on interference, system capacity, handoff techniques
CO-2: Distinguish various multiple-access techniques for mobile communications
CO-3: Analyze path loss and interference for wireless telephony and their influences on a Mobile communication system's performance
CO-4: Appreciate functionality of CDMA system
CO-5: Appreciate the developments in wireless technology

UNIT-I:
Cellular Communication Fundamentals: Cellular system design, Frequency reuse, cell splitting, handover concepts, Co channel and adjacent channel interference, interference reduction techniques and methods to improve cell coverage, Frequency management and channel assignment. GSM architecture and interfaces, GSM architecture details, GSM subsystems, GSM Logical Channels, Data Encryption in GSM, Mobility Management, Call Flows in GSM.2.5 G Standards: High speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS), 2.75 G Standards: EDGE.

UNIT-II:
Spectral Efficiency Analysis Based on Calculations for Multiple Access Technologies: TDMA, FDMA and CDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas. Wireless network planning (Link budget and power spectrum calculations).

UNIT-III:
Mobile Radio Propagation: Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings. Small Scale Fading and Multipath Propagation, Impulse Response Model, Multipath Measurements, Parameters of Multipath channels, Types of Small Scale Fading: Time Delay Spread; Flat, Frequency selective, Doppler Spread; Fast and Slow fading.

UNIT-IV:
Equalization, Diversity: Equalizers in a communications receiver, Algorithms for Adaptive equalization, diversity techniques, space, polarization, frequency diversity, Interleaving.

UNIT-V:
Code Division Multiple Access: Introduction to CDMA technology, IS 95 system Architecture, Air Interface, Physical and logical channels of IS 95, Forward Link and Reverse link operation, Physical and Logical channels of IS 95 CDMA, IS 95 CDMA Call Processing, soft Handoff, Evolution of IS 95 (CDMA One) to CDMA 2000, CDMA 2000 layering structure and channels.

UNIT-VI:

Higher Generation Cellular Standards: 3G Standards: evolved EDGE, enhancements in 4G standard, Architecture and representative protocols, call flow for LTE, VoLTE, UMTS, introduction to 5G.

TEXT BOOKS:

1. Mobile Cellular Telecommunications, W. C. Y. Lee, McGraw Hill, 2nd Edition, 1989
2. Wireless Communications, Theodore. S. Rapport, Pearson Education, 2nd Edition, 2002
3. Mobile Cellular Communication, Gottapu Sashi Bhushana Rao, Pearson, 2012

REFERENCES:

1. Principle and Application of GSM, V.K. Garg, J.E. Wilkes, 5th Edition, Pearson Education, 2008
2. IS-95 CDMA & CDMA 2000, V.K. Garg, 4th Edition, Pearson Education, 2009
3. Wireless Communications Principles and Practice, T. S. Rappaport, 2nd Edition, PHI, 2002
4. Mobile Cellular Telecommunications Analog and Digital Systems, William C. Y. Lee, 2nd Edition, TMH, 1995
5. A GSM System Engineering, Asha Mehrotra, Artech House Publishers Bosten, London, 1997

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M.Tech. II Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PC1CP03) MACHINE LEARNING

COURSE PRE-REQUISITES: Statistics and Linear Algebra

COURSE OBJECTIVE

- To learn the concept of how to learn patterns and concepts from data
- To design and analysis various machine learning algorithms and techniques with a modern outlook focusing on recent advances
- Explore supervised and unsupervised learning paradigms of machine learning
- To explore Deep learning technique and various feature extraction strategies

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Understand wide variety of learning algorithms
CO-2: Compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach
CO-3: Mathematically analyze various machine learning approaches and paradigms
CO-4: Apply machine learning algorithms to solve problems of moderate complexity

UNIT-I:
Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation, Over fitting and Under fitting,

UNIT-II:
Supervised Learning (Regression/Classification):
Basic Methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Bayes Rule &Naive Bayes
Linear Models: Linear Regression, Logistic Regression
Support Vector Machines, Nonlinearity and Kernel Methods

UNIT-III:
Unsupervised Learning:
Clustering: K-means, adaptive hierarchical clustering
Generative Model: Gaussian Mixture Model
Dimensionality Reduction: PCA and kernel PCA

UNIT-IV:
Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

UNIT-V:
Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning

UNIT-VI:
Other Topics in Machine Learning- Semi-supervised Learning, Active Learning, Reinforcement Learning, Collaborative filtering-based Recommendation Systems.

TEXT BOOKS:

1. Machine Learning: A Probabilistic Perspective, Kevin Murphy, MIT Press, 2012
2. The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer, 2009
3. Pattern Recognition and Machine Learning, Christopher Bishop, Springer, 2007

REFERENCES:

1. Machine Learning, Tom Mitchell, First Edition, McGraw-Hill, 1997
2. Introduction to Machine Learning, Ethem Alpaydin, Second Edition, MIT Press, 2010

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M.Tech. II Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PE1ES06) SOC AND NOC ARCHITECTURE

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To understand the principles of system on chip design and its applications
- To introduce the design principles of NOC
- To understand the various computation models of SOC and NOC design

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Appreciate the design of a system architecture for the given performance indicators such as Power, Performance, Area
CO-2: Differentiate and explain the principles of SOC and NOC design
CO-3: Explain the role of system-level design and performance metrics in choosing a SOC/NOC design

UNIT-I:
Introduction to SoC Design. Multiprocessor SOC and Network on Chip. Low-Power SoC Design.

UNIT-II:
System Design: Co-Design using System Models Validation and Verification, Hardware/Software Co-Design Application Analysis, Synthesis.

UNIT-III:
Communication System: Separation of Computation and Communication. Communication-Centric SOC Design, Communication Synthesis. Network-Based Design, Network on Chip, Architecture of NOC.

UNIT-IV:
NOC Topology & Protocol Design: Analysis Methodology, NoC Topology, Energy Exploration, NOC Protocol Design.

UNIT-V:
Low-Power Design for NOC: Low-Power Signalling, On-Chip Serialization, Low-Power Clocking, Low-Power Channel Coding, Low-Power Switch, Low-Power Network on Chip Protocol.

UNIT-VI:
Example SOC/NOC Designs: Real Chip Implementation, Industrial Implementations, Intel's Tera-FLOP 80-Core NOC, Intel's Scalable Communication Architecture, Design case studies.

TEXT BOOKS:
1. Low Power NoC for High Performance SoC Design, Hoi-Junyoo, Kangmin Lee, Jun Kyoungkim, CRC Press, 2008
2. A Platform-Centric Approach to System-on-Chip (SOC) Design, Vijay K. Madisetti, Chonlameth Arpikanondt, Springer, 2005

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M.Tech. II Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PE1ES07) NETWORK SECURITY AND CRYPTOGRAPHY

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To understand basic principles of Cryptography
- To introduce the concept of providing Confidentiality and Authentication for the data and systems
- To understand the principals involved in network security

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Explain modular arithmetic fundamentals and apply to public key cryptographic algorithms
CO-2: Appreciate various network security protocols
CO-3: Explore the attacks and countermeasures associated with E-mail, IP, transport-level and web security and System security

UNIT-I:
Introduction To Network Security and Cryptography: Need for security, security services, Attacks, OSI Security Architecture, Model for Network security, Classical Encryption Techniques, Cryptanalysis of Classical Encryption Techniques.

UNIT-II:
Private-Key (Symmetric) Cryptography: Block Ciphers, Stream Ciphers, Data Encryption Standard (DES), Block Cipher Design Principles and Modes of Operation, Advanced Encryption Standard (AES), Triple DES, RC5, IDEA, Linear and Differential Cryptanalysis, Placement of Encryption Function, Traffic Confidentiality.

UNIT-III:
Introduction to Number Theory: Fermat's and Euler's Theorem, The Chinese Remainder Theorem, Euclidean Algorithm, Extended Euclidean Algorithm, and Modular Arithmetic.
Public-Key (Asymmetric) Cryptography- RSA, Key Distribution and Management, Diffie-Hellman Key Exchange, Elliptic Curve Cryptography.

UNIT-IV:
Authentication Standards: Digital Signatures, Digital Signature Standards, Authentication Protocols, Message Authentication Code, Hash functions, MD5 message digest algorithm, Secure Hash algorithm, RIPEMD-160, HMAC, Kerberos authentication, X.509 Authentication Service.

UNIT-V:
Electronic Mail Security: Pretty Good Privacy (PGP), S/MIME. IP security- Architecture, Authentication Header, Encapsulating Security Payload, Key Management. Web Security - Secure Socket Layer, Transport Layer Security, Secure Electronic Transaction.

UNIT-VI:
System Security: Intruders, Intrusion Detection, Password Management, Worms, viruses, Trojans, Virus Countermeasures, Firewalls, Firewall Design Principles, Trusted Systems.

TEXT BOOKS:
1. Cryptography and Network Security – Principles and Practices, William Stallings, Prentice Hall of India, Fourth Edition, 2005

2. Cryptography and Network Security, Behrouz A. Forouzan, Second Edition, McGraw Hill Education, 2007

REFERENCES:

1. Cryptography: Theory and Practice (Discrete Mathematics and Its Applications), D. R. Stinson, 3rd Edition, CRC Press
2. Cryptography and Network Security, Atul Kahate, 2nd Edition, Tata McGraw Hill, 2008
3. Applied Cryptography: Protocols, Algorithms, and Source Code in C, B. Schneier, 2nd Edition, John Wiley & Sons
4. Network Security & Cryptography, Bernard Menezes, 1st Edition, Cengage Learning, Delhi, 2011

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M.Tech. II Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PE1ES08) ADVANCED COMPUTER ARCHITECTURE

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To understand the concepts of parallelism and pipelining with reference to computer architecture
- To introduce about the issues in vector and array processors
- To understand the concepts of multithreading and multiprocessor

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Understand the concept of parallelism and pipelining their design aspects and challenges with respect to computer architecture
CO-2: Appreciate the various issues involved in vector and array processors
CO-3: Understand the high performance scalable multithreaded and multiprocessor systems

UNIT-I:
Parallel Processing and Pipelining Processing- Architectural Classification, Applications of parallel processing, Instruction level Parallelism and Thread Level Parallelism, Explicitly Parallel Instruction Computing (EPIC) Architecture

UNIT-II:
Pipeline Architecture-Principles and implementation of Pipelining, Classification of pipelining processors, Design aspect of Arithmetic and Instruction pipelining, Pipelining hazards and resolving techniques, Data buffering techniques, Advanced pipelining techniques, Software pipelining, VLIW (Very Long Instruction Word) processor.

UNIT-III:
Vector and Array Processor- Issues in Vector Processing, Vector performance modelling, SIMD Computer Organization, Static Vs Dynamic network, Parallel Algorithms for Array Processors: Matrix Multiplication.

UNIT-IV:
Multiprocessor Architecture - Loosely and Tightly coupled multiprocessors, Inter Processor communication network, Time shared bus, Multiport Memory Model, Memory contention and arbitration techniques, Cache coherency and bus snooping, Massively Parallel Processors (MPP).

UNIT-V:
Multithreaded Architecture- Multithreaded processors, Latency hiding techniques, Principles of multithreading, Issues and solutions, Parallel Programming Techniques: Message passing program development.

UNIT-VI:
VLIW processors, Case study: Superscalar Architecture- Pentium, Intel Itanium Processor, Ultra SPARC, MIPS on FPGA, Vector and Array Processor, FFT Multiprocessor Architecture

TEXT BOOKS:

1. Computer Architecture and Parallel Processing, Kai Hwang, Faye A. Briggs, McGraw Hill Education, 2012
2. Advanced Computer Architecture, Kai Hwang, McGraw Hill Education, 1993
3. Computer Organization and Architecture, Designing for Performance, William Stallings, Prentice Hall, 6th Edition, 2006

REFERENCES:

1. Scalable Parallel Computing, Kai Hwang, McGraw Hill Education, 1998
2. High-Performance Computer Architecture, Harold S. Stone, Addison-Wesley, 1993

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M.Tech. II Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PE1VS08) IMAGE AND VIDEO PROCESSING

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To introduce the fundamental differences between image and video processing
- To understand various filtering operations essential for image/video processing
- To introduce the concept of compression with reference to image and video
- To introduce the principles of multi-dimensional estimation with reference to a video signal

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Understand the fundamentals of digital image processing
CO-2: Appreciate the advantages of compression in image /video processing
CO-3: Understand the concepts of video formation, sampling and representation
CO-4: Understand the principles of motion estimation in a video

UNIT-I:
Fundamentals of Image Processing: Basic steps of Image processing system sampling and quantization of an Image – Basic relationship between pixels
Image Transforms: 2 – D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Introduction to wavelet Transform, Continuous wavelet Transform, Discrete wavelet Transform, Filter banks

UNIT-II:
Image Enhancement:
Spatial Domain Methods: Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters
Frequency Domain Methods: Basics of filtering in frequency domain, image smoothing, image sharpening, selective filtering

UNIT-III:
Segmentation: Segmentation concepts, Point, Line and Edge Detection, Edge Linking using Hough Transform, Thresholding, Region Based segmentation.
Morphological Image Processing
Dilation and Erosion, Opening and closing, the hit or miss Transformation, Overview of Digital Image Watermarking Methods

UNIT-IV:
Image Compression: Image compression fundamentals – Coding Redundancy, Spatial and Temporal Redundancy. Compression Models: Lossy and Lossless, Huffmann Coding, Arithmetic Coding, LZW Coding, Run Length Coding, Bit Plane Coding, Transform Coding, Predictive Coding, Wavelet Coding, Wavelet Based Image Compression, JPEG standards.
Image Restoration: Degradation Models, PSF, Circulant and Block - Circulant Matrices, Deconvolution, Restoration Using Inverse Filtering, Wiener Filtering.

UNIT-V:
Basic Steps of Video Processing: Analog video, Digital Video, Time varying Image Formation Models: 3D Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Video Signals, Filtering Operations

UNIT-VI:

2-D Motion Estimation: Optical Flow, General Methodologies, Pixel Based Motion Estimation, Block Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, Multi Resolution Motion Estimation. Waveform based Coding, Block based Transform Coding, Predictive Coding, Application of Motion Estimation in video Coding.

TEXT BOOKS:

1. Digital Image Processing, Gonzaleze and Woods,3rd Ed., Pearson
2. Video Processing and Communication, Yao Wang, Joern Ostermann and Ya-Qin Zhang, I Ed., Prentice Hall

REFERENCES:

1. Digital Video Processing, M. Tekalp, Prentice Hall International

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

M.Tech. II Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PE1ES09) SENSORS AND ACTUATORS

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To provide the ability to understand the operating principles of sensors and transducers
- To appreciate the applications of various sensors and transducers
- To provide the ability to develop an application specific automated system using sensors, actuators and embedded controllers

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Appreciate the operational features of various sensors and actuators
CO-2: Explain the working of a sensor-based measurement system
CO-3: Apply the knowledge of the sensors and actuators in building an application specific automated system

UNIT-I:
Sensors / Transducers: Principles, Classification, Parameters, Characteristics, Environmental Parameters (EP), Characterization
Mechanical and Electromechanical Sensors: Introduction, Resistive Potentiometer, Strain Gauge, Resistance Strain Gauge, Semiconductor Strain Gauges
Inductive Sensors: Sensitivity and Linearity of the Sensor, Types
Capacitive Sensors: Electrostatic Transducer, Force/Stress Sensors Using Quartz Resonators, Ultrasonic Sensors

UNIT-II:
Thermal Sensors: Introduction, Gas thermometric Sensors , Thermal Expansion Type Thermometric Sensors, Acoustic Temperature Sensor, Dielectric Constant and Refractive Index thermo sensors, Helium Low Temperature Thermometer, Nuclear Thermometer, Magnetic Thermometer, Resistance Change Type Thermometric Sensors, Thermo emf Sensors, Junction Semiconductor Types, Thermal Radiation Sensors, Quartz Crystal Thermoelectric Sensors, NQRT Thermometry, Spectroscopic Thermometry, Noise Thermometry, Heat Flux Sensors

UNIT-III:
Magnetic Sensors: Introduction, Sensors and the Principles Behind, Magneto resistive Sensors, Anisotropic Magneto resistive Sensing, Semiconductor Magneto resistors, Hall Effect and Sensors, Inductance and Eddy Current Sensors, Angular/Rotary Movement Transducers, Synchros, Synchro- resolvers, Eddy Current Sensors, Electromagnetic Flow meter, Switching Magnetic Sensors SQUID Sensors

UNIT-IV:
Radiation Sensors: Introduction, Basic Characteristics, Types of Photo sensistors/Photo detectors, X, ray and Nuclear Radiation Sensors, Fiber Optic Sensors
Electro Analytical Sensors: Introduction, The Electrochemical Cell, The Cell Potential, Standard Hydrogen Electrode (SHE), Liquid Junction and Other Potentials, Polarization, Concentration Polarization, Reference Electrodes, Sensor Electrodes, Electro ceramics in Gas Media.

UNIT-V:
Smart Sensors: Introduction, Primary Sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing, Data Communication, Standards for Smart

Sensor Interface, The Automation Sensors ,
Applications: Introduction, On-board Automobile Sensors (Automotive Sensors), Home Appliance Sensors, Aerospace Sensors, Sensors for Manufacturing, Sensors for environmental Monitoring

UNIT-VI:
Pneumatic and Hydraulic Actuation Systems: Actuation systems, Pneumatic and hydraulic systems, Directional Control valves, Pressure control valves, Cylinders, Servo and proportional control valves, Process control valves, Rotary actuators.
Mechanical Actuation Systems: Types of motion, Kinematic chains, Cams, Gears, Ratchet and pawl, Belt and chain drives, Bearings, Mechanical aspects of motor selection.
Electrical Actuation Systems: Electrical systems, Mechanical switches, Solid state switches Solenoids, D.C. Motors, A.C. motors, Stepper motors.

TEXT BOOKS:
1. Sensors and Transducers, D. Patranabis, PHI Learning Private Limited
2. Mechatronics, W. Bolton, Pearson Education Limited

REFERENCES:
1. Sensors and Actuators, D. Patranabis, 2nd Ed., PHI, 2013

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

M.Tech. II Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PE1ES10) HIGH PERFORMANCE NETWORKS

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To introduce the evolution of communication networks and ways of enhancing their performance
- To understand the layered structure of communication networks
- To introduce the concepts of VOIP and VPN networks
- To introduce the concepts of the Network Security and Network Management

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Appreciate various services offered by communication networks
CO-2: Understand the various issues in the design of VOIP and VPN networks
CO-3: Understand the statistics associated with the network traffic
CO-4: Appreciate the functionalities of various layers of a communication network and various stages of network management

UNIT-I:
Types of Networks, Network design issues, Data in support of network design. Network design tools, protocols and architecture. Streaming stored Audio and Video, Best effort service, protocols for real time interactive applications, beyond best effort, scheduling and policing mechanism, integrated services, and RSVP-differentiated services.

UNIT-II:
VoIP system architecture, protocol hierarchy, Structure of a voice endpoint, Protocols for the transport of voice media over IP networks. Providing IP quality of service for voice, signalling protocols for VoIP, PSTN gateways, VoIP applications.

UNIT-III:
VPN-Remote-Access VPN, site-to-site VPN, Tunnelling to PPP, Security in VPN. MPLS operation, Routing, Tunneling and use of FEC, Traffic Engineering, MPLS based VPN, overlay networks-P2P connections.

UNIT-IV:
Traffic Modelling: Little's theorem, Need for modelling, Poisson modelling, Non-poison models, Network performance evaluation.

UNIT-V:
Network Security and Management: Principles of cryptography, Authentication, integrity, key distribution and certification, Access control and fire walls, attacks and counter measures, security in many layers.

UNIT-VI:
Infrastructure for network management, Internet standard management framework – SMI, MIB, SNMP, Security and administration, ASN.

TEXT BOOKS:
1. High-Speed Networks: TCP/IP and ATM Design Principles, Stallings W., Prentice Hall, 1998
2. Communication Networks, Leon Garcia, Widjaja, 7th Reprint TMH, 2002
3. Network Security, Essentials, William Stalling, 4th Edition, Pearson Education Asia Publication, 2011

REFERENCES:

1. Telecommunications Network Design Algorithms, Kershenbaum A., Tata McGraw Hill, 1993
2. Computer Networks: A System Approach, Larry Peterson & Bruce David, Morgan Kaufmann, 2003
3. IP Telephony: The Integration of Robust VoIP Services, Douskalis B.,Pearson Ed. Asia, 2000
4. High-Performance Communication Networks, Warland J., Varaiya P., Morgan Kaufmann, 1996

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

M.Tech. II Semester (ES)	**L**	**T/P**	**C**
	0	**3**	**1.5**

(18PC2ES02) SYSTEM DESIGN WITH EMBEDDED LINUX LABORATORY

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To introduce the principles involved in the development of Linux based systems
- To understand the concepts programmable real time embedded system

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Demonstrate the difference between process and thread with reference to an embedded operating system
CO-2: Develop coding using system calls
CO-3: Appreciate the necessity of Inter Process Communication and synchronization mechanisms
CO-4: Apply the concept of RTOS in the design of real time systems

LIST OF EXPERIMENTS:

Develop a program in Embedded Linux for the following:
1. Create new process using fork ().
2. Communicate between parent and child process using pipes and FIFOs.
3. Develop a program using system calls that is similar to 'cp' command.
4. Create a new thread using POSIX Thread library
5. Develop a program to demonstrate the use of synchronizing access to shared resource using semaphores. (POSIX Thread based)
6. Develop a program to demonstrate the use of synchronizing access to shared resource using mutex (POSIX Thread based)
7. Develop a program to communicate between processes using message queue.
8. Develop a program to demonstrate the use of signaling semaphore for sending event from one thread to another. (POSIX Thread based)

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M.Tech. II Semester (ES)	**L**	**T/P**	**C**
	0	**3**	**1.5**

(18PC2ES03) MACHINE LEARNING AND WIRELESS COMMUNICATION LABORATORY

COURSE OBJECTIVES:
- To learn the principles of patterns with reference to data
- To introduce the applications of machine learning algorithms and techniques
- To explore supervised and unsupervised learning paradigms of machine learning
- To understand the modelling of fading communication channels

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Appreciate the machine learning algorithms and their comparison
CO-2: Understand the Mathematical analysis
CO-3: Apply machine learning algorithms to solve problems of moderate complexity
CO-4: Appreciate the effect of fading on the performance of communication channel

MACHINE LEARNING:

WEEK 1: Import or Export data, Data Visualization and Data shaping.
WEEK 2: Outlier Detection, Data Cleaning
WEEK 3: Classification of Data using Decision Trees.
WEEK 4: Implementing Naive Bayes Algorithm.
WEEK 5: Implementation of K Nearest-Neighborhood Algorithm.
WEEK 6: Implementation of K Means Algorithm.
WEEK 7: Implementation of Support Vector Machine (SVM) Algorithm.
WEEK 8: Implementation of Ensemble Learning.

WIRELESS COMMUNICATION:

WEEK 9: Implementation of collaborative filtering algorithm for recommender system.
WEEK 10: Free Space Propagation – Path Loss Model
WEEK 11: Outdoor Propagation – Okumura Model
WEEK 12: Outdoor Propagation – Hata Model

TEXT BOOKS:
1. Machine Learning With R, Brett Lantz, Second Edition, Packt Publishing, 2015

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M.Tech. II Semester (ES)	**L**	**T/P**	**C**
	0	**4**	**2**

(18PW4ES02) MINI-PROJECT

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Understand the formulated industry / technical / societal problems
CO-2: Analyze and / or develop models for providing solution to industry / technical / societal problems
CO-3: Interpret and arrive at conclusions from the project carried out
CO-4: Demonstrate effective communication skills through oral presentation
CO-5: Engage in effective written communication through project report

COURSE OUTLINE:

- A student shall undergo a mini-project during II semester of the M.Tech. programme.
- A student, under the supervision of a faculty member, shall collect literature on an allotted project topic of his / her choice, critically review the literature, carry out the mini-project, submit it to the department in a prescribed report form.
- Evaluation of the mini-project shall be done by a Project Review Committee (PRC) consisting of the Head of the Department, faculty supervisor and a senior faculty member of the specialization / department.
- Prior to the submission of mini-project report to the PRC, its soft copy shall be submitted to the PG Coordinator for PLAGIARISM check.
- The mini-project report shall be accepted for submission to the PRC only upon meeting the prescribed similarity index.

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M.Tech. II Semester (ES)	**L**	**T/P**	**C**
	2	**0**	**0**

(18AU5EN01) ENGLISH FOR ACADEMIC AND RESEARCH WRITING

COURSE OBJECTIVES:

- To understand the usage of appropriate vocabulary (Formal, Informal, Gender Insensitive etc.)
- To understand the features and processes of academic writing
- To identify the resources
- To understand standard documentation styles

COURSE OUTCOMES: After completion of the course, students should be able to

CO-1: Use appropriate vocabulary (Formal, Informal, Slang, Gender Insensitive etc.)

CO-2: Employ processes of academic writing

CO-3: Identify the resources

CO-4: Understand standard documentation styles

UNIT- I:

Introduction to Research:

i. Identifying the topic
ii. Identifying Sources; Finding Sources
iii. Defining the broad area; Defining the specific area; Difference between a broad area and specific area
iv. Choosing a topic
v. Mechanics of Writing – Language, Tone, Style, Ethics

UNIT-II:

Referencing & Library Skills:

i. Literature Survey
ii. Writing Objectives
iii. Hypothesis
iv. Methodology
v. Prospects for Future Research

UNIT-III:

Academic Writing Skills:

i. Paraphrasing
ii. Summarizing
iii. Quoting
iv. Rewriting
v. Expansion

UNIT-IV:

Kinds of Academic Writing:

i. Essays
ii. Reports
iii. Reviews
iv. SOPs
v. Abstracts
vi. Proposals

UNIT-V:

Research Process:

i. Selection of Topic

ii. Formulation of Hypothesis
iii. Collection of Data
iv. Analysis of Data
v. Interpretation of Data
vi. Presentation of Data

UNIT-VI:

i. Title
ii. Abstract
iii. Introduction
iv. Literature Survey
v. Methodology
vi. Discussion
vii. Findings/Results
viii. Conclusion
ix. Documenting Sources

TEXT BOOKS:

1. Writing for Science, Goldbort R., Yale University Press (available on Google Books), 2006
2. Handbook of Writing for the Mathematical Sciences, Highman N., SIAM. Highman's Book, 1998

REFERENCES:

1. How to Write and Publish a Scientific Paper, Day R., Cambridge University Press, 2006
2. English for Writing Research Papers, Adrian Wall Work, Springer New York Dordrecht Heidelberg London, 2011
3. MLA Handbook for Research

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

M.Tech. III Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18OE1MT01) SELECTED TOPICS IN MATHEMATICS

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To demonstrate accurate and efficient use of specific techniques from the mathematical sciences
- To demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from the mathematical sciences
- To formulate and solve some of problems in natural sciences and engineering by using probabilistic setup

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Characterize and represent data collected from experiments using statistical methods
CO-2: Model physical process/systems with multiple variables towards parameter estimation and prediction
CO-3: Represent systems/architectures using graphs and tree towards optimized objective

UNIT-I:
Probability and Statistics: Conditional probability, Bayes Theorem and independent events. Random Variables: Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, moment generating function, Chebyshev inequality.

UNIT-II:
Special Distributions: uniform, Binomial, Geometric, Poisson, Exponential, Gamma, Normal distributions-Pseudo random sequence generation with given distribution, Functions of a Random Variable

UNIT-III:
Joint Distributions: Joint, marginal and conditional distributions, product moments, correlation, independence of random variables, bi-variate normal distribution.- Stochastic Processes: Definition and classification of stochastic processes, Poisson process - Norms, Statistical methods for ranking data

UNIT-IV:
Multivariate Data Analysis- Linear and non-linear models, Regression Prediction and Estimation, Design of Experiments – factorial method - Response surface method

UNIT-V:
Graphs and Trees: Graphs: Basic terminology, multi graphs and weighted graphs, paths and circuits, shortest path Problems, Euler and Hamiltonian paths and circuits, factors of a graph, planar graph and Kuratowski's graph and theorem, independent sets, graph coloring

UNIT-VI:
Trees: Rooted trees, path length in rooted trees, binary search trees, spanning trees and cut set, theorems on spanning trees, cut sets , circuits, minimal spanning trees, Kruskal's and Prim's algorithms for minimal spanning.

REFERENCES:
1. Probability and Random Process with Applications to Signal Processing, Henry Stark, John W. Woods, 3rd Edition, Pearson Education, 2003

2. Elements of Discrete Mathematics, C. L. Liu, 2nd Edition, Tata McGraw-Hill, 1999
3. Introduction to Linear Regression Analysis, Douglas C. Montgomery, E. A. Peck and G. G. Vining, John Wiley and Sons, 2001
4. Design and Analysis of Experiments, Douglas C. Montgomery, John Wiley and Sons, 2001
5. Random Phenomena: Fundamentals of Probability and Statistics for Engineers, B. A. Ogunnaike, CRC Press, 2010

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

M.Tech. III Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PE1ES11) WIRELESS SENSOR NETWORKS

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES

- To introduce WSN technology and supporting protocols, with an emphasis on standardized sensor systems
- To introduce medium access control protocols and various issues in a physical layer
- To understand the key routing protocols for sensor networks and their design issues
- To understand sensor management in networks and design requirements

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Appreciate various design issues of wireless sensor networks
CO-2: Understand the hardware details of different types of sensors and select the application specific sensor
CO-3: Understand radio standards and communication protocols to be used for wireless sensor networks

UNIT-I:
Introduction and overview of sensor network architecture and its applications, sensor network comparison with Ad Hoc Networks, Sensor node architecture with hardware and software details.

UNIT-II:
Hardware: Examples like mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and Sun SPOT, Software (Operating Systems): TinyOS, MANTIS, Contiki, and RetOS.

UNIT-III:
Programming Tools: C, nesC. Performance comparison of wireless sensor networks simulation and experimental platforms like open source (ns-2) and commercial (QualNet, Opnet)

UNIT-IV:
Overview of Sensor Network Protocols (Details of atleast 2 important protocol per layer): Physical, MAC and routing/ Network layer protocols, node discovery protocols, multi- hop and cluster based protocols, Fundamentals of 802.15.4, Bluetooth, BLE (Bluetooth low energy), UWB.

UNIT-V:
Data Dissemination and Processing: Differences compared with other database management systems, data storage; query processing.

UNIT-VI:
Specialized Features: Energy preservation and efficiency; security challenges; Fault tolerance, Issues related to Localization, connectivity and topology, Sensor deployment mechanisms; coverage issues; sensor Web; sensor Grid, Open issues for future research, and Enabling technologies in wireless sensor network.

TEXT BOOKS:

1. Wireless Sensor Networks Technology, Protocols, and Applications, Kazem Sohraby, Daniel Minoli, Taieb Znati, John Wiley & Sons, 2007
2. Protocols and Architectures for Wireless Sensor Networks, H. Karl and A. Willig, John Wiley & Sons, India, 2012

3. Wireless Sensor Networks, C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors, 1st Indian Reprint, Springer Verlag, 2010

REFERENCES:

1. Wireless Sensor Networks: An Information Processing Approach, F. Zhao and L. Guibas, 1st Indian Reprint, Morgan Kaufmann, 2013
2. Wireless Sensor Network and Applications, Yingshu Li, My T. Thai, Weili Wu, Springer Series on Signals and Communication Technology, 2008
3. Principles of Mobile Communications, Gordon L. Stuber, Springer International, 2nd Edition, 2001

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M.Tech. III Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18PE1VS09) MEMORY TECHNOLOGIES

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To introduce the concepts of memory and its classification
- To understand the issues associated with the selection of application specific memory unit
- To introduce the recent advancements in the design of semiconductor memories

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Select architecture and design semiconductor memory circuits and subsystems
CO-2: Identify various fault models, modes and mechanisms in semiconductor memories and their testing procedures.
CO-3: Knowhow of the state-of-the-art memory chip design

UNIT I:
Random Access Memory Technologies: Static Random Access Memories (SRAMs), SRAM Cell Structures, MOS SRAM Architecture, MOS SRAM Cell and Peripheral Circuit operation, Bipolar SRAM technologies, Advanced SRAM Architectures and technologies, Application Specific SRAMs.

UNIT II:
Dynamic Random Access Memory: DRAM technology Development, MOS DRAM Cell theory and advanced cell structures, Bi-CMOS DRAM, Error Failures in DRAM, Advanced DRAM Design and Architecture, Application Specific DRAMs. SRAM and DRAM Memory controllers.

UNIT III:
Non-Volatile Memories: Masked ROMs, High Density ROM, PROMs, Bipolar ROM, CMOS PROM, EEPROMs, Floating Gate EPROM Cell, One time programmable EPROM, EEPROM technology and architecture, Non-volatile SRAM, Flash Memories.

UNIT IV:
Semiconductor Memory Reliability and Radiation Effects: General Reliability Issues, RAM Failure modes and mechanism, Non-volatile Memory reliability, reliability modeling and failure rate prediction. Design for reliability, Reliability Test structures, screening and qualification, Radiation Effects, Single Event Phenomenon (SEP), Radiation Hardening Techniques, process and design issues. Radiation Hardened Memory Characteristics, Radiation Hardness Assurance and Testing.

UNIT V:
Advanced Memory Technologies and High-density Memory Packing Technologies Ferroelectric Random Access Memories (FRAMs), Gallium Arsenide (GaAs) FRAMs, Analog Memories, Magneto Resistive Random Access Memories (MRAMs), Experimental Memory Devices.

UNIT VI:
Memory Hybrids (2D & 3D), Memory Stacks, Memory MCM Testing and Reliability Issues, Memory Cards, High Density Memory Packaging.

TEXT BOOKS:
1. Advanced Semiconductor Memories: Architectures, Designs and Applications, Ashok K.

Sharma, Wiley-IEEE Press, 2002 (ISBN: 978-0-471-20813-6)
2. VLSI Memory Chip Design, Kiyooltoh, Springer Series, 2001 (ISBN: 978-3-662-04478-0)

REFERENCES:

1. Semiconductor Memories: Technology, Testing and Reliability, Ashok K. Sharma, Wiley-Blackwell, Sep 2002
2. Modern Semiconductor Devices for Integrated Circuits, Chenming C. Hu, 1st Edition, Pearson, April 2009

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M.Tech. III Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18OE1CN01) BUSINESS ANALYTICS

COURSE OBJECTIVES:

- To understand the role of business analytics within an organization and to analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making and to become familiar with processes needed to develop, report, and analyze business data
- To use decision-making tools/Operations research techniques and to manage business process using analytical and management tools
- To analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Apply knowledge of data analytics
CO-2: Think critically in making decisions based on data and deep analytics
CO-3: Use technical skills in predicative and prescriptive modeling to support business decision-making
CO-4: Translate data into clear, actionable insights

UNIT-I:
Business Analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.
Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT-II:
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data Business Analytics Technology.

UNIT-III:
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.
Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT-IV:
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.
Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT-V:

Decision Analysis: Formulating Decision Problems, Decision Strategies without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

UNIT-VI:

Recent trends in Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

TEXT BOOKS:

1. Business Analytics-Principles, Concepts, and Applications, Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press
2. Business Analytics, James Evans, Pearson Education
3. Business Analytics, Purba Halady Rao, PHI, 2013

REFERENCES:

1. Business Analytics for Managers: Taking Business Intelligence Beyond Reporting, Gert H. N. Laursen, Jesper Thorlund, 2nd Edition, Wiley Publications
2. Business Analytics: Data Analysis & Decision Making, S. Christian Albright, Wayne L. Winston 5th Edition, 2015
3. Business Intelligence Guidebook: From Data Integration to Analytics, Rick Sherman Elsevier, 2014

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M.Tech. III Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18OE1AM01) INDUSTRIAL SAFETY

COURSE PRE-REQUISITES: Elements of Mechanical, Civil, Electrical and Industrial Engineering

COURSE OBJECTIVES:

- To achieve an understanding of principles, various functions and activities of safety management
- To communicate effectively information on Health safety and environment facilitating collaboration with experts across various disciplines so as to create and execute safe methodology in complex engineering activities
- To anticipate, recognize, and evaluate hazardous conditions and practices affecting people, property and the environment, develop and evaluate appropriate strategies designed to mitigate risk
- To develop professional and ethical attitude with awareness of current legal issues by rendering expertise to wide range of industries

COURSE OUTCOMES: After completion of the course, students should be able to

CO-1: Apply risk management principles to anticipate, identify, evaluate and control physical, chemical, biological and psychosocial hazards

CO-2: Communicate effectively on health and safety matters among the employees and with society at large

CO-3: Demonstrate the use of state-of-the-art occupational health and safety practices in controlling risks of complex engineering activities and understand their limitations

CO-4: Interpret and apply legislative / Legal requirements, industry standards, and best practices in accident prevention programmes in a variety of workplaces

UNIT-I:

Safety Management: Evaluation of modern safety concepts – Safety management functions – safety organization, safety department – safety committee, safety audit - performance measurements and motivation – employee participation in safety and productivity.

UNIT-II:

Operational Safety: Hot metal Operation – Boiler, pressure vessels – heat treatment shop - gas furnace operation-electroplating-hot bending pipes – Safety in welding and cutting. Cold-metal Operation- Safety in Machine shop-Cold bending and chamfering of pipes – metal cutting – shot blasting, grinding, painting – power press and other machines

UNIT-III:

Safety Measures: Layout design and material handling - Use of electricity – Management of toxic gases and chemicals – Industrial fires and prevention – Road safety– Safety of sewage disposal and cleaning – Control of environmental pollution – Managing emergencies in industrial hazards.

UNIT-IV:

Accident Prevention: Human side of safety – personal protective equipment – Causes and cost of accidents. Accident prevention programmes - Specific hazard control strategies - HAZOP – Training and development of employees – First Aid – Firefighting devices – Accident reporting investigation.

UNIT-V:

Safety, Health, Welfare & Laws: Safety and health standards – Industrial hygiene – occupational diseases prevention - Welfare facilities – History of legislations related to safety–

pressure vessel act- Indian boiler act- The environmental protection act – Electricity act - Explosive act.

UNIT-VI:

Safe Handling and Storage: Material Handling, Compressed Gas Cylinders, Corrosive Substances, Hydrocarbons, Waste Drums and Containers

TEXT BOOKS:

1. Safety Management, John V. Grimaldi and Rollin H. Simonds, All India Travellers Bookseller, New Delhi, 1989.
2. Safety Management in Industry, Krishnan N. V., Jaico Publishing House, 1996.

REFERENCES:

1. Occupational Safety Manual, BHEL
2. Industrial Safety and The Law, P. M. C. Nair Publisher's, Trivandrum
3. Managing Emergencies in Industries, Loss Prevention of India Ltd., Proceedings, 1999
4. Safety Security and Risk Management, U. K. Singh & J. M. Dewan, A. P. H. Publishing Company, New Delhi, 1996
5. Industrial Safety Management: Hazard Identification and Risk Control, L. M. Deshmukh, McGraw-Hill Education (India) Private Limited, 2005

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M.Tech. III Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18OE1AM02) OPERATIONS RESEARCH

COURSE PRE-REQUISITES: Mathematics, Industrial Engineering

COURSE OBJECTIVES:
- To analyze linear programming models in practical and their practical use
- To apply the transportation, assignment and sequencing models and their solution methodology for solving problems
- To apply the theory of games, replacement, inventory and queuing models and their solution methodology for solving problems
- To evaluate the dynamic programming and simulation models

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Apply and solve the dynamic programming problems
CO-2: Apply the concept of non-linear programming
CO-3: Carry out sensitivity analysis
CO-4: Model the real-world problem and simulate it

UNIT-I:
Introduction to Operations Research-Definitions of OR, Characteristics of OR, Scope of OR, Classification of Optimization Techniques, models in OR, General L.P Formulation, Graphical solution, Simplex Techniques.

UNIT-II:
Revised simplex method - duality theory - dual simplex method – sensitivity or post optimality analysis - parametric programming

UNIT-III:
Nonlinear programming problem - Kuhn-Tucker condition, min cost flow problem - max flow problem - CPM/PERT

UNIT-IV:
Scheduling and sequencing, Inventory models, deterministic inventory, models - Probabilistic inventory control models - Geometric Programming.

UNIT-V:
Waiting line Models, Single and Multi-channel Problems, Dynamic Programming, Game Theory, Simulation.

UNIT-VI:
Introduction to Genetic Algorithms, Operators, applications to engineering optimization, Problems.

TEXT BOOKS:
1. Operations Research, S. D. Sharma, Kedarnath Ramnath, Meerut, New Delhi
2. Engineering Optimization, S. S. Rao, New Age International Publications, 2014
3. Introduction to Genetic Algorithms, S. N. Sivanandam, Springer

REFERENCES:
1. Operations Research-An Introduction, H. A. Taha, PHI, 2008
2. Principles of Operations Research, H. M. Wagner, PHI, Delhi, 1982
3. Introduction to Optimization: Operations Research, J. C. Pant, Jain Brothers, Delhi, 2008

4. Operations Research, Hitler Liebermann McGraw-Hill Pub., 2009
5. Operations Research, Pannerselvam, Prentice Hall of India, 2010

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M.Tech. III Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18OE1AM03) COMPOSITE MATERIALS

COURSE PRE-REQUISITES: Maths, Physics, Chemistry, Engineering Mechanics, Mechanics of Solids

COURSE OBJECTIVES:
- To understand composite materials and their properties, relationship between them and manufacturing methods
- To understand the principles of material science applied to composite materials
- To study the equations to analyze problems by making good assumptions and learn systematic engineering methods to solve practical composite mechanics problems

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Apply fundamental knowledge of mathematics to modeling and analysis of composite materials
CO-2: Understand the manufacturing methods of various composite materials
CO-3: Analyze the failure modes of composites

UNIT-I:
Introduction: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT-II:
Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements.
Mechanical Behavior of Composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT-III:
Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications.
Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT-IV:
Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications, Introduction to Machining of Composites.

UNIT-V:
Elastic Behavior of Laminate: Basic assumptions, Strain-displacement relations, Stress-strain relation of layer within a laminate, Force and moment resultant, General load–deformation relations, Analysis of different types of laminates

UNIT-VI:
Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first ply failure-insight

strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TEXT BOOKS:

1. Material Science and Technology, Vol. 13–Composites, R. W. Cahn – VCH, West Germany
2. Analysis and Performance of Fiber Composites, Third Edition, B. D. Agarwal, Wiley Publishers

REFERENCES:

1. Mechanics of Composite Materials, Second Edition. Robert M. Jones, Scripta Book Company
2. Materials Science and Engineering-An Introduction, W. D. Callister Jr., Adapted by R. Bala Subramaniam, John Wiley & Sons, NY, Indian Edition, 2007
3. Composite Materials, K. K. Chawla
4. Composite Materials Science and Applications, Deborah D. L. Chung
5. Composite Materials Design and Applications, Danial Gay, Suong V. Hoa and Stephen W. Tasi

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M.Tech. III Semester (ES)	**L**	**T/P**	**C**
	3	**0**	**3**

(18OE1PS01) WASTE TO ENERGY

COURSE PRE-REQUISITES: None

COURSE OBJECTIVES:
- To create awareness in students of energy conservation
- To identify the use of different types of Bio waste energy resources
- To understand different types of bio waste energy conservations
- To detect different waste conversion into different forms of energy

COURSE OUTCOMES: After completion of the course, students should be able to
CO1: Find different types of energy from waste to produce electrical power
CO2: Estimate the use of bio waste to produce electrical energy
CO3: Understand different types of bio waste and its energy conversions
CO4: Analyze the bio waste utilization to avoid the environmental pollution

UNIT-I:
Introduction to Energy from Waste: Classification of waste as fuel, Agro based, Forest residue, Industrial waste, MSW (Municipal solid waste) – Conversion devices – Incinerators, Gasifiers, Digestors

UNIT-II:
Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT-III:
Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT-IV:
Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT-V:
Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion.

UNIT-VI:
Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

TEXT BOOKS:
1. Biogas Technology-Transfer and Diffusion, M. M. EL-Halwagi, Elsevier Applied Science Publisher, New York, 1984
2. Introduction to Biomass Energy Conversions, Sergio Capareda

REFERENCES:

1. Non-Conventional Energy, Desai Ashok V., Wiley Eastern Ltd., 1990
2. Biogas Technology - A Practical Handbook, Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw-Hill Publishing Co. Ltd., 1983
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996

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M.Tech. III Semester (ES)	**L**	**T/P**	**C**
	0	**16**	**8**

(18PW4ES03) PROJECT PART-I

M.Tech. IV Semester (ES)	**L**	**T/P**	**C**
	0	**28**	**14**

(18PW4ES04) PROJECT PART-II

COURSE OUTCOMES: After completion of the course, students should be able to
CO-1: Identify and formulate the problem (Industry/technical/societal)
CO-2: Analyze, design and develop a solution to industry/technical/societal problems
CO-3: Implement and execute the solution
CO-4: Demonstrate effective communication skills through oral presentation
CO-5: Engage in effective written communication through project report

COURSE OUTLINE:

- M.Tech. project work shall be for a minimum duration of 40 weeks spread over two semesters i.e., Project Part-I in III semester and Project Part-II in IV semester.
- A student shall be permitted to register for the major project after satisfying the attendance requirement in all the courses, i.e., theory and practical courses.
- Project reviews namely Project Review I and Project Review II in III semester and Project Review III and Project Pre-submission Seminar in IV semester shall be conducted during the course of Project work.
- A Project Review Committee (PRC) consisting of the Head of the Department as Chairperson and PG Coordinator, Project Supervisor and one senior faculty member of the Department offering the M. Tech. programme as members shall evaluate the progress of project work.
- In Project Review I, a student, in consultation with his Project Supervisor, shall present the title, objective and plan of action of his/her project work to the PRC for approval within four weeks from the commencement of III semester.
- A student can initiate the project work only after obtaining the approval of the PRC.
- The work on the project shall be initiated at the beginning of the III semester.
- Project Review II shall be conducted and evaluated at the end of the III semester.
- Project Review III shall be conducted during IV semester to examine the overall progress of the project work.
- A project pre-submission seminar shall be conducted to decide whether or not the project is eligible for final submission.
- After approval from the PRC, a soft copy of the thesis shall be submitted for PLAGIARISM check to the Examination Branch.
- At the end of IV semester upon fulfilling the above conditions, project viva-voce shall be conducted.
- A student shall submit project progress in prescribed report format during each of the project reviews.