SHRI DHARMASTHALA MANJUNATHESHWARA COLLEGE OF ENGINEERING & TECHNOLOGY, DHARWAD – 580 002

Electronics & Communication Engineering

UG Syllabus of courses having focus on employability/entrepreneurship/ skill development

18UHUC500 Management, Entrepreneurship & IPRs (4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

This course focuses on concepts of Entrepreneurship, concepts of Management and about the Intellectual Property Rights. Entrepreneurship part discusses about meaning of Entrepreneurship, Business ideas, family business and doing business in India. Management part discusses about Planning, Forecasting, Organizing & Staffing, Motivating and Controlling. Intellectual Property Rights part discusses various legal aspects of Patents, Trademarks and Copyright.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Understand** the concept of Entrepreneurship and Business ideas.	12	6	-
CO-2	**Describe** about family business in India and doing business in India	12	6	-
CO-3	**Discuss** Management principles/process and illustrate Planning and Organizing.	-	11	-
CO-4	**Analyze** aspects of Motivating and Controlling functions of Management.	-	6	-
CO-5	**Discuss** about the legal aspects of Intellectual Property Rights: Patents, Trade Marks and Copyright.	8	12	7

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	-	-	-	-	-	2.0	1.0	3.0	-	-	2.0	2.7	**-**	**-**

Contents:

Unit-I

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Entrepreneurship

Understanding Entrepreneurship: Introduction, Definition, Role of an Entrepreneur, Reasons for growth of Entrepreneurship, Age of an Entrepreneurial firm, Why start a business, Entrepreneurial Characteristics & Skills, Types of Entrepreneurs, Entrepreneurial failure.

Growth of a Business Idea: Introduction, New Business Idea, Pre-selection process, Sources of Business Ideas, Preliminary Research, Business Idea Evaluation, Other analysis.

Family Business: Introduction, Family Business in India, The Founder, The Next Generation, Entry of Family Members, Non-family Managers, Succession, Best Practices. **11 Hrs**

Unit-II

Doing Business in India: Introduction, Major Issues, Types of Organizations, Legal Compliances.

Entrepreneurial Support: Introduction, Policies, Business Incubation, Business Clusters.

Management Planning, Forecasting and Decision Making: Nature of Planning, the foundation of planning, some planning concepts, forecasting, nature of decision making, management science, tools for decision-making. 11 Hrs

Unit-III

Organizing and staffing: nature of organizing, traditional organizational theory, technology and modern organization structures, staffing technical organization, authority and power; delegation, meeting & committees.

Motivating: Motivation, leadership, motivating and leading technical professionals. **10 Hrs**

Unit-IV

Controlling: process of control, financial controls, and non-financial controls.

Intellectual Property Rights

Patents: Introduction, Protectable Subject Matter-Patentable Invention, Procedure for Obtaining Patent, Provisional and Complete Specification, Rights conferred on a Patentee, Transfer of Patent, Revocation and Surrender of Patents, Infringement of Patents. **10 Hrs**

Unit-V

Trade Marks: Introduction, Statutory Authorities, Principles of Registration of Trade Marks, Rights conferred by Registration of Trade Marks, Infringement of Trade Marks and Action against Infringement, Procedure of Registration and Duration.

Copyright: Introduction, Author and Ownership of Copyright, Rights conferred by Copyright, Term of Copyright, Assignment/License of Copyright, Infringement of Copyright, Infringement in Literary, Dramatic and Musical Works. **10 Hrs**

Reference Books:

1) Rajeev Roy, “Entrepreneurship”, 2nd Edition, 2011, Oxford University Press, New Delhi.
2) Daniel L Babcock, Lucy C Morse, "Managing Engineering and Technology"

Third Edition, 2005, Prentice Hall of India Pvt. Ltd., New Delhi.
3) Wadehra B. L.,"Law relating to Intellectual Property",4th Edition, 2012, Universal Law Publishing Co. Pvt. Ltd., Delhi.
4) N. K. Acharya, "Text book on Intellectual Property Rights" Asia Law House, Hyderabad, 4th Edition.

18UECE512	Scientific Computing using Python	(3-0-0)3

Contact Hours: 39

Course Learning Objectives (CLOs):

The course focuses on programming concepts in Python. It includes basic numerical algorithms covering interpolation, integration, differentiation, ordinary differential equations (ODE) and partial differential equations (PDE) solvers, and basic linear algebra.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1,12)/ PSOs (13, 14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Examine** Python syntax and semantics and use the Python flow control and functions.	-	1,2,13	3
CO-2	**Write** Python scripts for plotting functions and understand the core data structures like Lists, Dictionaries.	-	1,2,3	12,5
CO-3	**Understand and apply** the basic array methods to statistical problems.	-	1,2,3	12
CO-4	**Implement** the codes for manipulating the polynomials, matrices and understand the basics of Matplotlib.	-	1,2,3	12,5
CO-5	**Solve** the Integration and ordinary differential equations, and perform interpolation.	-	1,2,3	12

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2	2	1.8	-	1	-	-	-	-	-	-	1	2	-

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Pre-requisites: Programming Fundamentals

Contents:

Unit-I

The core Python language I: Introduction, The Python shell, Numbers, variables, comparisons and logic, Python objects I: strings, Python objects II: lists, tuples and loops, Control flow, File input/output, Functions. **08 Hrs**

Unit-II

Simple plotting with Pylab: Basic plotting, Labels, legends and customization, more advanced plotting.

The core Python language II: Errors and exceptions, Python objects III: dictionaries and sets, Pythonic idioms: "syntactic sugar", Modules and packages, An introduction to object-oriented programming. **08 Hrs**

Unit-III

Numpy I: Basic array methods: Creating an array, NumPy's basic data types, universal functions and special values, changing the shape of an array, indexing and slicing an array, sorting an array, structured arrays, arrays as vectors, Reading and writing an array to a file, Statistical methods: ordering statistics, averages, variance and correlations, histograms. **07 Hrs**

Unit-IV

Numpy II: Polynomials: defining and evaluating a polynomial, polynomial algebra, root finding, calculus, fitting polynomials, Linear algebra: basic matrix operations, Eigen values and Eigen vectors, solving equations, Matrices: creating a matrix, matrix operations.

Matplotlib: Matplotlib basics, bar charts and pie charts, multiple subplots. **09 Hrs**

Unit-V

SciPy: Integration: definite integrals of a single variable, integrals of two or more variables, Ordinary differential equations: single 1^{st} order ODE, single 2^{nd} order ODE, Interpolation: univariate and multivariate interpolations. **07 Hrs**

Reference Books:

1) Christian Hill, "Learning Scientific Programming with Python", Cambridge University Press, 2015.
2) Sandeep Nagar, "Introduction to Python for Engineers and Scientists: Open Source Solutions for Numerical Computation", Apress Publication, 2018.
3) T.R. Padmanabhan, "Programming with Python", Springer, 2016.
4) Allen B. Downey, "Think Python", Second Edition, O'Reilly Publication, 2015.

18UECC500	CMOS VLSI Design	(4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on the theory, fabrication and design principles of CMOS devices and circuits. The course concentrates on the study and analysis of various combinational and sequential MOS logic circuits for digital VLSI applications.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Explain** the theory, construction and the characteristics of MOS structures and logic circuits.	-	-	1,2,13
CO-2	**Elaborate** the steps and processes involved in the VLSI fabrication technology.	-	-	1,2,4
CO-3	**Apply** design rules to design layout of various digital VLSI circuits.	5	1,2	3,9
CO-4	**Estimate** the parasitics for various MOS layouts.	-	1	2
CO-5	Perform a **comparative** study of different MOS circuit technologies.	2	4,13	1,5,9

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	1.4	1.6	1	1.5	2	-	-	-	1	-	-	-	1.5	-

Pre-requisites: Semiconductor Devices, Analog Electronic circuits, Digital Electronic circuits

Contents:

Unit-I

MOS Transistor: Metal Oxide Semiconductor (MOS) Structure, MOS System under External Bias, Structure and Operation of MOS Transistor, MOSFET Current-Voltage Characteristics, MOSFET Scaling and Small-Geometry Effects. Introduction to FinFET.

MOS Inverters: Static Characteristics: Introduction, Resistive-Load Inverter, Inverters with n-Type MOSFET Load, CMOS Inverter. **10 Hrs**

Unit-II

Fabrication Technology: Introduction, Czochralski growth process, Fabrication processes: Thermal oxidation, Diffusion, Ion implantation, Photo lithography,

Epitaxy, Metallization and interconnections, Ohmic and Schottky contacts, fabrication of resistors and capacitors.

Basic CMOS Technology: Basic CMOS technology: P-Well / N-Well / Twin Well process, MOS mask layer, stick diagrams, Lambda based design rules, Schematic and Layouts **10 Hrs**

Unit-III

Basic Circuit Concepts: Sheet resistance, standard unit capacitance, concepts delay unit time, Inverter delays, driving capacitive loads, Propagation delays, PVT analysis and Process corners, RC delay, Elmore Delay, Logical Effort, Electrical Effort, Parasitic delay, Non-ideal delay, Examples **12 Hrs**

Unit-IV

Combinational MOS Logic Circuits & Sequential MOS Logic Circuits: Introduction, MOS logic circuits with depletion nMOS loads, CMOS logic circuits, complex logic circuits, CMOS Transmission gate, Introduction to sequential MOS logic circuits, Behavior of bi-stable elements, SR latch circuit, clocked latch and flip flop circuits **10 Hrs**

Unit-V

Dynamic Logic Circuits: Introduction, Basic principles of Pass transistor circuits, voltage bootstrapping, synchronous dynamic circuit techniques, dynamic CMOS circuit techniques, high performance dynamic CMOS circuits, Semiconductor Memories. **10 Hrs**

Reference Books:

1) Sung Mo Kang & Yusuf Leblebici, “CMOS Digital Integrated Circuits: Analysis and Design”, 3/e, McGraw-Hill, 2008.
2) Kanaan Kano, “Semiconductor Devices”, 3/e,Pearson education, 2004.
3) Douglas A Pucknell & Kamran Eshragian, “Basic VLSI Design”, 3/e, PHI, 2005.
4) Michael John Sebastian Smith “Application Specific Integrated Circuits”, Pearson Publication, 2013.

18UECE622	Data Structures using C++	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The course deals with the basics of data structures. Linked lists, stack, queues and trees etc. are included. An introductory chapter on pointers helps in the knowledge of data structures. Real life examples enhance the effectiveness of the course.

Course Outcomes (COs):

Description of the Course Outcome:	Mapping to POs(1,12)/

At the end of the course the student will be able to:		PSOs (13,14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	**Apply** various concepts of C++ such as Arrays, Strings, Structures, Unions, Files, Pointers and Functions in solving problems.	-	1,2,13	3
CO-2	**Understand and Implement** the operational aspects of linked lists (using pointers) such as creation, insertion, deletion and searching in problem solving.	-	1,2,3	5,12
CO-3	**Realize and Implement** the operational aspects of stack in problem solving using Arrays and Pointers.	-	1,2,3	12
CO-4	**Implement** the operational aspects of queue in problem solving using Arrays and Pointers**.**	-	1,2,3	5,12
CO-5	**Implement** the operational aspects of trees using Arrays and Pointers, and Hash concept in problem solving.	-	1,2,3	5,12

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	2	2	1.8	-	1	-	-	-	-	-	-	1	2	-

Pre-requisites: Object Oriented Programming using C++

Contents:

Unit-I

Structure, unions and Pointer Revisit: Motivation for using structures. Pointer, access data from memory through pointer, pointer to structures. Motivation for dynamic memory requirement. Realizing arrays using pointer and dynamic memory allocation. Importance of memory management during allocation and de-allocation of memory. **07 Hrs**

Unit-II

Lists: Constructing dynamic data structures using self-referential structure (using the same realized linked Lists), operations on lists. Doubly Linked list. Application of Lists in sorting. **08 Hrs**

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Unit-III

Stack: Realization of stack and its operations using static and dynamic structures. Application of stack in converting an expression from infix to postfix and evaluating a postfix expression, Heterogeneous stack using Unions. **08 Hrs**

Unit-IV

Queues: Realization of queues (FIFO, Double-ended queue, Priority queue) and its operations using static and dynamic data structures. **07 Hrs**

Unit-V

Trees: Types of trees and their properties, Realization of trees using static and dynamic data structures. Operations on Binary trees and their application in searching (BST and AVL Tree), Binary heap as priority.

Hash Table: Realizing effective hash table with proper data structure and hash function, its application. **09 Hrs**

Reference Books:

1) Aaron M. Tenenbaum, Yedidyah Langsam and Moche J. Augenstein, "Data Structures using C & C ++" , Pearson Education / PHI, 2006
2) E. Balagurusamy, "Programming in ANSI C", 4th edition, Tata McGraw Hill, 2008.
3) Behrouz A. Foruzan and Richard F. Gilberg, "Computer Science: A Structured Programming Approach Using C", 2nd edition, Thomson, 2003.
4) Robert Kruse and Bruce Leung, "Data structures and Program Design in C", Pearson Education, 2007.

18UECE623 Artificial Intelligence (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

This course focusses on overview of the main concepts in Artificial Intelligence (AI), algorithms applied in construction of intelligent systems, agents, problem solving, search, representation, reasoning, planning, communication, perception, robotics and neural networks.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Discuss** the basic concepts and characteristics of AI with illustrations of current state of the art research, solving real world problems with	14	2,3,4	1

	searching approaches.			
CO-2	**Explain** the strengths and limitations of various state-space search algorithms along with knowledge representation, planning and constraint management.	11	1,2,3,4	13
CO-3	**Identify** the type of an AI problem with search inference, decision making under uncertainty, game theory, etc.	-	2,5	13
CO-4	**Apply** basic principles of AI in solutions that require different forms of learning and decision trees.	-	6,12,14	-
CO-5	**Demonstrate** different language models, steps in Natural language Processing (NLP) and expert systems.	-	14	-

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	1.5	2	3	4	2	2					3	2	1	2

Pre-requisites: Discrete Mathematics, basic probability theory and Statistics Knowledge of any programming language and data structures.

Contents:

Unit-I

Introduction: Introduction and Intelligent systems, What Is AI, The Foundations of Artificial Intelligence, The History of Artificial Intelligence, Applications of A.I. Intelligent Agents: Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents, How the components of agent programs work.

Solving Problems by Searching: Study and analysis of various searching algorithms. Implementation of Depth-first search Problem Solving Agents, Searching for Solutions, Uninformed and informed Search Strategies. **09 Hrs**

Unit-II

Local Search Algorithms and Optimization Problems: Local Search in Continuous Spaces, Searching with Nondeterministic Actions, Searching with

Partial Observations, Introduction to adversarial Search and constraint satisfaction problems with examples.

Logical Agents: Knowledge agents, first-Order Logic, Inference to First-Order Logic, Classical planning, Planning and acting in the real world, knowledge representation. **08 Hrs**

Unit-III

Quantifying Uncertainty: Acting under Uncertainty, Basic Probability Notation, Inference Using Full Joint Distributions, Bayes' Rule and Its Use, Representing Knowledge in an Uncertain Domain, Other Approaches to Uncertain Reasoning, Rule-based methods for uncertain reasoning, representing vagueness: Fuzzy sets and fuzzy logic, Study of fuzzy logic and Decision trees, Implementation aspects of Decision trees. **07 Hrs**

Unit-IV

Learning from Examples: Forms of Learning, Supervised Learning, Learning Decision Trees, The decision tree representation, Expressiveness of decision trees, inducing decision trees from examples. **08 Hrs**

Unit-V

Natural Language Processing: Language Models, Steps in NLP, Syntactic Analysis (Parsing), Semantic interpretation, Discourse and pragmatic Processing, Text Classification. Discourse and pragmatic 24 Processing, Implementation aspects of Syntactic Analysis (Parsing)

Expert Systems: What is Expert system, Components of Expert System, Case studies on Expert System. **07 Hrs**

Reference Books:

1) Stuart Russell, Peter Norvig**,** "Artificial Intelligence: A Modern Approach" by Pearson 3rd Edition, 2015.
2) Elaine Rich, Kevin Knight, Shivashankar B. Nair, "Artificial Intelligence", Tata McGraw-Hill Education Pvt. Ltd, 3rd Edition, 2017.
3) Saroj Kausik, "Artificial Intelligence", Cengage Learning, 1st edition, 2011.
4) N P Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press, 2005.

18UECO632	Automotive Electronics	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The course focuses on Electronic Engine control system, construction and operation of sensors and actuators, role of electronics in vehicle motion control, instrumentation and advanced features for safety and comfort in vehicles.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Explain** various parts and operation of automobile system, electronic control system and microcomputer system.	-	1	-
CO-2	**Explain** and **apply** control system approach to Engine control and **define** various performance parameters.	3	7	2
CO-3	**Describe** the construction and operation of various sensors and actuators used in automotive control applications.	-	5	13
CO-4	**Analyze** and **Explain** vehicle motion control system and automotive instrumentation systems.	-	2	14
CO-5	**Describe** various advanced electronic features, communication protocols and diagnostics	6	4	12

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.0	1.5	3.0	2.0	2.0	3.0	2.0	-	-	-	-	1.0	1.0	1.0

Pre-requisites: Basics of Automobiles and Engines, Analog and Digital Electronic Circuits, Control systems and microcontrollers.

Contents:

Unit-I

Automotive Fundamentals: Evolution of Automotive Electronics, Automobile Physical configuration, The SI Engine and its operation, Engine control, Ignition system, Diesel Engine, Hybrid vehicle configuration, Drive Train, Brakes, Suspension, Steering System

Control System Approach: Open loop and closed loop control systems, Proportional Controller, Proportional-Integral controller, Closed Loop Limit Cycle control**.**

Microcomputer Systems: Microcontroller applications in automotive systems, Instrumentation applications of microcomputers, Microcomputers in control systems. **08 Hrs**

Unit-II

Basics of Electronic Engine Control: Motivation for electronic engine control, Government Test procedures, Concept of an electronic engine control system, Definition of General Terms and Engine performance terms, Engine Mapping, Control Strategy, Electronic fuel control system, Analysis of intake manifold pressure, Idle speed control, Electronic Ignition. **08 Hrs**

Unit-III

Sensors and Actuators: Control system applications of sensors and actuators, Airflow rate sensors, Engine Crankshaft angular position sensors, Throttle angle sensor, Temperature Sensors, Sensors for feedback control, Knock sensors, Engine control actuators, variable valve Timing. **08 Hrs**

Unit-IV

Vehicle Motion Control: Typical Cruise control system, Cruise control electronics, Antilock braking System, Electronic Suspension system, Electronic steering control.

Automotive Instrumentation: Modern Automotive Instrumentation, Input and Output Signal Conversion, Sampling, Fuel Quantity measurement, Coolant Temperature measurement, Oil Pressure measurement, Vehicle Speed measurement. **08 Hrs**

Unit-V

Advanced Automotive Electronic Systems: Occupant Protection Systems, Collision avoidance RADAR warning system, Low Tyre-pressure warning system, Sensor and Control Signal Multiplexing, Navigation.

Communication Protocols: CAN protocol, LIN protocol. **07 Hrs**

Reference Books:

1) William B. Ribbens, “Understanding Automotive Electronics”, 6/e, Newnes,2003
2) A. K. Babu, “ Automotive Electrical and Electronics”, 2/e, Khanna publishing,2016
3) Tom Denton, “Automobile Electrical and Electronic Systems”, 5/e, Institute off Motor Industry, 2017
4) Najamuz Zaman, “Automotive Electronics Design Fundamental’’ first edition, Springer 2015.

18UECC701	Computer Communication Networks	(4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on the process of data communication in computer network through the layered architecture. It also deals with the IEEE standards and various protocols at different layers.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Exploring** layered architecture in OSI and TCP/IP network models and **Explain** the functionalities of layers.	-	1	-
CO-2	**Analyze** and **compare** various protocols for framing, error and flow control and medium access.	1,2	3,14	-
CO-3	**Identify** the IEEE standards for wired and wireless networking and **discuss** the significance of connecting devices in networking.	-	1,3	2
CO-4	**Understand** IPv4 and IPv6 addressing in internetworking and **identify** the need for transition from IPv4 to IPv6	2,3	1	-
CO-5	**Analyze and compare** different routing protocols in network layer and protocols for process to process delivery of information in transport layer.	-	2,3	4

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	2.25	2.25	2.25	1.0		-	-	-	-	-	-	-	-	2

Pre-requisites: Basics of communication.

Contents:

Unit-I

Introduction to computer networks: Data Communication, Networks, The Internet, Protocols and Standards.

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Network Models: Layered tasks, OSI Model, Layers in OSI model, TCP/IP Protocol Suite, Addressing levels

Using Telephone and cable networks for data transmission: Telephone networks, Dial up modem, DSL, Cable TV for data transmission.

10Hrs

Unit-II

Data Link Control: Framing, Flow and error control, Noiseless channels and noisy channels, Protocols Piggybacking

Multiple Access protocol: Random access, Controlled access, Channelization.

11 Hrs

Unit-III

Wired LANs - Ethernet: IEEE standards, Standard Ethernet, Changes in the Standards.

Wireless LANs: IEEE 802.11, Bluetooth.

Connecting LANs, Backbone Networks and Virtual LANs: Connecting devices, Back bone Networks, Virtual LANs **10 Hrs**

Unit-IV

Network Layer: Logical addressing Ipv4 addresses, classful and classless addressing, network address translations (NAT),Ipv6 addresses, Internetworking, Ipv4, Ipv6, Transition from Ipv4 to Ipv6. **10 Hrs**

Unit-V

Network Layer - Delivery, Forwarding and Routing: Delivery, Forwarding techniques, Unicast Routing Protocols, distance vector routing, link state routing.

Transport layer-Process to process Delivery, User Datagram Protocol (UDP), Transmission Control Protocol (TCP). **11Hrs**

Reference Books:

1) B. Forouzan, **"Data Communication and Networking"**, 4th Edition, TMH, 2006.
2) James F. Kurose, Keith W. Ross "**Computer Networks"**, Pearson Education, 2nd Edition, 2003.
3) Wayne Tomasi, **"Introduction to Data communication and Networking"**, Pearson Education, 2007.
4) Andrew S. Tanenbaum, "**Computer Networks**", 4th Edition, Pearson Education, 2009.

18UECC800	Wireless Communication	(4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on evolution of wired Telecommunication, comparison of wireless1G, 2G, 3G, LTE,4G and 5G Networks, its advantages/ applications. It covers cellular structure, capacity expansion methods, modulation techniques with mathematical description for their parameters and its Hardware and IEEE standards with respect to 4G technology.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Discuss** the evolution and history of wireless technology and **compare** different mobile Networks along with their common System components.	-	3,4,5,13	1,2,10,12
CO-2	**Apply** the cellular concepts such as frequency reuse, handoff to **evaluate** the signal reception and Performance of cellular systems.	13	4,5,14	1,2,3,10, 12
CO-3	**Explain** the GSM techniques and its architecture with time slot structures and **study** different traffic case operations and protocol stack in GSM.	-	4,5	1,2,3,10, 12
CO-4	**Analyze** CDMA techniques with their channel structures and **scrutinize** future mobile communication networks.	-	5,6,7	1,2,3,4,10, 12
CO-5	**Describe** modulation techniques in wireless networks and **Explain** IEEE standards and protocols of Wireless networks	-	5,6,7	1,2,3,4,10, 12

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	1	1	1.2	1.6	2	2	2	-	-	1	-	1	2.5	2

Pre-requisites: Analog Communication, Digital Communication

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Contents:

Unit-I

Introduction to Wireless Communication: Introduction to wireless communication systems and networks, history and evolution, different generations of wireless cellular networks, 1G, 2G, 3G and 4G networks.
Cellular System: Common cellular system components, common cellular network components, hardware and software, views of cellular networks, 3G cellular systems components, and cellular component identification call establishment.

12 Hrs

Unit-II

Cellular structure and fundamentals: Wireless network architecture and operation, cellular concept, cell fundamentals, capacity expansion techniques, mobility management, radio sources and power management, wireless network security, SS7. **09 Hrs**

Unit-III

Second Generation mobile system: GSM and TDMA techniques, GSM system, overview, GSM network and system architecture, GSM channel classifications & concepts, GSM identifiers.
GSM system operation: System Operation traffic cases, call handoff, roaming, GSM protocol architecture, TDMA systems. **12 Hrs**

Unit-IV

Third, Fourth and Fifth Generation mobile system: CDMA technology CDMA overview, CDMA channel concept, CDMA operations. LTE and 4G architectures and their comparisons, Introduction to 5G and its features. **9 Hrs**

Unit-V

Modulation Techniques: Wireless modulation techniques and hardware, characteristics of air interface, path loss models, wireless coding techniques, digital modulation techniques, OFDM, UWB radio techniques, diversity techniques, demonstration of typical GSM, CDMA hardware.
IEEE standards: Introduction to wireless LAN, 802.11X technologies, introduction to 802.15X, technologies in PAN applications, Introduction to Bluetooth model, introduction to broadband wireless MAN, 802.16X technologies, Black Berry Handsets. **10 Hrs**

Activity beyond Syllabus:
BSNL exchange visit

Reference Books:

1) Mullet,"Wireless Telecommunication Systems and networks", Thomson Learning 2006.
2) Lee W.C.Y," Mobile Cellular Telecommunication",MGH,2002.

3) D.P. Agrawal," Wireless communication",2/e, Thomson Learning,2007.
4) T.S. Rappaport," Wireless Communications", principles &practice, 3/e, Pearson Education,2008.

18UECE713	Optical Fiber Communication	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The course focuses on principles of Optical Fiber Communication, devices involved in communication system and challenges in Optical Fiber Communication networks.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Classify** the structures of Optical fiber and types and **Calculate** their different parameters in single mode and Multimode operation.	13	-	1
CO-2	**Illustrate** the optical fiber channel impairments and **analyze** various types of optical fiber coupling losses.	4,13	1,2	-
CO-3	**Discuss** different Optical sources and detector swith their principles and **analyze** link power and rise time budget schemes for optical fiber links.	4,13	2,3	1
CO-4	**Describe** the working principles of WDM with different active and passive devices of optical fiber link.	3,13	1,2	-
CO-5	**Explain** concepts, working principles of different types of optical networks andtheirstructures.	-	3,13	1,2,12

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	1.5	1.75	2.33	1.5								1	2.8	

Pre-requisites: Optical physics, Analog Communication, Digital Communication

Contents:

Unit-I

Optical fiber Communications: Historical development, The general system, Advantages of optical fiber communication, Optical fiber wave guides: Ray theory transmission, Modes in planar guide, Phase and group velocity, And Cylindrical fiber: Modes, Step index fibers, Graded index fibers, Single mode fibers, Cutoff wavelength, Mode field diameter, effective refractive index. Fiber Materials, Photonic cystalfibers (PCF)

09 Hrs

Unit-II

Transmission characteristics of optical fiber: Attenuation, Material absorption losses, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, Dispersion, Chromatic dispersion, Intermodal dispersion: Multimode step index fiber. Optical Fiber Connectors: Fiber alignment and joint loss, Fiber splices, Fiber connectors, Fiber couplers. **09 Hrs**

Unit-III

Optical sources: Energy Bands, Direct and Indirect Band gaps, Light Emitting diodes: LED Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation. Laser Diodes: Modes and Threshold conditions, Rate equation, External Quantum Efficiency, Resonant frequencies, Laser Diode structures and their principles.

Photo detectors: Physical principles of Photodiodes, Photo detector noise, Detector responsetime. **07 Hrs**

Unit-IV

Optical Receiver: Optical Receiver Operation: Error sources, Receiver sensitivity, Quantum Limit, Introduction, point–to–point links, System considerations, link power budget, rise-time budget calculations. Short wavelength band and transmission distance for single mode fibers, Power penalties, nodal noise and chirping.

Analog Links: Analog links — Introduction, overview of analog links, CNR, multichannel transmission techniques, key link parameters, Radio over fiber links, microwave photonics. **07 Hrs**

Unit-V

WDM Concepts and Components : Overview of WDM, Operational Principles of WDM, WDM standards, Multiplexers, Isolators and Circulators, Fiber grating filters,Dielectric Thin-Film Filters, Diffraction Gratings, Active Optical Components, Tunable light sources.

Optical Networks: Optical Networks concepts, Network Topologies, Introduction to SONET/SDH networks, Optical Add/Drop Multiplexing, Wavelength Division Multiplexing (WDM) Concepts. Revolution of optical networks in India. **07 Hrs**

Reference Books:

1) Gerd Keiser, “Optical Fiber Communication”,5th Edition,McGraw Hill Education

(India) Private Limited,2015.
2) John M Senior, “Optical Fiber Communications, Principles and Practice”,3rdEdition, Pearson Education, 2010.
3) Rama Swamy & Sivarajan, ”Optical Networks”,2nd edition,Elsevier publishers, 2010.
4) Govind P .Agarwal,”Fiber Optic Communication Systems”,3rd edition,John Wiley India.2001.

18UECE811	Reconfigurable Design	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The course focuses on key criteria: area, speed, optimization techniques employed, various system architectures considered in the FPGA method of Design.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Demonstrate** the basics of FPGA Architecture and its Function mapping.	-	1,2	13,14
CO-2	**Modeling** the languages and its synthesis.	-	1,2	-
CO-3	**Understand** AdvancedFPGA design principles w.r.t speed and area.	1,2	-	-
CO-4	**Design** strategies for DSP and Image Processing applications.	3	13,14	5
CO-5	**Analyze** and **explore** the architectural design of FPGA for Deep Learning Applications.	3	13,14	5

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	2.33	2.33	3	-	1	-	-	-	-	-	-	-	1.66	1.66

Pre-requisites: Knowledge of FPGA and microcontroller architecture

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Contents:

Unit-I

FPGA Design Flow: Reconfigurable Logic Devices, Field-Programmable Gate Arrays, Basic Architecture, Example Actel Devices: ACT1 logic module, Shannon's expansion theorem, Routing, Programmable I/O Architectures**,** Specialized Function Blocks: Embedded Microprocessors. Coarse-Grained Reconfigurable Arrays: Raw &PipeRench Architectures. **6 Hrs**

Unit-II

Languages and Compilation, Design Cycle, Languages, Algorithmic RC Languages, Hardware Description Languages (HDL): Modelling of Abstraction Level, High Level Compilation, Compiler Phases. Analysis and Optimizations, Scheduling, Low Level Design Flow, Logic Synthesis Technology Mapping, Logic Placement, Signal Routing Configuration Bit streams **8Hrs**

Unit-III

Architecting Speed & Area Speed: High Throughput, Low Latency, Timing, Add Register Layers, Parallel Structures, Flatten Logic Structures, Register Balancing, Reorder Paths.**Area:**Rolling Up the Pipeline, Control-Based Logic Reuse, Resource Sharing, Impact of Reset on Area, Resources Without Reset, Resources Without Set, Resources Without Asynchronous Reset, Resetting RAM, Utilizing Set/Reset FF Pins. **8 Hrs**

Unit-IV

FPGA Applications: Signal processing applications: Filtering, DSP application building blocks: Efficient Airthmetic, CORDIC, Transforms, Examples: Beam forming, Software Defined Radio. **Image and video processing**: Local Neighbourhood functions, Convolution, Morphological Operations, Feature Extraction & matching. **8 Hrs**

Unit-V

Accelerating the CNN Inference on FPGAs : Introduction, Background on CNNs and Their Computational Workload, General Overview, Inference versus Training, Inference, Layers, and CNN Models, FPGA-Based Deep Learning Computational Transforms: Winograd Transform and Fast Fourier Transform, Loop Unrolling. Loop Tiling. **Approximate Computing of CNN Models**: Approximate Arithmetic for CNNs, Fixed-Point Arithmetic, Dynamic Fixed Point for CNNs, FPGA Implementations, Extreme Quantization and Binary Networks, Reduced Computations, Weight Pruning, Low Rank Approximation. **9 Hrs**

Activity Beyond Syllabus: Seminar on Reconfigurable Computing.

Reference Books:

1) M. Gokhale and P. Graham, “Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays”, Springer, 2005.
2) Steve Kilts,” Advanced FPGA Design Architecture, Implementation, and Optimization”, WILEY INTERSCIENCE, 2007.
3) Mahmoud Hassaballah and Ali Ismail Awad, “Deep Learning inComputer Vision”, CRC Press,Taylor& Francis Group, 2020.
4) Deep Learning by Ian Goodfellow and YoshuaBengio and Aaron Courville, MIT Press.https://www.deeplearningbook.org/

18UECO723	Mobile Computing	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The course focuses on basics of mobile communications, mobile computing, GSM systems, networking, transport and application layer protocols, different mobile platforms and application development and security issues.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain the basics of mobile telecommunication systems	-	-	1,4,6,7
CO-2	Illustrate the generations of telecommunication systems in wireless networks	-	1,2,4,5	12,13,14
CO-3	Determine the functionality of MAC, network layer and Identify a routing protocol for a given Adhoc network	-	2,4	12,13,14
CO-4	Explain the functionality of Transport and Application layers	-	1,2,4,10	-
CO-5	Develop a mobile application using android/blackberry/ios/Windows SDK	1,2,3,4,5,13, 14	-	-

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	2.0	2.25	3.0	2.0	2.5	1.0	1.0	-	-	2.0	-	1.0	1.33	1.33

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Pre-requisites: Wireless communication, Digital communication Computer Communication Networks;

Contents:

Unit-I

Introduction: Mobile Communications, Mobile Computing– Paradigm, Promises/Novel Applications and Impediments and Architecture; Mobile and Hand held Devices, Limitations of Mobile and Handheld Devices.

GSM–Services, System Architecture, Radio Interfaces, Protocols, Localization, Calling, Handover, Security, New Data Services, GPRS,CSHSD, DECT. **08 Hrs**

Unit-II

(Wireless) Medium Access Control (MAC): Motivation for a specialized MAC (Hidden and exposed terminals, Near and far terminals), SDMA, FDMA, TDMA, CDMA, Wireless LAN / (IEEE802.11)

Mobile Network Layer: IP and Mobile IP Network Layers, Packet Delivery and Handover Management, Location Management, Registration, Tunnelling and Encapsulation, Route Optimization, DHCP. **08 Hrs**

Unit-III

Mobile Transport Layer: Conventional TCP/IP Protocols, Indirect TCP, Snooping TCP, Mobile TCP, Other Transport Layer Protocols for Mobile Networks.

Database Issues: Data base Hoarding & Caching Techniques, Client-Server Computing & Adaptation, Transactional Models, Query processing, Data Recovery Process & QoS Issues. **07 Hrs**

Unit-IV

Data Dissemination and Synchronization: Communications Asymmetry, Classification of Data Delivery Mechanisms, Data Dissemination, Broadcast Models, Selective Tuning and Indexing Methods ,Data Synchronization– Introduction, Software, and Protocols. **09 Hrs**

Unit-V

Mobile Device Operating Systems – Special Constraints & Requirements – Commercial Mobile Operating Systems – Software Development Kit: iOS, Android, BlackBerry, Windows Phone–M Commerce–Structure–Pros & Cons– Mobile Payment System–Security Issues.

Protocols and Platforms for Mobile Computing: WAP,Bluetooth,XML,J2ME, Java Card, Palm OS, Windows CE, Symbian OS, Linux for Mobile Devices, Android. **07 Hrs**

Reference Books:

1) Jochen Schiller, “Mobile Communications” ,PHI,SecondEdition,2003.
2) RajKamal, “Mobile Computing”, Oxford University Press,2007,

3) Prasant Kumar Pattnaik ,Rajib Mall,"Fundamentals of Mobile Computing", PHI ,2012

18UECL405	HDL Programming Laboratory	(0-0-3) 1.5

Contact Hours: 36

Course Learning Objectives (CLOs):

The course focuses on experiments based on HDL programming for digital circuit design using Verilog. Also, the course contemplates the interfacing programs to interface different hardware components using Field Programmable Logic Device (FPGA).

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Relate** the need for HDL in Typical design flow of VLSI Technology.	-	14	1
CO-2	**Apply** appropriate techniques, resources, and EDA tools for modeling, simulation and synthesis of various digital systems.	5,14	3,4,13	1,2
CO-3	**Design** combinational and Sequential circuits using various programming techniques.	-	3,4,5,13, 14	1,2
CO-4	**Build** the HDL model to interface FPGA kits with various peripherals	14	5	1,2,3,4
CO-5	**Generate** the test vectors for the HDL model using stimulus block.	-	3,4,5,13, 14	1,2

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	1	1	1.75	1.75	2.25	-	-	-	-	-	-	-	2	2.4

List of Experiments:

1) Write a Verilog code to implement the following Basic Gates: (Using Dataflow, Behavioral and Structural style of modelling).
2) Write a Verilog code to implement Adders, Subtractors, Encoders and Decoders.

(Using Dataflow, Behavioral and Structural style of modelling).

3) Write a Verilog code to implement Multiplexers, De-multiplexers, Code converters, Comparators.
4) (Using Dataflow, Behavioral and Structural style of modelling).
5) Write a Verilog Code to implement 4-bit ALU. Verify the same generating test vectors for the various operations. Write the test bench (stimulus block) and verify that it behaves as ALU.
6) Design a 4-bit ripple carry adder using concept of hierarchical structured modeling by using module instantiation, tasks and functions.
7) Write the verilog code to implement all flip flops.
    a) Write a Verilog code to implement the following:
    b) 4-bit Shift register (Right shift and left shift)
    c) 4-bit Ring counter and Johnson counter
    d) 4-bit up counter and 4-bit down counter
    e) 4-bit updown counter
    f) Any given sequence counter (4-bit)
    g) BCD updown Counter
    h) Mealy and Moore's synchronous circuit design.
8) Write a verilog code to run the stepper motor in clockwise and anti-clockwise direction.
9) Write a verilog code to generate any given waveforms using DAC kit.
10) Write a verilog code to Interface hex keypad and display it on 7-segment LED.

Note: Simulation should be done using Xilinx ISE tool and Implementation on Spartan –6 FPGA Kits.

Reference Books:

1) Samir Palnitkar, "Verilog HDL", 2/e, Pearson Education, IEEE 1364-2001 Compliant, 2015.
2) T.R. Padmanabhan, B. Bala Tripura Sundari, "Design Through Verilog HDL", ISBN: 978-0-471-44148-9, Wiley-IEEE Press, 2004.
3) Nazeih M Botros, "HDL Programming, VHDL and Verilog", Deamtech Press, 2007.
4) Peter J. Ashenden, "Digital Design: An Embedded Systems Approach Using verilog", Elsevier, 2010.

18UECL505	Digital Signal Processing Laboratory	(0-0-3) 1.5

Contact Hours: 36

Course Learning Objectives (CLOs):

The laboratory course enables students to get practical experience in processing of signals, design of filters and realization of systems.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Perform** signal manipulations and **Compute** response of LTI systems	-	1,2,5, 12	13,14
CO-2	**Compute** DFT and inverse DFT and **Verify** the properties.	1,2	5,12	13,14
CO-3	**Apply** properties of DFT to **solve** signal processing problems	1,2	5,12	-
CO-4	**Design** analog filters to meet the given specifications	2, 3	5,12	-
CO-5	**Design** digital filters to meet the given specifications	2, 3	5,12	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.66	2.8	3	-	2	-	-	-	-	-	-	2	1	1

Contents:

1. Basic signal processing operations.
2. Response of LTI systems.
3. Computation of DFT/IDFT and verification of properties.
4. Frequency analysis of signals using DFT.
5. Linear filtering of long data sequence using DFT.
6. Efficient computation of DFT.
7. Design analog IIR filters for the given specifications and their realization.
8. Design digital IIR filters for the given specifications and their realization.
9. Design digital FIR filters for the given specifications.
10. Applications of signal processing.

Reference Books:

1) Proakis & Monalakis, “Digital Signal Processing: Principles, Algorithms & Applications”, 4/e, Pearson Education, New Delhi, 2007.
2) Sanjit K. Mitra, “Digital Signal Processing”, 2/e Tata Mc-Graw Hill, 2004.
3) Li Tan, “Digital Signal Processing Fundamentals and Applications”, Elsevier, 2003.
4) Emmanuel C. Ifeachor, Barrie W. Jervis, “Digital Signal Processing: A Practical Approach”, 2/e, Pearson Education, 1999.

18UECL506	Minor Project-1	(0-0-2) 1

Contact Hours: 30

Course Learning Objectives (CLOs):

Minor project –1 is introduced at V semester level to encourage students mainly to solve real time societal problems by integrating the knowledge gained in previous semesters. It may involve the investigation of a problem and the specification and implementation of a solution. Minor project help students to develop problem solving, analysis, synthesis and evaluation skills. It also helps in developing collaborative work culture and team work. In focus with this, students understand the basics of electronics, communication and programming languages in depth and then work on Planning, analyzing, designing and executing a hardware/software project.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Identify** technical / social problemand **formulate** a problem statement	1,2	6	-
CO-2	**Propose** technical approach towards solution	2	6,7	11
CO-3	**Implement** the solution in hardware and / or software	3,5	13,14	11
CO-4	**Organize** the topics in a systematic manner and **Prepare** the report in a specific format	9,10	12	-
CO-5	**Present** the work in a systematic manner	10	12	-

POs/PSO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	3	3	3	-	3	2	2	-	3	3	1	2	2	2

Prerequisites:

Basics of Electronics, Communication and Programming languages.

Guidelines for Conduction Spirit of the Course:

To ensure that undergraduates successfully apply the knowledge they have gained in different courses and integrate material learnt at different stages of the curriculum up to the 5th semester so as to complete the project work within the stipulated time duration following guidelines are framed.

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1. Project groups are formed with 3-4 students in each team.
2. Project coordinators instruct student project batches to submit synopsis in the prescribed format in the field of their choice.
3. Project coordinators allot guides based on their field of specialization. However students can have further discussions on the project topic and can modify their project title.
4. Students are instructed to report to their respective guides on weekly basis for discussion.
5. Students are instructed to maintain separate project diary/notebook to show the progress work while having discussion with guide and review committee members.
6. Two reviews are fixed in a semester to monitor the progress of the project.

Assessment: CIE- Guides evaluate project for 30 marks and 20 marks are allotted by reviewers by conducting 2 reviews. Total marks for project is 50 (CIE only). **SEE:** There is no semester end exam (SEE) component for minor project-1.

Note:

- Designated committee is constituted with 2-4 committee members to monitor the process of Mini Project-1
- An internal guide is allotted per group who guides and monitors the project
- progress.
- Problem statements can be derived from industry, society, etc., after interacting with them.
- Course outcomes (4 or more) are written and mapped toprogram outcomes and program specific outcomes. In addition to that other POs can also be included if those POs are deemed suitable.
- At the end of the course, students are required to document the project in the form of report.

18UECL604	**Minor Project-2**	**(0-0-4) 2**

Contact Hours: 30

Course Learning Objectives (CLOs):

Minor project-2 focuses on an exposure to the project work in the domain of their interest by selecting a problem definition from an emerging area. The problem could be defined to develop prototypes for industrial needs.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Identify** and **justify** the technical aspects of the chosen project with a comprehensive and systematic approach.	1	2,4	6,7
CO-2	**Reproduce** and **refine** technical aspects for engineering projects.	2	13	-
CO-3	**Work** as an individual or in a team in development of projects	9	8	-
CO-4	**Implement** the solution in hardware and / or software	3,5	13,14	11
CO-5	**Present** the work in a systematic manner	10	12	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	3	2.5	3	2	3	1	1	2	3	3	1	2	2	2

Prerequisites: Knowledge of VLSI, Signal Processing, Analog& Digital Communication and Any Programming Language

Guidelines for Conduction Spirit of the Course:

To ensure that undergraduates successfully apply the knowledge they have gained in different courses and integrate material learnt at different stages of the curriculum up to the 4th semester so as to complete the project work within the stipulated time duration following guidelines are framed.

1. Project groups are formed with 3-4 students in each team.
2. Project coordinators instruct student project batches to submit synopsis in the prescribed format in the field of their choice. In genuine case students can continue their minor project-I for this semester.
3. Project coordinators allot guides based on their field of specialization. However students can have further discussions on the project topic and can modify their project title.

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4. Students are instructed to report to their respective guides on weekly basis for discussion.
5. Students are instructed to maintain separate project diary/notebook to show the progress work while having discussion with guide and review committee members.
6. Two reviews are fixed in a semester to monitor the progress of the project.

Assessment: CIE: Project guides evaluate for 30 marks and 20 marks are allotted by reviewers conducting two reviews. 50 marks allotment under CIE. **SEE:** Minor project-2has SEE component and marks allotted for SEE is 50, where students need to demonstrate the project and present it in the presence of examiners.

Note:

- Designated committee is constituted with 2-4 committee members to monitor the process of Mini Project-1
- An internal guide is allotted per group who guides and monitors the project progress.
- Problem statements can be derived from industry, society, etc., after interacting with them.
- Course outcomes (4 or more) are written and mapped to program outcomes and program specific outcomes. In addition to that other POs can also be included if those POs are deemed suitable.
- At the end of the course, students are required to document the project in the form of report.

18UECL703	**Major Project Phase - I**	**(0-0-4) 2**

Contact Hours: 52

Course Learning Objectives (CLOs):

The objectives of final year project during phase-I are to:

- Allow the students to demonstrate the skills learnt during their course of study by asking them to deliver a product that has passed through design, analysis, testing and evaluation stages.
- Encourage multidisciplinary research through the integration of material learnt in number of courses.
- Allow students to develop problem solving, analysis, synthesis and evaluation skills.

- Encourage teamwork and improve students' communication skills through project reports and presentations of their work.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Identify** societal problems and analyze from engineering view point.	1,2	-	6,7
CO-2	**Perform** extensive literature survey on the identified problem and **explore** possible technical solutions.	1,2,3,4	5	13,14
CO-3	**Implement** and provide feasible solution for the identified problem.	1,2,3,4	5	13
CO-4	**Develop** presentation skills of summarizing technical contents and **organize** the study material in the form of a report.	10	11	-
CO-5	**Inculcate** professional ethics, moral responsibilities and develop the spirit of team work.	8,9	12	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**3**	**3**	**3**	**2**	**2**	**1**	**1**

Major Project phase-I is a substantial piece of work that requires creative activity and original thinking. The project phase-I has to start with the problem formulation that will lead to feasible solutions. The material collection, survey, visits, data collection, preliminary design, analysis etc. is to be done in this phase. The project shall consist of a team of students not more than 4. Each batch shall be assigned with a guide. The guide will continuously monitor and evaluate the student project. Further, a review team will also evaluate the project progress.

18UECL704	Internship	4 Weeks

Course Learning Objectives (CLOs):

The students are to undergo internship in Private industries/R&D organizations/ Centres of Excellence/Laboratories of Reputed Institutions/Govt. & Semi Govt. organizations, PSUs, construction companies, entrepreneurial organizations, inter departments within the college etc. to get en exposure to the external world for a period of 4 weeks in the summer vacation after VI semester and before start of VII semester. The students are to prepare a report on the internship work carried out. The internal faculty shall monitor the student and award CIE marks. There is a SEE in which the student shall present his work before a panel of examiners consisting of HoD, Guide and one faculty member during VII semester. The performance shall be communicated to the CoE office and the same shall reflect in the VII semester grade card.

Course Outcomes(COs):

Description of the Course Outcome: At the end of the course the student will be able to		**Mapping to POs (1-6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	**Acquire** practical experience in an organizational setting	1,2	-	-
CO-2	**Apply** the knowledge and skill set in engineering design processes appropriate to the internship program.	1,2,3,4	5	-
CO-3	**Apply** modern tools and processes to solve the live problems.	5	3,4	-
CO-4	**Get** an opportunity to learn new skills	10	11	-
CO-5	**Learn** strategies like time management, multi-tasking, communication and team work skills in an industrial setup.	8,9	12	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	**3**	**3**	**2.5**	**2.5**	**2.5**	**-**	**-**	**3**	**3**	**3**	**2**	**2**	**-**	**-**

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- **18UHUL507 Soft skills/Aptitude (0-0-2)1**

- **Contact Hours: 24**

- **Course Learning Objectives (CLOs):**

- This is included with the objectives of improving the communication skills, proficiency in English language and aptitude ability of the student to enhance the employability.

- **Course Outcomes (COs):**

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Explain** the significance of communication in the profession.	-	10	-
CO-2	**Use** the English language with proficiency	-	10	12
CO-3	**Solve** Aptitude related problems	-	9	12
CO-4	**Demonstrate** the competency in the placement activities.	-	9	-

PO's	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
Mapping Level	-	-	-	-	-	-	-	-	2.0	2.0	-	1.0	-	-	-

- **Contents:**

- Training on communication skills, proficiency in English language and aptitude ability involving the internal and external resource.

- **Evaluation:**

- Both the internal and external resource persons shall be engaged in imparting the related knowledge and shall have only CIE as the evaluation component. There shall be one test conducted at the end for 25 marks in Aptitude testing and there shall be one presentation by the student for 25

marks or any other suitable testing components. The arrangement for CIE evaluation is to be done by the department and maintain the relevant documents.

18UECL802	Project Phase – II	(0-0-12) 7

Contact Hours: 100

Course Learning Objectives (CLOs):

The objectives of final year project are to:

- Allow students to demonstrate wide range of skills learned during their course of study by asking them to deliver a product that has passed through the design, analysis, testing and evaluation stages.
- Encourage multidisciplinary research through the integration of material learned in a number of courses.
- Allow students to develop problem solving, analysis, synthesis and evaluation skills.
- Encourage teamwork.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Arrive** at an optimal solution towards the problem identified	1,2,3,9	4	5,12
CO-2	**Implement** proposed solution in the form of development of software and/ or hardware prototype.	3,4,9,13, 14	5,6,7	12
CO-3	**Organize** the topics in a systematic manner and **prepare** report in a specific format	9,10,11	-	12
CO-4	**Present** the work in a systematic way	-	1,6,10	-
CO-5	**Adopt** professional ethics and responsibilities	8	11,12	-

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14

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Mapping Level	3	3	3	2.5	1	2	2	3	3	2.5	2.5	1.3	3	3

Major Project phase-II is the continuation from phase – I in which the students are expected to go for material collection, survey, visits, data collection, optimized design, analysis, model development, code writing, field work etc. The same project team formed for phase –I will continue the work under the guidance of the same faculty member. For all the projects, problems may be domain specific or interdisciplinary in nature. The guide will continuously monitor and evaluate the student project. Further, a review team will rigorously evaluate the project progress and completion.

18UECE513 Sensors and Transducers (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The course focuses on fundamentals in sensors & transducers like classification of various transducers, choice of proper transducers to measure various physical parameters like temperature, pressure, force, velocity and acceleration.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Explain** the working of different types of sensors, transducers and measurement systems	--	1	2
CO-2	**Describe** various methods of measurement for velocity, speed, vibration and acceleration	--	1	2
CO-3	**Explain** the working principle of various force and torque measurement transducers and their applications	--	1,12	3,13
CO-4	**Describe** construction, working principle of various pressure transducers and their applications	--	1,12	3,13
CO-5	**Discuss** the operation and applications of various temperature sensors/transducers	--	1,12	13

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Mapping Level	2	1	1	--	--	--	--	--	--	--	--	2	1	--

Pre-requisites: Basic Electronics, Electrical Measurement Systems

Contents:

Unit-I

Introduction: Measurement and measurement system, industrial measuring parameters and their units, definitions of sensors and transducers, classification of transducers, static and dynamic characteristics, selection criteria.

Displacement Measurement: Resistive: Potentiometer, Strain gauges, Inductive: LVDT and Eddy current type, Capacitive: Capacitance pickups, Differential capacitive type, Piezoelectric, Ultrasonic transducers and Hall effect transducers, Optical transducers **09 Hrs**

Unit-II

Velocity, Speed, Vibration and Acceleration measurement: Velocity and Speed: Electromagnetic tachometer, Photoelectric tachometer, Toothed rotor variable reluctance tachometer. Magnetic pickups, Encoders, Photoelectric pickups, Stroboscopes, Shaft speed measurement. Vibration and acceleration: Eddy current type, Piezoelectric type, Seismic Transducer, Accelerometer: Potentiometric type, LVDT type **07 Hrs**

Unit-III

Force and torque measurement: Basic methods of force measurement, elastic force traducers, strain gauge, load cells, piezoelectric force transducers, vibrating wire force transducers, Strain gauge, torque meter, Inductive torque meter, Magnetostrictive transducers, torsion bar dynamometer, etc. Dynamometer (servo control and absorption) instantaneous power measurement and alternator power measurement. **07 Hrs**

Unit-IV

Pressure measurement: Definition, pressure scale, standards, working principle, types, materials, design criterion: Manometers, elastic pressure sensors, secondary pressure sensors, differential pressure sensors, force balance type, motion balance, capacitive (delta cell), ring balance, vibrating cylinder type, high-pressure gauges, vacuum gauges, dead weight and vacuum gauge tester **08 Hrs**

Unit-V

Temperature measurement: Temperature Scales, Standards and Units and relations, Classification of temperature sensors Bimetallic Thermometer, Filled system thermometers, SAMA classifications, Resistance Temperature Detectors

(RTD), Thermistor, Thermocouples, Study of thermocouple tables (calculation of intermediate temperature and voltage), Lead wire compensation, Cold junction compensation techniques, Protection (Thermo well), Thermopiles, Pyrometers, Temperature IC sensors (AD590 and LM35) **08 Hrs**

Reference Books:

1) B. C. Nakra and K. K. Choudhari, "Instrumentation Measurements and Analysis", 3/e, Tata McGraw Hill Education, 2009
2) D. Patranabis, "Principle of Industrial Instrumentation", 2/e, Tata McGraw Hill, 1994.
3) D.V.S. Murty, "Instrumentation and Measurement Principles", 2/e, PHI, 2008
4) E.O. Doebelin, "Measurement Systems: application and design", 5/e, McGraw Hill, 2003

21UAEE350 Basics of Data Science (2-0-0) 2

Contact Hours: 26

Course Learning Objectives (CLOs):

The course focuses on the theory and applications of Data Science. The course concentrates on the gathering data, cleaning data, generating hypothesis, making inferences, visualizing data, assessing solutions, etc.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to Pos(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	To get **insight** of the tools that data scientists use and the significance of Python and its libraries for data scientists.	1	5,14	2
CO-2	**Evaluate** the central measures of tendency such as the sample mean and median; and measures of variability such as the variance and standard deviation **and apply** the concepts of descriptive statistics to explore a dataset.	1,2		5,14
CO-3	**Analyze** and **address** the problem of statistical inference.	1	4	
CO-4	To **build** a model to predict the response from the variables by **analyzing** the behavior of data (the relation between the response and the	3,4,14	2,5	

	variables) and **assessing** the importance of variables for the model.			
CO-5	To **utilize** techniques that seek to **summarize and explain** key features or structures of the data by data mining methods used to preprocess data and **tackle** the problems namely Clustering, Dimensionality reduction, Outlier detection, Novelty detection.	3,4,14	2,5	

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	3.0	2.0	3.0	2.7	1.75	-	-	-	-	-	-	-	-	2.25

Pre-requisites: Mathematics, Basic Programming skills.

Contents:

Unit-I

Introduction to Data Science: What is data science?

Toolboxes for Data Scientists: Introduction, Why Python?, Fundamentals of python libraries for data scientists, Data Science Ecosystem, Web Integrated Development Environment (WIDE), Python for Data Scientist **4 Hrs**

Unit-II

Descriptive Statistics: Introduction, Data Preparation, Exploratory Data-Summarizing the Data, Data Distributions, Outlier Treatment, Measuring Asymmetry: Skewness and Pearson's Median Skewness Coefficient, Continuous Distribution Analysis, Kernel Density, Estimation-Sample and Estimated Mean, Variance and Standard Scores, Covariance, and Pearson's and Spearman's Rank Correlation. **6 Hrs**

Unit-III

Statistical Inference: Introduction, Statistical Inference: The Frequentist Approach, Measuring the Variability in Estimates, Hypothesis Testing

Supervised Learning: Learning and Learning Curves, Training, Validation and Test, Two Learning Models , Random Forest , Ending the Learning Process **6 Hrs**

Unit-IV

Regression Analysis: Introduction, Linear Regression, Logistic Regression **5 Hrs**

Unit-V

Unsupervised Learning: Introduction, Clustering, Case Study

5 Hrs

Reference Books:

1) Laura Igual & Santi Segui, “Introduction to Data Science”, Springer, ISBN 978-3-319-50016-4.
2) John V. Guttag, “Introduction to Computation and Programming Using Python”,The MIT Press,ISBN978-0-262-52500-8

18UECL602	Embedded Systems Laboratory	(0-0-3)1.5

Contact Hours: 36

Course Learning Objectives (CLOs):

The course focuses on embedded systems design and development. Hardware-software co design process is explored in real-time system design.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Realize** embedded system design using Integrated Development Environment (IDE).	-	1,5	3,7
CO-2	**Develop** simple embedded C applications using RTOS-APIs.	2,5	3	7,12
CO-3	**Construct** embedded systems using sensors and actuators.	2,13,14	4,5	7,9, 12
CO-4	**Execute** basic IoT applications on embedded platform.	1,2,14	4,5,13	9,6
CO-5	**Realize** communication protocols used in embedded systems.	5	13,14	4

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.5	3	1.5	1.6	2.4	1	1	-	1	-	-	1	2.3	2.6

List of Experiments:

1. Sample Embedded C-programs.
2. Develop Embedded C-Program for the following interfacing examples
    a. ADC and DAC.
    b. LED and PWM.

c. Real time clock and serial port.
d. Keyboard and LCD.
e. EPROM and interrupt.

3. Demonstrate Inter-Process Communication using Mailbox.
4. Interrupt performance characteristics of ARM Controllers.
5. Write a C program to blink LEDs on ARM Controller board.
6. Develop a system to rotate a stepper motor by 180^0 when temperature is above set threshold.
7. Develop a system to rotate a DC motor with different rpm depending upon temperature.
8. Implement Communication protocol on ARM Controllers.
9. Local processing on the sensor nodes
10. Develop a sample IoT application by connecting devices to the cloud and vice Versa

Reference Books:

1) Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, 2nd Edition, Newnes, (Elsevier), 2010.
2) Shibu K V, “Introduction to Embedded Systems”, Tata McGraw Hill Education Private Limited, 2nd edition.
3) Andrew N. Sloss “Arm System Developer’s Guide” Elsevier Inc. 2004 edition, Morgan Kaufmann Publishers.
4) James K. Peckol, "Embedded systems- A contemporary design tool", John Wiley, 2008, ISBN: 978-0-471-72180-2.
5) Yifeng Zhu, “Embedded Systems with Arm Cortex-M Microcontrollers in Assembly Language andC”, 2nd E -Man Press LLC ©2015
6) Embedded real time systems by K.V. K. K Prasad, Dreamtech publications, 2003.

18UECL603	VLSI Laboratory	(0-0-3) 1.5

Contact Hours: 36

Course Learning Objectives (CLOs):

The course focuses on exploring the theoretical concepts studied as part of subjects, CMOS VLSI Design and Analog and Mixed Mode VLSI Design in practical with the help of Cadence tool framework. The lab introduces the complete custom IC design flow and Analog and Mixed Signal (AMS) flow for Analog circuits, Digital circuits and Analog and mixed signal circuits design respectively.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-12)/ PSOs (13,14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	**Demonstrate** the working of digital and analog circuits and **apply** the design steps of VLSI flow to build the schematic and layouts of VLSI circuits.	1, 2	5	13
CO-2	**Design** and **perform** the DC and transient analysis on combinational & sequential VLSI circuits.	2	1,5	-
CO-3	**Design** and **Perform** the DRC, LVS and RC extraction of layout designs of combinational & sequential VLSI circuits.	2	1,5	-
CO-4	**Design** analog and mixed signal circuits **and Evaluate their** performance**.**	3,5	13	-
CO-5	**Compare and evaluate** the performance of VLSI circuits.	2	10,13	1,4,14

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	1.5	3	3	1	2.25	-	-	-	-	2	-	-	1.6	1

List of Experiments:

Draw the Schematic and Layout for the following digital and analog circuits mentioned below with the help of Cadence tool frame work and verify the following.

a. Schematic: i) DC Analysis ii) Transient Analysis iii) Parametric analysis

b. Layout: i) DRC ii) LVS iii) RCX

1. Design CMOS Inverter with given specifications.
2. Design CMOS two input NAND and NOR gates.
3. Design Transmission gate & Multiplexer using transmission gates.
4. Design XOR, AND & OR gates using transmission gates.
5. Design D F/F, SR F/F sequential circuits.
6. Design 2-bit up-down counter using D F/Fs.
7. Design a Common Source Amplifier with resistive load for given specifications.
8. Design a source follower circuit.
9. Design single stage Differential Amplifier with given specifications.

10. Design single stage OPAMP using common source amplifier with resistive load.
11. Design 4 bit R-2R DAC using Op-amp with given specifications.

Reference Books:

1) Sung Mo Kang & Yusuf Leblebici, “CMOS Digital Integrated Circuits: Analysis and Design”, 3/e, McGraw-Hill, 2008.
2) Douglas A Pucknell& Kamran Eshragian, “Basic VLSI Design”, 3/e, PHI, 2005.
3) Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, Tata McGraw-Hill Edition 2008.
4) R. Jacob Baker, Harry W. LI, David E. Boyce, “CMOS Circuit Design, lay out and Synthesis”, IEEE press, 2005.

18UECL702	**CCN Laboratory**	**(0-0-2) 1**

Contact Hours: 36

Course Learning Objectives (CLOs):

The course focuses on the process of data communication in computer network through the layered architecture. It also deals with the IEEE standards and various protocols at different layers.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Illustrate** the importance of High-Level Data Link Control.	-	1	4
CO-2	**Demonstrate** various functionalities Of Network Layer and usage of algorithms for routing strategies, packet management.	1,4	-	-
CO-3	**Demonstrate** the performance of various protocols and algorithms for Framing, Flow control, Error control and media access control	1,2	3,14	11

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CO-4	**Illustrate** the various functionalities of RTOs.	-	3,14	1,2
CO-5	**Demonstrate** the usage and importance of Inter Process Communication(IPC)	2,3	14	-

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	2.25	2.23	2.23	2.0		-	-	-	-	-	1	-	-	2

Pre-requisites: Fundamentals of Computer Communication Networks Operating Systems, Knowledge of Embedded Systems.

CCN Experiments:

- Write a C program to simulate bit stuffing and de stuffing in data frames.
- Write a C program to simulate shortest path algorithm.
- Write a C program to implement Sliding Window protocol.
- Write a C program to implement Pipelining protocol which allows multiple outstanding frames.
- Write a C program to compute the polynomial cyclic redundancy check code (CRC Code checksum) for CRC-CCITT.
- Write a C program to simulate a positive acknowledgement with retransmission protocol.
- Write a C program for congestion control using leaky bucket algorithm.
- Write a C program for hamming code (error detection and error correction).

Embedded Experiments:

Note: Implement using RTOS Kernel either RTX, uCOS-II or Free RTOS on LPC2148 ARM-7 kit.

- OS concepts such as task management, IPC, Semaphore, Scheduling can also be demonstrated on Linux platform using gcc.
- Write a C program to create two tasks one to blink all LEDs with fixed delay, other to blink half of the LEDS (use task create, prioritize tasks, task delay and finally kill one of the task after certain delay).
- Demonstrate Producer and Consumer problem using semaphores.
- Demonstrate IPC using pipes and mailboxes.
- Create multiple tasks and demonstrate different scheduling algorithms (round robin, FIFO ,Preemptive).

Reference Books:

1) B. Forouzan, “Data Communication and Networking”,4th Edition, TMH, 2006.
2)James F .Kurose, KeithW. Ross, “Computer Networks”, Pearson education,2ndEdition, 2003.
3) Wayne Tomasi, “Introduction to Data communication and Networking”, Pearson Education,2007.
4) James K. Peckol, “Embedded Systems–A contemporary Design Tool”, John Weily, 2008.

18UECL407	Introductory Project	(0-0-2) 1

Contact Hours: 24

Course Learning Objectives (CLOs):

The course provides an exposure to the students to identify simple societal problems and propose a technical solution. It also helps them to find related material, use appropriate tool to obtain the solution and prepare a report based on the work carried out.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Conduct a **survey** and **identify** the community needs.	-	6, 7	2
CO-2	**Formulate** the problem statement.	-	2	1
CO-3	**Propose** a solution by applying the fundamental knowledge of basic sciences and basic engineering courses	-	1,2	3
CO-4	**Develop** the team spirit, communication and management skills.	-	9,10,12	11
CO-5	**Prepare** a report and present the findings.	-	9,12	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	1.5	1.7	1	-	-	2	2	-	2	2	1	2	-	-

Contents:

Introductory Project is introduced with an objective of understanding and identifying the community expectation in terms of possible engineering solutions by applying the fundamental knowledge of basic sciences and basic engineering courses. The Project shall be engineering oriented in terms of problem definition,

related literature survey and existing solutions. Students are supposed to meet the faculty members, discuss the problem definition and formulate the project. Project Team size Minimum of 03 and Maximum of 04 Students. The synopsis format shall be strictly adhered failing which may lead to rejection of the proposal and may cause delay in project. If the Introductory-Project idea is suggested by the faculty member, the synopsis must be duly signed by the respective faculty member. Maximum efforts will be made to allocate the same guide but may not be guaranteed. If the proposed project matches with one or more project titles, they are suggested to modify them in consultation with their respective guides and proceed with the submission.

1)

21UECC403	**ARM Processor**	**(3-0-0) 3**

Contact Hours: 39

Course Learning Objectives (CLOs):

The course deals on the evolution of computer architecture and ARM. It explores the Instruction Set Architectures provided by the ARM. It also focuses on the special hardware architectures available and instructions and to use them at different language levels (High, assembly) to build an optimized application. It tries to understand the memories/ peripherals and bus standards to build an effective structure and code for a given functionality.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Express, Analyze** and appreciate the evolution of Computer Architecture in general and ARM.	2	4	12
CO-2	**Explore** the. Instruction Set Architectures of ARM and **utilize** them in **generating** efficient and optimized code for a given application.	2,3	4	14
CO-3	**Effectively use** the hardware architectures available by using high level language [C] and Assembly	1,4	5,2,14	13

	optimally.			
CO-4	**Interpret and use** exception handling to create effective and **reactive** applications; and the bus architectures to **interface** the memories.	2,3,4,13,14		5,7,9,10,14
CO-5	**Contrast** and **choose** the peripherals along with the bus standards while building an application	13,14		

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	3	2.75	3	2.5	1.5		1		1	1		1	2.3	1.6

Pre-requisites: Digital Circuits and basic programming skills.

Contents:

Unit-I

ARM Processor / Controller, CISC versus RISC, The RISC Design Philosophy , The ARM Design Philosophy , Embedded System Hardware, Embedded System Software, ARM Processor Fundamentals, Registers, Current Program Status Register, Pipeline ,Exceptions, Interrupts, and the Vector Table, Core Extensions , Architecture Revisions, ARM Processor Families **6 Hrs**

Unit-II

Introduction to the ARM Instruction Set, Data Processing Instructions, Branch Instructions, Load-Store Instructions, Software Interrupt Instruction, Program Status Register Instructions, Loading Constants , ARMv5E Extensions, Conditional Execution ,[2]Assembler Rules and Directives

Introduction to the Thumb Instruction Set, Thumb Register Usage, ARM-Thumb Interworking, Other Branch Instructions, Data Processing Instructions, Single-Register Load-Store Instructions, Multiple-Register Load-Store Instructions, Stack Instructions, Software Interrupt Instruction **8 Hrs**

Unit-III

Efficient C Programming ,Overview of C Compilers and Optimization ,Basic C Data Types ,C Looping Structures ,Register Allocation, Function Calls Pointer Aliasing ,Structure Arrangement Bit-fields ,Unaligned Data and Endianness ,Division ,Floating Point , Inline Functions and Inline Assembly ,Calling between C and Assembly[2],Portability Issues , Writing and Optimizing ARM Assembly Code, Writing Assembly Code, Profiling and Cycle Counting, Instruction Scheduling, Register

Allocation, Conditional Execution, Looping Constructs, Bit Manipulation, Efficient Switches, Handling Unaligned Data **9 Hrs**

Unit-IV

Exception and Interrupt Handling, Exception Handling, Interrupts, Interrupt Handling Schemes,

[3]Bus Structure, Register Programming, Memory Accelerator Module, FLASH Memory Programming.., Memory Map Control, Bootloader, External Bus Interface, External Memory Interface **8 Hrs**

Unit-V

User Peripherals Outline ,General Purpose I/O, General Purpose Timers, PWM Modulator, Real Time Clock ,Watchdog ,UART, I2C Interface, SPI Interface, Analog To Digital Converter, Digital To Analog Converter **8 Hrs**

Reference Books:

1) Andrew N. Sloss, Dominic Symes and Chris Wright, "ARM System Developer's Guide", Morgan Kaufmann Publishers, An imprint of Elsevier, 2004.
2) William Hohl and Christopher Hinds, "ARM Assembly Language Fundamentals and Techniques", second edition, CRC Press,2015.
3) Trevor Martin**,** **"**The Insider's Guide Philips ARM®7 based Microcontrollers An Engineer's Introduction To The LPC2100 Series" Hitex (UK) Ltd.,2005.

PG Syllabus of courses having focus on employability/entrepreneurship/ skill development

18PDEE151 Machine Learning (4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on introduction to the fundamental concepts in machine learning and popular machine learning algorithms. It includes linear modeling, Bayesian approach, classification, clustering and Principal Component Analysis. In the course also discusses various issues related to the application of machine learning algorithms.

Course Outcomes(COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	**Describe** variety of mathematical modeling, inference, and prediction algorithms for machine learning	3	2	
CO-2	**Analyze** the situations of applying variety of mathematical models and algorithms for machine learning	2,3	1	
CO-3	**Compare and justify** mathematical models and algorithms for machine learning	1, 4		2
CO-4	**Apply** algorithms for machine learning and **solve** concerned problems	4, 6		
CO-5	**Justify** the selection of algorithms for machine learning	3	2	
CO-6	**Evaluate** the performance of algorithms for machine learning	3	1	

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	2.3	4	3	3	-	3

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Pre-requisites:

Basics of probability and statistics.

Course Contents:

1. **Linear Modeling-A Least Squares Approach:** Linear Modeling, Making Predictions, Vector/Matrix Notation, Non-Linear Response from a Linear Model, Generalization and Over-Fitting, Regularized Least Squares. **06 Hrs.**
2. **Linear Modeling-A Maximum Likelihood Approach:** Errors as Noise, Random Variables and Probability, Popular Discrete Distributions, Continuous Random Variables - Density Functions, Popular Continuous Density Functions, Likelihood, The Bias-Variance Trade-off, Effect of Noise on Parameter Estimates, Variability in Predictions. **08 Hrs.**
3. **The Bayesian Approach to Machine Learning**: A Coin Game, The Exact Posterior, The Three Scenarios, Marginal Likelihoods, Hyper parameters, Graphical Models, A Bayesian Treatment of the Olympic100m Data, Marginal Likelihood for Polynomial Model Order Selection. **08 Hrs.**
4. **Bayesian Inference:** Non-Conjugate Models, Binary Responses, A Point Estimate - The Map Solution, The Laplace Approximation, Sampling Techniques. **07 Hrs.**
5. **Classification:** The General Problem, Probabilistic Classifiers, Non-Probabilistic Classifiers, Assessing Classification Performance, Discriminative and Generative Classifiers. **08 Hrs.**
6. **Clustering:** The General Problem, K-Means Clustering, Mixture Models. **08 Hrs.**
7. **Principal Components Analysis and Latent Variable Models:** The General Problem, Principal Components Analysis, Latent Variable Models, Variational Bayes, A Probabilistic Model for PCA, Missing Values, Non-Real-Valued Data. **07 Hrs.**

Activity beyond Syllabus: Program development for the machine learning Algorithms in MATLAB and Python.

Reference Books:

1. Simon Rogers, Mark Girolami, "A First Course in Machine Learning", CRC Press, 2017.
2. Ethem Alpaydin, "Introduction to Machine Learning", Prentice Hall of India, Third edition, 2014
3. Mohssen Mohammed, Muhammad Badruddin Khan, Eihab Bashier Mohammed Bashier,

"Machine Learning, Algorithms and Applications", CRC Press, 2017.
4. Tom Mitchell, "Machine Learning", First Edition, McGraw- Hill, 1997.
5. Michael Paluszek, Stephanie Thomas, "MATLAB Machine Learning", A press, 2017

18PDEE157 Advanced Embedded System Design (4-0-0)4

Contact Hours: 52

Course Learning Objectives(CLOs):

The course focuses on real time task scheduling, modifications required in multiprocessor environment, handling of resource sharing and database requirements. Knowledge of General Embedded system and Operating System is required as prerequisite.

Course Outcomes(COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping of POs(1-6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	Identify the principles and characteristics of various applications of Basic and advanced ES.	3		1
CO-2	Distinguish and compare performances various Embedded systems.		3,4	2
CO-3	Design and development of Embedded Systems	1		
CO-4	Architecture and programming concepts of 32-bit Micro controller family.		4	5
CO-5	Embedded System Design based on RTOS.		5	
CO-6	Development of IDE for Design of Advanced ES.	6		

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	2	2	2.5	2	1.5	3

Course Contents:

1. **Typical Embedded System: Core** of the Embedded System, Memory, Sensors and Actuators, Communication Interface, **8 Hrs.**

2. **Embedded Hardware Design and Development**: EDA Tools, How to Use EDA Tool, Schematic Design – Place wire, Bus , port, junction, creating part numbers, Design Rules check, Bill of materials, Netlist creation , PCB Layout Design – Building blocks, Component placement, PCB track routing. **14 Hrs.**
   Embedded Firmware Design and Development: Embedded Firmware Design Approaches, Embedded Firmware Development Languages.
3. **ARM -32 bit Microcontroller family :** Architecture of ARM Cortex M3 –General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Register,. Nested Vector Interrupt Controller. Interrupt behavior of ARM Cortex M3. Exceptions Programming. Advanced Programming Features. Memory Protection. Debug Architecture. **12 Hrs**.
4. **Real-Time Operating System (RTOS) based Embedded System Design** : Operating System Basics, Types of OS, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling: Putting them altogether, Task Communication, Task Synchronization, Device **10 Hrs.**
5. **The Embedded System Development Environment**: The Integrated Development Environment (IDE), Types of Files Generated on Cross compilation, Disassembler/ELDompiler, Simulators, Emulators and Debugging, Target Hardware Debugging, Boundary Scan. **8Hrs.**

Activity beyond syllabus:

Case study and Implementation of RTES.

Reference Books:

1. Shibu K. V., “Introduction to Embedded Systems”, Tata McGraw Hill Education Pvt. Ltd.,, 2009.
2. Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, Newnes, (Elsevier), 2008.
3. James K Peckol, “Embedded Systems – A contemporary Design Tool”, John Weily, 2008.

18PDEE250 Advanced Reconfigurable Computing

Contact H

Course Learning Objectives(CLOs):

Reconfigurable Computing is an elective theory course at postgra semester level. Knowledge of design based on FPGA and microc

architecture are required as prerequisites. The course focuses on key criteria: power, area, speed, optimization techniques employed, various system architectures considered in the design of digital circuits.

Course Outcomes(COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	**Understand** the basics of computing required for processor speed	4	3	1,2
CO-2	**Explain** the technique of reconfiguration required for RTL synthesis	4	2,3	1
CO-3	**Simulate** and **synthesize** the reconfigurable computing architectures.	3	5,2	1
CO-4	**Analyze** and use the reconfigurable architectures for the design of a digital system.	3	1	5,2
CO-5	**Design** of digital systems for a variety of applications on signal processingan d system on chip configurations.	4,2		1
CO-6	**Analyze** the applications of reconfigurable computing applications.	4	1,2	3

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping levels	1.33	1.83	2.6	3.0	1.5	-

Pre-requisites:

Algorithms, Verilog & VHDL Basics

Course Contents:

1. **Introduction:** History, Reconfigurable Vs Processor based system, RC Architecture. **Reconfigurable Logic Devices**: Field Programmable Gate Array, Coarse Grained Reconfigurable Arrays. **Reconfigurable Computing System**: Parallel Processing on Reconfigurable Computers, A survey of Reconfigurable Computing **10 Hrs**

2. **Languages and Compilation:** Design Cycle, Languages, HDL, High Level Compilation, Low level Design flow, Debugging Reconfigurable Computing Applications. **10 Hrs.**
3. **Implementation:** Integration, FPGA Design flow, Logic Synthesis. **10 Hrs.**
   High Level Synthesis for Reconfigurable Devices: Modelling,Temporal Partitioning Algorithms.
4. **Partial Reconfiguration Design:** Partial Reconfiguration Design, Bitstream Manipulation with JBits, The modular Design flow, The Early Access Design Flow, Creating Partially Reconfigurable Designs, Partial Reconfiguration using Hansel-C Designs, Platform Design. **10 Hrs.**
5. **Signal Processing Applications:** Reconfigurable computing for DSP, DSP application building blocks, Examples: Beam-forming, Software Radio, Image and video processing, Local Neighborhood functions, Convolution. **12 Hrs.**
   System on a Programmable Chip: Introduction to So PC, Adaptive Multiprocessing on Chip.

Activity beyond Syllabus:

1. Simple examples may be given on the various concepts/algorithms for better understanding of the subject.
2. Mini project on Image processing using Reconfigurable Hardware

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Reference books:

1. M. Gokhale and P. Graham, “Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays”, Springer, 2005.
2. C. Bobda, “Introduction to Reconfigurable Computing: Architectures, Algorithms and Applications”, Springer, 2007.
3. D. Pellerin and S. Thibault, “Practical FPGA Programming in C”, Prentice-Hall, 2005.
4. W. Wolf, “FPGA Based System Design”, Prentice-Hall, 2004
5. R. Cofer and B. Harding, “Rapid System Prototyping with FPGAs: Accelerating the Design Process”, Newnes, 2005.

18PDEE252	Low Power VLSI	(4-0-0)4

Contact Hours: 52

Course Learning Objectives(CLOs):

course will enable students to know the basics and advanced techniques in low power design which is a hot topic in today's market where the power plays a major role. Describe the various power reduction and the power estimation methods. Explain power dissipation at all layers of design hierarchy from technology, circuit, logic, architecture and system. Apply State-of-the art approaches to power estimation and reduction. Practice the low power techniques using current generation design style and process technology

Course Outcomes(COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	Identify the sources of power dissipation in CMOS circuits.		5,6	
CO-2	Perform power analysis using simulation based approaches and probabilistic analysis.	3,6		5
CO-3	Use optimization and trade-off techniques that involve power dissipation of digital circuits.		3,5	6
CO-4	Make the power design a reality by making power dimension an integral part of the design process	6	3	
CO-5	Use practical low power design techniques and their analysis at various levels of design abstraction and analyze how these are being captured in the latest design automation environments.		3,5	
CO-6	Apply the low power techniques to build efficient system.	4,5		6

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	-	-	2.5	3	2.7	2.5

KURAKUNDI RAGHAVENDRARAO GOPINATH

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Pre-requisites:
Digital VLSI Design

Course Contents:

1. **Introduction:** Need for low power VLSI chips, charging and discharging capacitance, short circuit current in CMOS circuit, CMOS leakage current, static current, basic principles of low power design, low power figure of merits. **6 Hrs**
2. **Simulation power analysis**: SPICE circuit simulation, discrete transistor modeling and analysis, gate level logic simulation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation. **6 Hrs**
3. **Probabilistic power analysis**: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy. **5 Hrs**
4. **Circuit**: Transistor and gate sizing, equivalent pin ordering, network restructuring and reorganization, special latches and flip flops, low power digital cell library, adjustable device threshold voltage. **5 Hrs**
5. **Logic:** Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic. **5 Hrs**
6. **Low power Clock Distribution:** Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co design of clock network . **5 Hrs**
7. **Low power Architecture & Systems:** Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation. **5 Hrs**
8. **Low power arithmetic components:** Introduction, circuit design style, adders, multipliers, division. **5 Hrs**
9. **Low power memory design:** Introduction, sources and reductions of power dissipation in memory subsystem, sources of power dissipation in DRAM and SRAM. **5 Hrs**
10. **Algorithm & Architectural Level Methodologies:** Introduction, design flow, Algorithmic level analysis & optimization, Architectural level estimation & synthesis.**Advanced Techniques:** Adiabatic computation, pass transistor logic synthesis, Asynchronous circuits. **5 Hrs**

Activity beyond syllabus: Power simulation at gate level, logic level and architectural level assignments using Spice tool.

Reference Books:

1. Gary K. Yeap, “Practical Low Power Digital VLSI Design”, Kluwer Academic, 1998.

2. Jan M.Rabaey, Massoud Pedram, "Low Power Design Methodologies" Kluwer Academic, 2010.
3. Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design" Wiley, 2000
4. A.P.Chandrasekaran and R.W.Broadersen, "Low power digital CMOS design", Kluwer Academic,1995.
5. A Bellamour and M I Elmasri, " Low power VLSI CMOS circuit design", Kluwer Academic,1995.

18PDEE254	Image and Video Processing	(4-0-0)4 4

Contact Hours: 52

Course Learning Objectives (CLOs):

Image and Video Processing is an elective course offered at II semester PG level. To learn this subject student should have prior knowledge of Digital signal processing and engineering mathematics. The course focuses on image sampling, quantization, various image enhancement techniques in spatial and frequency domain, color image processing, image compression and fundamental concepts in video processing.

Course Outcomes(COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO (1-6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	**Describe** image perception and color vision model.			1
CO-2	**Compute** image transforms with different transformation techniques	3	2	1
CO-3	**Apply** suitable enhancement and restoration techniques for image processing.			1,5
CO-4	**Differentiate** between various filtering techniques in image processing.		2,3	1,5
CO-5	**Choose** appropriate feature extraction techniques for analyzing the given image.		2	1,5
CO-6	**Select** appropriate compression techniques for various image processing applications.		2	1
CO-7	**Describe** various video			1

	processing techniques.			

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	1.0	1.75	2.0	-	1.0	-

Pre-requisites: Digital signal processing**,** Stochastic and random process Engineering Mathematics.

Course Contents:

1. **Image Perception:** Light, Luminance, Brightness, Contrast, MTF of the visual system, Visibility function, Monochrome vision models, Fidelity criteria, Color representation, Chromaticity diagram, Color coordinate systems, Color difference measures, Color vision model, Temporal properties of vision. **06 Hrs.**
2. **Image Sampling and Quantization:** Introduction, 2D sampling theory, Limitations in sampling & reconstruction, Quantization, Optimal quantizer, Compander, Visual quantization. **04 Hrs.**
3. **Image Transforms:** Introduction, 2D orthogonal & unitary transforms, Properties of unitary transforms, DFT, DCT, DST, Hadamard, Haar, Slant, KLT, SVD transform. **06 Hrs.**
4. **Image Enhancement:** Point operations, Histogram modeling, Spatial operations, Transform operations, Multi-spectral image enhancement, False color and pseudo-color, Color Image enhancement. **08 Hrs.**
5. **Image Filtering & Restoration:** Image observation models, Inverse & Wiener filtering, Fourier domain filters, Smoothing splines and interpolation, Least squares filters, Generalized inverse, SVD and iterative methods, Maximum entropy restoration, Bayesian methods. **08 Hrs.**
6. **Image Analysis & Computer Vision:** Spatial feature extraction, Transform features, Edge detection, Boundary extraction, Boundary representation, Region representation, Moment representation, Structure, Shape features, Texture, Scene matching & detection, Image segmentation, Classification techniques. **08 Hrs.**
7. **Image Data Compression:** Introduction, Pixel coding, Predictive techniques, Transform coding, Inter-frame coding, Coding of two tone images, Image compression standards. **06 Hrs.**
8. **Video Processing:** Fundamental concepts in video – Types of video signals, Analog video, Digital video, Color models in **06 Hrs.**

video, Video compression techniques – Motion compensation, Search for motion vectors, H.261, H.263, MPEG I, MPEG 2, MPEG 4, MPEG 7 and beyond, Content based video indexing.

Activity beyond Syllabus:
Seminar, Simulation based Project.

Reference books:

1. Anil K. Jain, “Fundamentals of Digital Image Processing, " Pearson Education (Asia) Pvt. Ltd., Prentice Hall of India, 2004.
2. Z. Li and M.S. Drew, “Fundamentals of Multimedia”, Pearson Education (Asia) Pvt. Ltd., 2004.
3. R. C. Gonzalez and R. E. Woods, “Digital Image Processing”, 2nd edition, Pearson Education (Asia) Pvt. Ltd, Prentice Hall of India, 2004.
4. M. Tekalp, “Digital Video Processing”, Prentice Hall, USA, 1995.

18PDEE256 Multimedia Communication (4-0-0)4

Contact Hours: 52

Course Learning Objectives (CLOs):
The course deals with the understanding quantitative principles guiding the Multimedia Communication. It focuses on data/information representation. Addresses representation standards and compression algorithms. Understanding the requirements Multimedia operating systems. Understand and analyze synchronization concept across network, as well as choice of appropriate network protocols and standards to meet QOS.

Course Outcomes(COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	**Understand** information representation, **analyze and choose** information representation based on QOS requirements	1,2,3	4	
CO-2	**Identify and address** data formats, compression standards and methodologies	1, 2	3	4
CO-3	**Comprehend** MPEG4 video standard		1,2,3	
CO-4	**Visualize** notion of synchronization in Multimedia Communication**.**	1,3		
CO-5	**Understand and inspect** multimedia	2	4	

	communication across different networks and protocols			
CO-6	**Understand and analyze** requirements of multimedia operating systems.		3,4	

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping levels	2	2.5	-	1	-	-

Pre-requisites:

Knowledge of Processor/Controllers, Languages-Compilers is appreciated.

Course Contents:

1. **Multimedia Communications**: multimedia information representation, multimedia networks, multimedia applications, network QoS and application QoS. **4 Hrs.**
2. **Information Representation:** text, images, audio and video, Text and image compression, compression principles, text compression, image compression. Audio and video compression, audio compression, video compression, video compression principles, video compression standards: H.261, H.263, P1.323, MPEG 1, MPEG 2, Other coding formats for text, speech, image and video. **12 Hrs.**
3. **Detailed Study of MPEG 4**: coding of audiovisual objects, MPEG 4 systems, MPEG 4 audio and video, profiles and levels. MPEG 7 standardization process of multimedia content description, MPEG 21 multimedia framework, Significant features of JPEG 2000, MPEG 4transport across the Internet. **4 Hrs.**
4. **Synchronization:** notion of synchronization, presentation requirements, reference model for synchronization, Introduction to SMIL, Multimedia operating systems, Resource management, process management techniques. **8 Hrs.**
5. **Multimedia Communication Across Networks:** Layered video coding, error resilient video coding techniques, multimedia transport across IP networks and relevant protocols such as RSVP, RTP, RTCP, DVMRP, multimedia in mobile networks, multimedia in broadcast networks. **6 Hrs.**

Reference Books:

1. Fred Halsall, “Multimedia Communications”, Pearson education, 2001
2. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, “Multimedia

Communication Systems", Pearson education, 2004.

1. Raif steinmetz, Klara Nahrstedt, "Multimedia: Computing, Communications and applications", Pearson education, 2002
2. Tay Vaughan, "Multimedia: Making it work", 6th edition, Tata McGraw Hill, 2004.
3. John Billamil, Louis Molina, "Multimedia: An Introduction", PHI, 2002
4. Pallapa Venkataram, "Multimedia Information Systems", Pearson education, 2005.

18PDEE351	Artificial Neural Networks	(4-0-0) 4

Contact Hours: 52

ourse Learning Objectives(CLOs)

ne course focuses on both the classical and the new techniques of neural networks upervised, unsupervised and reinforcement learning schemes. Particularly, a sing erceptron and neurons, feed-forward neural networks, Kohonen's maps, associati emories, Hopfield's and many other recurrent networks will be considered.

ourse Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to Pos (1-6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	**Understand** the role of neural networks in engineering, artificial intelligence and **Learn** basic neural network architecture.	6		
CO-2	**Understand** the differences between networks for supervised and unsupervised learning.		2	
CO-3	**Design** single and multi-layer feed-forward neural networks.	3		
CO-4	**Develop** and train radial-basis function networks.		4	
CO-5	**Design** support vector machines.		4	
CO-6	**Analyze** principal component analysis and **Apply** Self Organizing		2	

	Maps to image coding.			

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	-	2	3	2	-	3

Pre-requisites:

Linear Algebra, Probability

Course Contents:

1. **Introduction:** Neural Network, The human brain, Models of a neuron, Neural networks viewed as directed graphs, Feedback, Network architectures, Knowledge representation, Learning processes, Learning tasks. **03 Hrs.**
2. **Rosenblatt's Perceptron**: Perceptron, The perceptron convergence theorem, Relation between the perceptron and Bayes classifier for a Gaussian environment, Computer experiment: pattern classification, The batch perceptron algorithm. **04 Hrs.**
3. **The Least-Mean-Square Algorithm**: Filtering structure of the LMS algorithm, Unconstrained optimization: a review, The wiener filter, The Least-Mean-Square algorithm, Markov model portraying the deviation of the LMS algorithm from the Wiener filter, The Langevin equation: characterization of Brownian motion, Kushner's direct-averaging method, Statistical LMS learning theory for small learning-rate parameter, Computer experiment I: Linear prediction, Computer experiment II: Pattern classification, Virtues and limitations of the LMS algorithm, Learning-rate annealing schedules. **06 Hrs**.
4. **Multilayer Perceptrons**: Preliminaries, Batch learning and on-line learning, The back-propagation algorithm, XOR problem, Heuristics for making the back-propagation algorithm perform better, Computer experiment: Pattern classification, Back propagation and differentiation, The Hessian and its role in on-line learning, Optimal annealing and **12 Hrs.**

adaptive control of the learning rate, Generalization, Approximations of functions, Cross-validation, Complexity regularization and network pruning, Virtues and Limitations of Back-propagation learning, Supervised learning viewed as an optimization problem, Convolutional networks, Nonlinear filtering, Small-scale versus large-scale learning problems.

5. **Kernel Methods and Radial-Basis Function Networks**: Cover's theorem on the separability of patterns, The interpolation problem, Radial-basis-function networks, K-means clustering, Recursive least-squares estimation of the weight vector, Hybrid learning procedure for RBF networks, Computer experiment: pattern classification, Interpretations of the Gaussian hidden units, Kernel regression and its relation to RBF networks. **10 Hrs.**

6. **Support Vector Machines:** Optimal hyperplane for linearly separable patterns, Optimal hyperplane for nonseparable patterns, The support vector machine viewed as a Kernel machine, Design of support vector machines, XOR problem, Computer experiment: pattern classification, Regression: robustness considerations, Optimal solution of the linear regression problem, The representer theorem and related issues. **05 Hrs**.

7. **Principal-Components Analysis:** Principles of self-organization, Self-organized feature analysis, Principal-Components Analysis: perturbation theory, Hebbian-based maximum Eigenfilter, Hebbian-based Principal-Components Analysis, Case study: Image coding, Kernel Principal-Components Analysis, Basic issues involved in the coding of natural images, Kernel Hebbian algorithm. **06 Hrs**.

8. **Self-Organizing Maps:** Two basic feature-mapping models, Self-organizing map, Properties of the feature map, Computer experiment I: Disentangling lattice dynamics using SOM, Contextual maps, Hierarchical vector quantization, Kernel self-organizing map, Computer experiment II: Disentangling lattice dynamics using Kernel SOM, Relationship between Kernel SOM and Kullback-Leibler divergence. **06 Hrs**.

Reference Books:

1. Simon Haykin, “Neural Networks and Learning Machines” (3rd Edition), Pearson Education, 2009.
2. R. P. Lippmann, “An Introduction to Computing with Neural Nets”, IEEE ASSP Magazine, PP: 4-22, 1987.
3. Robert J. Schalkoff, “Artificial Neural Networks", McGraw-Hill, 1997.
4. Laurene Fausett, “Fundamentals of Neural Networks-Architectures, Algorithms and Applications”, Pearson Education, 2004.
5. B. Yegnanarayana, “Artificial Neural Networks”, Prentice Hall, 2006.
6. S. N. Sivanandam, S. Sumathi, S. N. Deepa “Introduction to Neural Networks using MATLAB 6.0", McGraw-Hill, 2007.

18PDEE352 Cryptographic Systems (4-0-0) 4

Contact Hours: 52

Course Learning Objectives(CLOs):

Cryptographic Systems is an elective theory course at III semester PG level. Knowledge of Finite Fields and communication networks are required as a prerequisite. The course focuses on security principles, architecture, services and encryption / decryption techniques.

Course Outcomes(COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	**Analyze** and **Apply** different symmetric cryptographic techniques to encrypt and decrypt data.		3	
CO-2	**Describe** basic mathematical concepts and pseudorandom number generators required for cryptography	3,4		
CO-3	**Apply** and **estimate** different asymmetric cryptographic algorithms.	4	6	

CO-4	**Explain** authentication functions, Hash functions and MAC to authenticate and protect the encrypted data.		2	
CO-5	**Analyze** key exchange algorithms.		3	2
CO-6	**Discuss** algorithms for digital signature schemes.		3	

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	-	1.5	2.25	3	-	2

Pre-requisites:

Communication networks and finite fields.

Course Contents:

1	**Symmetric Block Ciphers**: Terminology, Steganography, substitution ciphers and transpositions ciphers, Simple XOR, One-Time Pads, Computer Algorithms (Text 2: Chapter 1: Section 1.1 to 1.6), Traditional Block Cipher structure, Data encryption standard (DES), Double DES, 3DES, The AES Cipher. (Text 1: Chapter 2: Section2.1, 2.2, 2.3,2.4,Chapter 4)	**10 Hrs.**
2	**Number Theory**: Introduction to modular arithmetic, Prime Numbers, Fermat's and Euler's theorem, primality testing, Chinese Remainder theorem, discrete logarithms. (Text 1: Chapter 7: Section 1, 2, 3, 4, 5)	**8 Hrs.**
3	**Principles of Public-Key Cryptosystems**: The RSA algorithm, Diffie - Hellman Key Exchange, Elgamal cryptographic system, Elliptic Curve Arithmetic, Elliptic Curve Cryptography (Text 1: Chapter 8, Chapter 9)	**10 Hrs.**

4	**Pseudo-Random-Sequence Generators and Stream Ciphers:** Linear Congruential Generators, Linear Feedback Shift Registers, Design and analysis of stream ciphers, Stream ciphers using LFSRs, A5, Hughes XPD/KPD, NANOTEQ, RAMBUTAN, Additive generators, GIFFORD, Algorithm M, PKZIP (Text 2: Chapter 16)	**10 Hrs.**
5	**One-Way Hash Functions:** Background, SNEFRU, N-Hash, MD4, MD5, Secure Hash Algorithm [SHA],One way hash functions using symmetric block algorithms, Using public key algorithms, Choosing a one-way hash functions, Message Authentication Codes. (Text 2: Chapter 18: Section 18.1 to 18.5, 18.7, 18.11 to 18.14)	**8 Hrs.**
6	**Digital Signatures:** Digital signatures, Elgamal Digital Signature Scheme, Digital signature Algorithm, RSA digital signatures, Elliptic Curve DSA. (Text 1: Chapter 12: Section 12.1, 12.2, 12.4,12.5)	**6 Hrs.**

Activity beyond Syllabus:

Simulation of cryptographic algorithms.

Reference Books:

1. William Stallings, “Cryptography and Network Security Principles and Practice”, Pearson Education Inc., 6th Edition, 2014, ISBN: 978-93-325-1877-3.
2. Bruce Schneier, “Applied Cryptography Protocols, Algorithms, and Source code in C”, Wiley Publications, 2nd Edition, ISBN: 9971-51-348-X.
3. Behrouz A. Forouzan, “Cryptography and Network Security”, 2nd Edition, TMH, 2007.
4. Atul Kahate, “Cryptography and Network Security”, 3rd Edition, TMH, 2013.

18PDEE353	VLSI Digital Signal Processing	(4-0-0)4

Contact Hours: 52

Course Learning Objectives(CLOs):

The subject focuses on DSP Architecture, parallel processing issues in analyzin

DSP Computation systems. The next part covers further the Systolic Architecture Design and pipe lined and parallel recursive and Adaptive filters.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to Pos (1-6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	**Identify** the typical signal processing tasks	3		
CO-2	**Gain knowledge** possibility of reducing the computational complexity	3	6	
CO-3	**Acquire knowledge** various architectures	2		
CO-4	**Acquire knowledge** about optimization in view of power, area and speed	2, 4		
CO-5	**Acquire knowledge** about algorithms available for the purpose of optimization	1, 4, 6		
CO-6	**Compare** the techniques / architectures	6		

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	3	3	3	3	-	2.5

Pre-requisites:

Knowledge of Digital Signal Processing, Analog and digital electronics, CMOS VLSI design.

Course Contents:

1	**Introduction to DSP Systems**: Introduction to DSP Systems, Iteration bound, Data Flow graphs (DFGs) representation, Loop Bound, Iteration rate, Critical loop, Critical path, Area-Speed-Power trade-offs, Algorithms for computing iteration bound, Pipelining of FIR Digital Filters, Parallel Processing, Pipelining and Parallel Processing for low power.	**10 Hrs.**
2	**Algorithmic Transformations**: Retiming Definitions and properties, Retiming Techniques, Clock period minimization, Unfolding, An algorithm for unfolding, Critical path, Applications of unfolding, Sample period reduction, Folding, Folding order, Folding Factor, register minimization techniques, register minimization in folded architecture, Forward Backward Register Allocation technique, folding of multi-rate systems, Folding Bi-quad filters, Retiming for folding.	**12 Hrs.**
3	**Systolic Architecture Design and Fast Convolution:** Introduction, system array design methodology, FIR systolic arrays, , Systolic Design for space representations containing delays Systolic architecture design methodology, Design examples of systolic architectures, selection of scheduling vector, matrix-matrix multiplication and 2-D systolic array design, Hardware Utilization efficiency, Cook-Toom Algorithm, Winograd Algorithm, Iterated Convolution, Cyclic Convolution, Design of fast convolution algorithm by inspection.	**12 Hrs.**
4	**Algorithm Strength Reduction in filter:**Introduction, Parallel FIR filters, Polyphase decomposition, Discrete Cosine Transform and Inverse Discrete Cosine Transform, parallel architectures for Rank Order filters.	**10 Hrs.**
5	**Pipelined and Parallel Recursive and Adaptive Filters**: Introduction, pipelining in 1st order IIR digital filters, pipelining in higher order IIR digital filters, parallel processing for IIR filters, combined pipelining and parallel processing for IIR filters, low power IIR Filter Design using pipelining and	**08 Hrs.**

parallel processing, pipelined adaptive digital filters.

References Books:

1. Parhi, K.K., “VLSI Digital Signal Processing Systems: Design andImplementation”, John Wiley 2007.
2. Oppenheim, A.V. and Schafer, R.W., “Discrete-Time Signal Processing”, Prentice Hall, 2009, 2nd edition.
3. Mitra, S.K., Digital Signal Processing. A Computer Based Approach, McGraw Hill, 2007, 3rd edition.
4. Wanhammar, L., DSP Integrated Circuits, Academic Press, 1999, 2005, ISBN: 978-0131543188

18PDEE356 Wireless Sensor Networks (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The course focuses on architecture of Wireless sensor nodes, Operating systems used in WSN, Medium Access Control Protocols, Networks Protocols, Power Management, Time Synchronization, Localization and security issues in WSN.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-6)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Identify** various parts of WSN and **explain** their construction and operation	3	-	-
CO-2	**Apply** suitable medium access control technique for a given application of WSN.	3	1	-
CO-3	**Apply** suitable data dissemination and routing protocol for a given application of WSN.	4	5	1
CO-4	**Apply** various techniques and **solve** the problems related to power efficiency and synchronization in WSN.	-	4	1

CO-5	**Apply** the techniques and **determine** solutions various issues related to localization and security issues in WSN	-	5	6

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	1.33	-	3	2.4	2	1

Pre-requisites: Sensors and Actuators, Wireless Communication, Microcontrollers, Communication Network protocols.

Contents:

1) **Wireless Sensor Network Basics**: Motivation, Definitions and Background, Challenges and Constraints, Areas of Applications, Node Architecture, Sensing Subsystem, Processor Subsystem, Communication Interfaces, Operating Systems, Functional and Non functional aspects of OS.
05 Hrs
2) **Medium Access Control:** Medium Access Control, Overview, Wireless MAC Protocols, Characteristics of MAC Protocols in Sensor Networks, Contention-Free MAC protocols, Contention based MAC protocols, Hybrid MAC protocols.
08 Hrs
3) **Network Layer**: Overview, Routing Metrics, Flooding and Gossiping, Data-centric Routing, Proactive Routing, On-Demand Routing, Hierarchical Routing, Location based Routing, QoS based routing protocols. **08 Hrs**
4) **Power Management and Time Synchronization:** Local Power Management Aspects, Dynamic Power Management, Conceptual Architecture, Clocks and synchronization problem, Time synchronization in WSN, Basics of Time synchronization, Time synchronization protocols. **09 Hrs**

5) **Localization and Security:** Overview, Ranging Techniques, Range based Localization, Range-Free Localization, Event Driven Localization, Fundamentals of Network Security, Challenges of Security in WSN, Security Attacks in Sensor Networks, Protocols and Mechanisms for Security. **09 Hrs**

Reference Books:

2) Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks”, Wiley Publications, 2014.
3) Kazem Sohraby, Daniel Minoli, Taieb Znati “Wireless Sensor Networks”, Wiley Publications, 2015.
4) Jun Zeng, Abbas Jamalipour "Wireless Sensor Networks", Wiley Publications, 2014.
5) S. Swapnakumar, "A Guide to Wireless Sensor Networks”, Laxmi Publications,

2013.

Course Outcomes (COs):

Description of the Outcome: Upon completion of the course, the student will be able to		**Mapping to POs (1-6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	**Explain** the background, overview and architectural elements of wireless sensor networks.		1,2	
CO-2	**Apply** knowledge of wireless sensor networks(WSN) to various application areas.	3,4	1,2,5	
CO-3	**Outline**the basics of wireless sensor technology	5	1,2	
CO-4	**Discuss &Analyse** the MAC, Transport, Routing protocols for wireless sensor networks.	6		
CO-5	**Estimate** all points related to the Middleware for Wireless Sensor Networks,	1,2,3,4		
CO-6	**Identify** and **observe** issues related to Network management, Network operating systems for Wireless Sensor Networks	1,2,3,4		
CO-7	**Illustrate** Network Operating Systems for Wireless Sensor Networks.	4,5		
CO-8	**Conduct** performance analysis of WSN and manage WSN.	5,6		

POs	PO1	PO2	PO3	PO4	PO5	PO6

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Mapping Level	2	2	1.5	2	2.5	3

Pre-requisites:

Basic of Computer communication networks, Basics of wireless networks.

18PDEP300	**Project Phase - I**	**(0-0-15) 8**

Contact Hours:120

Course Learning Objectives(CLOs):

The course focuses to encourage innovation, enhance research culture and promote team work. It also promotes for attaining leadership qualities with ethical values in developing and applying technology for the betterment of society.

Course Outcomes(COs):

Description of the Course Outcome: At the end of the course the student will be able to		**Mapping to POs (1-6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	**Identify** innovative/research based problem through literature survey and **analyze** from engineering view point.	1	6	
CO-2	**Explore** possible technical solutions for the problem identified		4,6	
CO-3	**Master** the required field by attending workshops / online courses	3		
CO-4	**Demonstrate** the work progress	5		
CO-5	**Prepare** the report in a specific format	2		
CO-6	**Present** the work in a systematic way.	2	6	

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POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping levels	3	3	3	2	3	2

18PDEP400	**Project Phase II**	**(0-0-20)22**

Contact Hours: 200

Course Learning Objectives(CLOs):

The course focuses to encourage innovation, enhance research culture and promote team work. It also promotes for attaining leadership qualities with ethical values in developing and applying technology for the betterment of society.

Course Outcomes(COs):

Description of the Course Outcome: At the end of the course the student will be able to		**Mapping to POs (1-6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	**Design** and **Implement** the solution	1,4,5		
CO-2	**Discuss** the outcome of the work and **justify** the approach and results	3		
CO-3	**Integrate** the work carried out by **producing** a technical paper **publication**	2	6	
CO-4	**Prepare** the report in a specific format.	2	6	
CO-5	**Present** the work in a systematic way	2	6	

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CO-6	**Imbibe** professional ethics and moral/societal responsibilities.		6	

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping levels	3	3	3	3	3	2

18PDEE35X	**Internship**	4 weeks

Internship: should be from the reputed industries. Duration of internship is about 4 weeks during 2nd to 3rd semester break period. Students who undergo Internship are to be exempted for one elective course in III semester.

20PDEE150	**Introduction to Artificial Intelligence & Machine Learning**	**(4-0-0) 4**

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on introduction to the fundamental concepts in artificial intelligence &machine learning. Topics covered include linear modeling, Bayesian approach, classification, clustering and popular machine learning algorithms in each topic. The course also discusses various issues related to the application of artificial intelligence using machine learning techniques.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1 to 6)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Recognize** the characteristics of artificial intelligence systems that make it useful to real-world problems	-	3,1	2
CO-2	**Analyze** the situations of applying variety of mathematical models and algorithms for machine	3	1	-

	learning			
CO-3	**Compare** and **justify** various mathematical models and algorithms used in machine learning	4,1	3	2
CO-4	**Justify** the selection of various classification and regression supervised/unsupervised learning problems of machine learning	-	3,1	-
CO-5	**Select** and **implement** machine learning techniques that are suitable for the applications under consideration	4	3,1	-
CO-6	**Evaluate** the performance of various machine learning algorithms	-	3	1

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	2.0	1.0	2.2	3.0	---	----

Pre-requisites: Basics of probability and statistics, Linear algebra

Contents:

1) **Introduction to Artificial Intelligence:** History of artificial intelligence, Propositional logic; basics of propositional logic, Resolution, Artificial intelligence applicatons, First order logic; basics of first order logic, certain knowledge representation; Taxonomic knowledge, Frames, Nonmonotonic logic. **08 Hrs**
2) **Linear Modeling-A Least Squares Approach:** Linear Modeling, Making Predictions, Vector/Matrix Notation, Non-Linear Response from a Linear Model, Generalization and Over-Fitting, Regularized Least Squares. **05 Hrs**
3) **Linear Modeling-A Maximum Likelihood Approach:** Errors as Noise, Random Variables and Probability, Popular Discrete Distributions, Continuous Random Variables - Density Functions, Popular Continuous Density Functions, Likelihood, The Bias-Variance Trade-off, Effect of Noise on Parameter Estimates, Variability in Predictions. **09 Hrs**
4) **The Bayesian Approach to Machine Learning**: A Coin Game, Exact Posterior, The Three Scenarios, Marginal Likelihoods, Hyper parameters, Graphical Models, A Bayesian Treatment of the Olympic100m Data, Marginal Likelihood for Polynomial Model Order Selection. **09 Hrs**
5) **Bayesian Inference:** Non-Conjugate Models, Binary Responses, A Point Estimate - The Map Solution, The Laplace Approximation, Sampling

Techniques. **08 Hrs**

6) **Classification:** The General Problem, Probabilistic Classifiers, Non-Probabilistic Classifiers, Assessing Classification Performance, Discriminative and Generative Classifiers. **05 Hrs**
7) **Clustering:** The General Problem, K-Means Clustering, Mixture Models. **08 Hrs**

Activity beyond Syllabus: Program development for the machine learning Algorithms in MATLAB/ Python.

Reference Books:

1) Simon Rogers, Mark Girolami, "A First Course in Machine Learning", second edition, CRC Press, 2017.
2) Richard E. Neapolitan &xia Jiang, "Artificial Intelligence with an introduction to machine learning", second edition, CRC press, 2018.
3) EthemAlpaydin, "Introduction to Machine Learning", Prentice Hall of India, Third edition, 2014.
4) Mohssen Mohammed, Muhammad Badruddin Khan, EihabBashier Mohammed Bashier, "Machine Learning, Algorithms and Applications", CRC Press, 2017.
5) Michael Paluszek, Stephanie Thomas, "MATLAB Machine Learning", A press, 2017.

20PDEE254	**IoT Applications**	**(4-0-0) 4**

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on all the important design and implementation details of various functions possible with IoT such as use of specific sensors, computational devices and connectivity to the Internet.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1 to 6)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Understand** the vision of IoT from a global context.	-	6	5
CO-2	**Determine** the market perspective of IoT	-	6	5
CO-3	**Explore** the devices, gateways and data management in IoT	-	4,6	-
CO-4	**Build** the state of art architecture in IoT	4	5,6	1
CO-5	**Apply** the concepts of IoT to solve	4,5	1	2

	industrial and commercial building automation and real world design constraints			
CO-6	**Understand** the vision of IoT from a global context	-	6	5

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	1.5	1	-	2.6	1.6	2

Pre-requisites: Fundamentals of computer network, wireless sensor network, communication & internet technology, web technology, information security.

Contents:

1) **IoT & Web Technology:** The Internet of Things Today, time for convergence, towards the IoT universe, Internet of things vision, IoT strategic research and innovation directions, IoT applications, Future Internet technologies, Infrastructure, Networks and Communication, processes, Data management, Security, Privacy & Trust, device level Energy issues, IoT related standardization, Recommendations on research topics. **10 Hrs**
2) **Machine to Machine(M2M) to IoT:** Basic perspective: Introduction, some definitions, M2M value chains, IoT value chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An architectural overview–building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. **09 Hrs**
3) **IoT Architecture:** Introduction, State of the art, Architecture Reference Model-Introduction, Reference model and architecture, IoT reference Model, IoT reference architecture-Introduction, Functional view, Information view, Deployment and operational view, Other relevant architectural views. **09 Hrs**
4) **IoT Applications for Value Creations**: Introduction, IoT applications for industry: Future factory concepts, Brownfield IoT, Smart objects, Smart applications, Four aspects in your business to master IoT, Value creation from big data and serialization, IoT for retailing industry, IoT for oil and gas industry, Opinions on IoT application and value for industry, Home management,e-Health. **12 Hrs**
5) **Internet of Things Privacy, Security and Governance:** Introduction, Overview of governance, Privacy and security issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-data-Platforms for smart cities, First steps towards a secure platform, Smart approach, Data aggregation for the IoT in smart cities security. **12 Hrs**

Reference Books:

1) Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", 1st Edition, VPT, 2015.
2) Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, A press Publications, 2013.
3) Cuno Pfister, "Getting Started with the Internet of Things," Reilly Media, 2011.
Raj Kamal, "Internet of Things: architecture and design principles "McGraw Hill Education (India),2017.

20PDEE256	**Advanced Mobile Networks**	**(4-0-0) 4**

Contact Hours: 52

Course Learning Objectives (CLOs):

This course focuses on existing Telecommunication networks, past wireless Communication and mobile networks, future LTE and 4G technology and brief overview of upcoming 5G technology.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1 to 6)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO 1	**Discuss** the evolution and history of wireless technology and **compare** different mobile Networks along with their common system components and channel types.	-	2,3,4	1,5,6
CO 2	**Analyze** CDMA techniques with their channel structures and **scrutinize** its operations	-	2,3,4	1,5,6
CO 3	**Understand** the basics of LTE standardization phases and specifications and **Explain** the system architecture of LTE	-	2,3,4	1,5,6
CO 4	**Analyze** the role of LTE radio interface protocols to set up, reconfigure and release the Radio Bearer, for transferring the EPS bearer.	-	2,3,4	1,5,6
CO 5	**Discuss** 4G-LTE cellular technology, architecture and features in detail.	-	2,3,4	1,5,6

CO 6	**Explain** 5G requirements, Regulations, Spectrum Analysis and Sharing for 5G spectrum. Channel modeling.	-	2,3,4	1,5,6

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	1	2	2	2	1	1

Pre-requisites: Wireless Communication

Contents:

1) **Introduction to Wireless Communication and mobile networks :**Existing Telecommunication infrastructure, AMPS Systems and its Frequency plan, The Cellular concept and its analysis, Capacity improvement in cellular systems, Co channel interference reduction.GSM and its Chanel concepts, GSM Network concept. **06 Hrs**
2) **CDMA:** Introduction to CDMA, Walsh codes, Variable tree OVSF, PN Sequences, Multipath diversity, RAKE Receiver, CDMA Receiver Synchronization. OFDM: Introduction to OFDM, Multicarrier Modulation and Cyclic Prefix, Channel model and SNR performance, OFDM Issues – PAPR, Frequency and Timing Offset Issues. **10 Hrs**
3) **LTE (Long Term Evolution) :**Introduction Overview of IP Convergence in the

   mobile networks, Introduction to LTE (Long Term Evolution) and SAE/e PC/EPS,LTE Network Architecture, LTE RAN, Self-Organizing Networks (SON). **10 Hrs**
4) **LTE Interfaces and protocols** : Introduction , Interfaces and protocol types, LTE Packet Core (SAE/EPC and EPS), Evolved Packet Core (EPC) Architecture, Interfaces and Protocols, LTE-Advanced (R10 and beyond), IMS and Voice over IMS for LTE-EPC Voice over LTE Voice over LTE (VolTE), SMS over LTE. **10 Hrs**
5) **4G LTE Cellular Technology:** Network Architecture and Mobile Standards, Introduction, fourth (4^{th}) generation mobile communication, Need and scope for 4G technology, Network architecture of 4G, Geographical Coverage of 4G, Wireless LAN Integration in 4G,features of 4G technology. **06 Hrs**
6) **Overview of 5G Broadband Wireless Communications:** Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro) , An Overview of 5G requirements, Regulations for 5G,Spectrum Analysis and Sharing for 5G. The 5G wireless Propagation Channels: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling, Channel Models for Millimeter (mm) Wave MIMO Systems. **10 Hrs**

Reference Books:

1) Gary J Mullet, Introduction to Wireless Telecommunications systems and Networks, India edition, Cenage leraning 2006.

2) Arunabha Ghosh, Jan Zhang, Jefferey Andrews, Riaz Mohammed, Fundamentals of LTE, Prentice Hall, Communications Engineering and Emerging Technologies.

3) Rakesh Kumar Singh, Ranjan Singh, 4G LTE Cellular Technology: Network Architecture and Mobile standards, Research article, International Journal of Emerging Research in Management & Technology, ISSN: 2278-9359 (Volume-5 Issue-12), December 2016.

4) Afif Osseiran, Jose F. Monserrat, Patrick Marsch, 5G Mobile and Wireless Communications Technology, First edition, Cambridge University Press, 2016

20PDEE257 Software Defined Radio (4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on SDR concepts, architecture and design issues in the design of transmitter and receiver in SDR. The course also covers some examples of SDR and applications of SDR.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1 to 6)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Understand** the architecture of SDR and **quantify** the dynamic performance of SDR.	3	4	
CO-2	**Acquire** the knowledge of various SDRs and **compare** them.	4	2	5
CO-3	**Model** transmitter / receiver synchronization requirements and **measure** the errors involved.	4		
CO-4	**Differentiate** the design and implementation issues in multicarrier Modulation in comparison with single carrier and **solve** the design issues.	5	1,2	6

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CO-5	**Employ** SDRs in advanced applications.		5	6

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	2	2	3	2.7	2	1

Pre-requisites: Digital Signal Processing, Communication Systems

Contents:

1) **Introduction to Software Defined Radio:** A brief idea of Software-Defined Radio, Networking and SDR, RF architectures for SDR, Processing architectures for SDR, Software Environments for SDR, Signal Metrics and Visualization, Receive Techniques for SDR, Digital Signal Processing techniques for SDR, Transmit Techniques for SDR. **10 Hrs**
2) **Understanding SDR Hardware:** Components of a Communication System, Components of an SDR, AD9363 Details, Zynq Details, Linux Industrial Input/Output Details, Radio I/O Basics, Continuous Transmit, Latency and Data Delays, Receive Spectrum, Automatic Gain Control, Common Issues, Example: Loopback with Real Data, Noise Figure. **10 Hrs**
3) **Synchronization:** Timing Synchronization, Matched Filtering, Timing Error, Symbol Timing Compensation, Alternative Error Detectors and System Requirements, Putting the Pieces Together, Carrier Synchronization, Carrier Offsets, Frequency Offset Compensation, Phase Ambiguity, Frame Synchronization and channel Coding, Putting the Pieces Together. **12 Hrs**
4) **Channel Estimation and Equalization and OFDM:** Channel Estimation, Equalizers, Receiver Realization, Rationale for MCM: Dispersive Channel Environments, General OFDM Model, Common OFDM Waveform Structure, Packet Detection, CFO Estimation, Symbol Timing Estimation, Equalization, Bit and Power Allocation. **12 Hrs**
5) **Applications for Software-Defined Radio:** Cognitive Radio, Bumblebee Behavioral Model, reinforcement Learning, Vehicular Networking. **08 Hrs**

Reference Books:

1) Software Defined Radio for Engineers, Travis F. Collins, Robin Getz, Di Pu, Alexander M, Wyglinski, Library of Congress Cataloging-in-Publication Data, 2018.
2) P. Kenington, “RF and Baseband Techniques for Software Defined Radio,” Artech House, 2005.
3) Jeffrey Hugh Reed, “Software Radio: A Modern Approach to Radio Engineering,” Prentice Hall Professional, 2002.

4) Tony J Rouphael, “RF and DSP for SDR,” Elsevier Newnes Press, 2008.