

FACULTY OF ENGINEERING

Scheme of Instruction & Examination (AICTE Model Curriculum)

and

Syllabi

B.E. VII and VIII Semesters of

Four Year Degree Programme in

ELECTRONICS & COMMUNICATION ENGINEERING

(With effect from the Academic Year 2023 - 2024)

(As approved in the Faculty Meeting held on 14/08/2023)



**Dean, Faculty of Engineering
Osmania University, Hyderabad – 500 007
2023**

SCHEME OF INSTRUCTION & EXAMINATION**B.E. VII- Semester****(ELECTRONICS AND COMMUNICATION ENGINEERING)**

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs /Wk	CIE	SEE	Duration in Hrs	
Theory Course										
1	PC416EC	Microwave Theory and Techniques	3	-	-	3	30	70	3	3
2	PE5XXEC	Professional Elective-III	3	-	-	3	30	70	3	3
3	PE5XXEC	Professional Elective-IV	3	-	-	3	30	70	3	3
4	OE6XXYY	Open Elective-II	3	-	-	3	30	70	3	3
Practical/Laboratory Course										
5	PC460EC	Embedded systems and IoT applications lab	-	-	2	2	25	50	3	1
6	PC461EC	Microwave Lab	-	-	2	2	25	50	3	1
7	PW702EC	Summer Internship	-	-	-	-	50	-	-	2
8	PW703EC	Major Project Phase-I	-	-	2	2	50	-	3	2
Total			12	-	6	18	270	380	21	18

PC: Professional Core**PE:** Professional Elective**OE:** Open Elective**PW:** Project Work**L:** Lecture**T:** Tutorial**P:** Practical**D:** Drawing**CIE:** Continuous Internal Evaluation**SEE:** Semester End Examination (Univ. Exam)**EC:** Electronics and Communication Engineering**Note:**

1. Each contact hour is a clock hour.
2. The duration of the practical class is two clock hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

Professional Elective-III		
S. No.	Course Code	Course Title
1	PE509EC	Satellite Communication
2	PE510EC	Embedded System Design
3	PE511EC	Fundamentals of Artificial Intelligence and Machine Learning
4	PE512EC	Fuzzy Logic for Neural Network Applications

Professional Elective-IV		
S. No.	Course Code	Course Title
1.	PE513EC	IC Verification using System Verilog
2	PE514EC	Optical Fiber Communication
3	PE515EC	Cellular and Mobile Communications
4	PE516EC	Electromagnetic Interference and Compatibility
5	PE517EC	Digital Signal Processors and Architecture

Open Elective – II		
S. No.	Course Code	Course Title
1	OE701 EE	Non- Conventional Energy Sources*
2	OE702 EE	Transducers and Sensors*
3	OE703 AE	Automotive Safety and Ergonomics*
4	OE704 ME	Entrepreneurship*
5	OE705 CE	Principles of Green Buildings *
6	OE706 AS	Data Mining *
7	OE707 CS	Web Application Development*
8	OE708 CS	Principles of Python*
9	OE709 AL	Introduction to Deep Learning*
10	OE710 DS	Database Management System*
11	OE711 CB	Privacy & Security in IOT*
12	OE712 IT	Introduction to Cyber security*
13	OE713 EC	Fundamentals of IOT (Not for ECE, CSE, IT, AI&ML, IOT, AI&DS students)
14	OE714 EC	Fundamentals of Neural Networks (Not for ECE, CSE, IT, AI&ML, IOT, AI&DS students)

***NOTE:** These subjects will not be offered to students of parent department

MICROWAVE THEORY AND TECHNIQUES

PC416EC	
<i>Instruction: 3 periods per week</i>	<i>Duration of SEE:- 3 hours</i>
<i>CIE: 30 marks</i>	<i>SEE:- 70 marks</i>
<i>Credits: 3</i>	
<i>Prerequisite: EMTL (PC405EC), AWP (PC412EC)</i>	

Course Objectives:

1. To understand the concept of Microwave signal propagation
2. To comprehend Microwave signal generation and amplification techniques.
3. To study the parameters of various components used in Microwave design.

Course Outcomes: On successful completion of the course, the students will be able to:

1. Analyze the propagation of Guided waves in different modes between parallel planes.
2. Evaluate different parameters (Like impedance, attenuation and quality factor.) for Rectangular & Circular Waveguides & Cavity Resonators.
3. Determine Scattering parameters of different microwave components and analyze their properties.
4. Integrate the concept of bunching and velocity modulation to summarize the operation of microwave tubes and the high frequency limitations of conventional tubes.
5. Analyze the principle, operation and characteristics of different microwave solid state devices.

UNIT – I

Guided Waves: Electromagnetic waves between parallel plates, Propagation of Transverse Electric (TE), Transverse Magnetic (TM) and Transverse Electro Magnetic (TEM) waves between parallel planes. Velocity of propagation, attenuation in parallel plane guides, wave impedance.

UNIT – II

Waveguides: Transverse Electric (TE) and Transverse Magnetic (TM) waves in rectangular and circular waveguides, Wave Impedance, Characteristic Wave Impedance, Attenuation and Quality factor of waveguides. Cavity resonators, resonant frequency and Q, Applications of cavity resonator

UNIT – III

Microwave Circuits and Components: Concept of Microwave circuit, Normalized voltage and current, Introduction to scattering parameters and their properties, S parameters for reciprocal and Non-reciprocal components- Magic Tee, Directional coupler, E and H Plane Tees and their properties, Attenuators, Phase Shifters, Isolators and circulators.

UNIT – IV

Microwave Tubes: High frequency limitations of conventional tubes, Bunching and velocity modulation, mathematical theory of bunching, principles and operation of two cavity, multi cavity and Reflex Klystron. Theory of crossed field interaction: Principles and operation of magnetrons and crossed field Amplifiers, TWT and BWO.

UNIT – V

Microwave Solid State Devices: Principles of operation, characteristics and applications of Varactor, PIN diode, GUNN diode and IMPATT diode. Elements of strip lines, micro strip lines, slot lines and fin-lines and their applications.

Suggested Reading:

1.	E. C. Jordan & Keith G. Balmain, 'Electromagnetic Waves and Radiating Systems', 2 nd edition, Pearson Education, 2006.
2.	Samuel Y. Liao, 'Microwave Devices and Circuits', 3 rd edition, Pearson Education, 2003.
3.	R. E. Collins, "Foundations for Microwave Engineering", 2 nd edition, Wiley India Pvt. Ltd., 2012.
4.	Annapurna Das and Sisir K. Das 'Microwave Engineering', McGraw Hill Education, Third edition, 2014.
5.	Skolnik, Krauss, Reich, 'Microwave principles', East West Press, 1976.
6.	https://onlinecourses.nptel.ac.in/noc20_ee91/preview

PROFESSIONAL ELECTIVE-III

SATELLITE COMMUNICATION

PE509EC	
<i>Instruction: 3 periods per week</i>	<i>Duration of SEE:- 3 hours</i>
<i>CIE: 30 marks</i>	<i>SEE:- 70 marks</i>
<i>Credits: 3</i>	
<i>Prerequisite: Digital Communication (PC413EC)</i>	

Course Objectives:

1. To study basic principles and various effects on satellite communications.
2. To familiarize about the various components in satellite and satellite TV systems.
3. To provide knowledge on the design of satellite communication link and study various access techniques as well as real time applications of satellite communications.

Course Outcomes: On successful completion of the course, the students will be able to

1. Illustrate the basic orbital mechanics of satellite operations.
2. Illustrate the orbital perturbations, launch vehicles and orbital effects on satellite communication systems.
3. Understand various components in satellite systems.
4. Analyse and design satellite space communication link.
5. Understand the operating principle of Direct Broadcast Satellite TV, Radio and satellite mobile services.

UNIT – I
Introduction: A Brief History of Satellite Communications, Overview and Indian Scenario of Satellite Communications. Orbital Mechanics: Kepler’s Laws of Planetary Motion, Satellite orbit, Locating the Earth-Orbiting Satellites, Orbital Elements: Apogee and Perigee Heights, Geostationary Satellite Orbit (GSO), Low earth Orbit (LEO) and Elliptical Orbit. Look Angle Determination.
UNIT – II
Orbital Perturbations, Launchers and Effects: Orbit Perturbations-Longitudinal and Inclination Changes, Orbit Determination. Launches and types of Launch Vehicles: Expendable Launch Vehicle (ELV), Placing Satellites into GSO. Orbital Effects on Communication Systems: Doppler Shift, Range Variations, Solar Eclipse and Sun Transit Outage.
UNIT – III
Satellite System: Satellite Subsystems-Power Supply, Attitude and Orbit Control System (AOCS), Telemetry, Tracking, Command and Monitoring (TTC&M), Communication Subsystems-Communication Systems and Transponders Satellite Antennas: Basic Types and Relationships. Equipment for space qualification, redundancy, reliability analysis using bath tub curve
UNIT – IV
The Space Link: Effective Isotropic Radiated Power, Transmission Losses, Link Power Budget Equation, System Noise, Carrier-to-Noise Ratio, Uplink- Saturation flux density, Input backoff, Downlink - Output back-off, Effects of Rain - Uplink and Downlink Rain-Fade Margin, Combined Uplink and Downlink C/N Ratio Single Access, Preassigned FDMA, Demand-Assigned FDMA, Spade System, TDMA, Preassigned TDMA, Demand-assigned TDMA, Satellite-Switched TDMA, CDMA.
UNIT – V

Direct Broadcast Satellite TV, Radio and Satellite Services: C-Band and Ku-Band Home Satellite TV, Digital DBS TV, DBS- TV System Design, DBS-TV Link Budget, Error Control in Digital DBS- TV, Master Control Station and Uplink, Installation of DBS-TV Antennas, Satellite Radio Broadcasting, Satellite Mobile Communication, VSATs, Radarsat, Introduction to GNSS, Satellite phones.

Suggested Reading:

1.	Timothy Pratt, Charles W. Bostian, and Jeremy E. Allnutt, "Satellite Communications", Wiley-India, 2 nd Edition, 2002.
2.	Dennis Roddy, "Satellite Communications", McGraw-Hill Education, 4 th Edition, 2006.
3.	Wilbur L. Pritchard, Henri G. Snyderhoud, and Robert A. Nelson, "Satellite Communication Systems Engineering", Pearson Education India, 2 nd Edition, 2003.
4.	Tri T. Ha, "Digital Satellite Communication", McGraw-Hill Education, 2 nd Edition, 2017.
5.	N. Agarwal, "Design of Geosynchronous Space Craft", Prentice Hall, 1986.

EMBEDDED SYSTEM DESIGN

PE510EC	
<i>Instruction: 3 periods per week</i>	<i>Duration of SEE:- 3 hours</i>
<i>CIE: 30 marks</i>	<i>SEE:- 70 marks</i>
<i>Credits: 3</i>	
<i>Prerequisite: Microprocessor & Microcontroller (PC409EC)</i>	

Course Objectives:

1. Study hardware and software components and design process of an embedded system
2. Introduce the RISC features of ARM core and study its architecture and instruction set.
3. Familiarize with the different IDEs for firmware development for different family of processors/controllers and study about different tools and techniques for embedded hardware debugging.

Course Outcomes: On successful completion of the course, the students will be able to

1. Classify different types of embedded systems with hardware and software components and discuss the challenges in design
2. Enumerate the instruction set of ARM Processor by studying the architecture of ARM core
3. Acquire knowledge on the serial and parallel communication protocols.
4. Apply modern engineering tools necessary for integrating software and hardware components in embedded system design
5. Summarize different tools and techniques for embedded hardware debugging.

UNIT – I

Introduction to Embedded Systems: Classification, Embedded Processor in a system, Embedded Hardware and Software: Processor embedded into a system, Processor selection for Embedded System, Embedded System-On-Chip, Design process in Embedded System, Characteristics and quality attributes of embedded systems, Design metrics and challenges in Embedded System design.

UNIT – II

The Arm Processor Fundamentals and Instruction set: RISC concepts with ARM Processors, Registers, Current Program status register, pipeline, Exception, Exceptions, Conditional execution, Interrupts and vector table, Core extensions, Architectural Revisions, Arm processors Families.
ARM Instruction Set: Data processing, Data transfer and Branch Instructions, Software interrupt, and Program status register instructions

UNIT – III

Serial Bus Communication protocols: Inter Integrated Circuit(I2C), Controller Area Network(CAN), Universal Serial Bus (USB), Fire wire-IEEE 1394 Bus standard, advanced serial high speed buses. Parallel Bus device protocols: ISA, PCI, PCI-X, ARM Bus, Advanced parallel high speed buses

UNIT – IV

Embedded Software Development Process and Tools: Embedded System design and co-design issues in system development process, Design cycle in the development phase for an Embedded Systems. Embedded software development tools: Host and Target Machines, Linker/Locators for embedded software, Embedded Software into the Target system.

UNIT – V

Testing Simulation and Debugging Techniques and Tools: Integration and testing of embedded hardware, testing methods, debugging techniques, Laboratory tools and target hardware debugging: Logic Analyser, simulator, emulator and in circuit emulator, Case Study: Embedded Systems design for automatic vending machines and digital camera.

Suggested Reading:

1.	Raj Kamal, “ <i>Embedded Systems-Architecture, Programming and Design,</i> ” 3/e, TMH 2017
2.	Andrew N. Sloss, Dominic Symes, Chris Wright,” <i>ARM System Developer’s Guide Designing and Optimizing System Software</i> ”, Elsevier 2004
3.	Shibu K V, “ <i>Introduction to Embedded systems</i> ”, 2/e, McGraw Hill Education 2017
4.	David E. Simon, “ <i>An Embedded software primer,</i> ” Pearson Education 1999
5.	Steve Furber, “ <i>ARM System on chip Architecture,</i> ” 2/e, Pearson Education 2000
6.	https://archive.nptel.ac.in/courses/108/102/108102169/#

FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

PE511EC	
<i>Instruction: 3 periods per week</i>	<i>Duration of SEE:- 3 hours</i>
<i>CIE: 30 marks</i>	<i>SEE:- 70 marks</i>
<i>Credits: 3</i>	
<i>Prerequisite: Probability Theory and Stochastic Process (ES304EC)</i>	

Course Objectives:

1. Study the foundations and Applications of AI.
2. Familiarize with Probabilistic Reasoning and other search algorithms
3. To design Bayesian Networks and Markov model and aspects of Reinforcement learning.

Course Outcomes: On successful completion of the course, the students will be able to

1. Identify problems that are amenable to solution using State space search algorithms.
2. Understand and analyze working of an AI technique using Heuristic search.
3. Understand and design the Bayesian Networks.
4. Understand and apply the concepts of Markov Decision process.
5. Apply of AI concepts to Reinforcement Learning.

UNIT – I

Overview and Search Techniques: Introduction to AI, Problem Solving, State space search, Blind search: Depth first search, Breadth first search, Informed search: Heuristic function, Hill climbing search, Best first search, A* & AO* Search, Constraint satisfaction problem; Game tree, Evaluation function, Mini-Max search, Alpha-beta pruning, Games of chance.

UNIT – II

Knowledge Representation (KR): Introduction to KR, Knowledge agent, Predicate logic, Inference rule & theorem proving forward chaining, backward chaining, resolution; Propositional knowledge, Boolean circuit agents; Rule Based Systems, Forward reasoning: Conflict resolution, backward reasoning: Structured KR: Semantic Net - slots, inheritance, Conceptual Dependency.

UNIT – III

Handling uncertainty and Learning: Source of uncertainty, Probabilistic inference, Bayes's theorem, Limitation of naïve Bayesian system, Bayesian Belief Network (BBN); Machine learning, Basic principal, Utility of ML, Different Paradigms of Machine Learning, Challenges in ML, Hypothesis Evaluation, Applications of ML.

UNIT – IV

Learning and Classifiers: Linear Regression, Multiple linear Regression, Decision Trees: Classification Trees, Regression Trees, Measures of Impurity for Evaluating Splits in Decision Trees: Information Gain, Gain Ratio and Gini Index, Clustering: K-Means Clustering, Hierarchical Clustering, Density-based Clustering.

UNIT – V

Dimensionally Reduction: Principal Component Analysis- Eigen values, Eigen vectors, Orthogonality, Linear Discriminate Analysis, Support vector Machines (SVM) –Hyperplanes, Linearly separable data, Optimal Separating Hyperplane, Kernel trick, Kernel functions.

Case Study: Predicting price of pre-owned cars/Classifying personal income.

Suggested Reading:

1.	Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", 4 th Edition, Pearson 2022
2.	Elaine Rich and Kevin Knight, "Artificial Intelligence", 3 rd Edition, Tata McGraw Hill.2017
3.	Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", 1 st Edition, Cambridge University Press.2014
4.	Ethem Alpaydm, "Introduction to Machine learning", 2 nd Edition, MIT press 2010
5.	M.Gopal, "Applied Machine Learning", 2 nd Edition, McGraw Hill Education (India) 2021
6.	https://nptel.ac.in/courses/106105077

FUZZY LOGIC FOR NEURAL NETWORK APPLICATIONS

PE512EC	
<i>Instruction: 3 periods per week</i>	<i>Duration of SEE:- 3 hours</i>
<i>CIE: 30 marks</i>	<i>SEE:- 70 marks</i>
<i>Credits: 3</i>	
<i>Prerequisite: Digital Electronics (ES303EC)</i>	

Course Objectives:

1. To familiarize with the concepts of regular sets, Fuzzy sets & Fuzzy relations
2. To comprehend Membership functions, Different Fuzzification & Defuzzification methods
3. To study Fuzzy Associative Memories, FAM system Architecture and its applications

Course Outcomes: On successful completion of the course, the students will be able to

1. Distinguish Crisp sets & Fuzzy sets and perform operations on Fuzzy sets
2. Define Fuzzy relations & apply operations on different Fuzzy relations
3. Convert crisp sets to Fuzzy sets using different Fuzzification methods
4. Convert Fuzzy sets to Crisp sets using different Defuzzification methods
5. Understand Fuzzy Associative Memories & FAM system Architecture

UNIT – I

Basics of Fuzzy sets: Introduction to Fuzzy sets, Operation on Fuzzy sets, Properties of Fuzzy sets, Extensions of Fuzzy set concepts: Other kind of Fuzzy sets, Further operations on Fuzzy sets, Extension principle and its applications: Operations of Type-2 Fuzzy sets, Consistency Degree of Two Fuzzy sets.

UNIT – II

Fuzzy Relations: Basics of Fuzzy relations, Fuzzy relation representation, Graph representation of binary Fuzzy relation: Bipartite graph, Simple Fuzzy graph, Operations on Fuzzy relations, Properties of Fuzzy relations, Various types of Binary fuzzy relations: Similarity relations, Resemblance relations & Fuzzy Partial Ordering.

UNIT – III

Properties of Membership functions, Fuzzification: Membership Functions, Features of the Membership function, Fuzzification, Comparisons of Fuzzy sets and Crisp or Fuzzy readings, Different Fuzzification methods: Intuition, Inference, Rank ordering, Neural Networks, Genetic Algorithms, Inductive Reasoning.

UNIT – IV

Defuzzification: Defuzzification to scalars, Different Defuzzification methods: Max membership principle (Height method), Centroid method (Center of area or Center of gravity), Weighted average method, Mean max membership (Middle-of-maxima), Center of sums, Center of largest area, First (or last) of maxima

UNIT – V

Fuzzy Associative Memories: FAMs as Mappings, Fuzzy Hebb FAMs, Bi-directional FAM theorem for Correlation-Minimum Encoding, Correlation-Product Encoding, Superimposing FAM rules, FAM

system Architecture, Example of Inverted pendulum, Fuzzy logic control (FLC) system: Basic structure and operation of FLC system, Applications of Fuzzy controllers.

Suggested Reading:

1.	Timothy J. Ross, "Fuzzy Logic with Engineering Applications", John Wiley & Sons, Third Edition 2010
2.	C.T. Lin and C.S. George Lee, "Neural Fuzzy Systems", PH PTR, 2006.
3.	Bant A KOSKO, "Neural Networks and Fuzzy Systems", PH PTR, 2012.
4.	Altrock, C.V., "Fuzzy Logic and Neuro Fuzzy Applications explained", PH PTR, 2000.
5.	George J. Klir, Bo Yuan, "Fuzzy Sets & Fuzzy Logic", Prentice Hall PTR, 2010.
6.	https://nptel.ac.in/courses/106105077

PROFESSIONAL ELECTIVE-IV

IC VERIFICATION USING SYSTEM VERILOG

PE513EC	
<i>Instruction: 3 periods per week</i>	<i>Duration of SEE:- 3 hours</i>
<i>CIE: 30 marks</i>	<i>SEE:- 70 marks</i>
<i>Credits: 3</i>	
<i>Prerequisite: VLSI Design (PC414EC)</i>	

Course Objectives:

1. Understand the Front-end design and verification techniques
2. Acquire knowledge of SystemVerilog language.
3. Learn about randomization in SystemVerilog, its blocks and functions

Course Outcomes: On successful completion of the course, the students will be able to

1. Understand about basic OOP, its classes and objects
2. Learn about different data types, arrays, queues, Structures and Unions. Understand tasks, functions, void functions and statements
3. Learn different verification processes and data types.
4. Understand about Inter Process Communication, packages, compiler directives, parameters
5. Understand Randomization in SystemVerilog

UNIT – I

Verification Guidelines: Introduction, Verification Process, Plan, Methodology Manual, Basic Testbench Functionality, Directed Testing, Methodology Basics, Constrained-Random Stimulus, Functional Coverage, Testbench Components, Layered Testbench.

UNIT – II

Data Types, Arrays: dynamic array, associative array, array manipulation methods, locator methods, ordering methods, reduction methods, iterator index querying. queues. structures and unions. If statement, loops: while loop, do while loop, forever loop, for loop, foreach loop, break and continue, functions and tasks, processes: fork join, fork join_any, fork join_none.

UNIT – III

Classes, accessing unallocated memory, class assignment, an array of objects, static properties and methods in classes, this keyword in classes, shallow copy, deep copy, inheritance, super keyword in classes, virtual keyword in classes, abstract class, polymorphism, scope resolution operator, extern method, parameterized classes, data encapsulation and hiding, local access qualifier, protected access qualifier, constant class properties, typedef class.

UNIT – IV

Randomization, if-else in constraints, implication operator in constraint, foreach loop in constraint, dist keyword in constraints, inheritance in constraint, function in constraint, disable randomization, static constraints, unique constraint, bidirectional constraint, solve before in constraint, inline constraints, soft constraint, randomization methods: pre_randomize and post_randomize, randcase.

UNIT – V

Inter Process Communication: events, nonblocking events, wait_order in events, merging events, passing an event, semaphores, mailbox, interface: modport, clocking block, virtual interface. program block, casting, packages, compiler directives, parameters, final block, named blocks, statement labels.

Suggested Reading:

1.	System Verilog for Verification: A Guide to Learning the Testbench Language Features, Chris Spear, Springer 2006.
2.	A System Verilog Primer J. Bhaskar, Publisher: ISBN: 9788178002804, BS Publications, 2022.
3.	Writing Testbenches Using SystemVerilog, Janick Bergeron, Springer, 2006.
4.	SystemVerilog for Design: A Guide to Using SystemVerilog for Hardware Design and Modeling, 2 nd Edition, Stuart Sutherland, Simon Davidman and Peter Flake, Springer 2004
5.	Writing Testbenches: Functional Verification of HDL Models, Second edition, Janick Bergeron, Kluwer Academic Publishers, 2003.
6.	https://archive.nptel.ac.in/courses/106/103/106103116/

OPTICAL FIBER COMMUNICATION

PE514EC	
<i>Instruction: 3 periods per week</i>	<i>Duration of SEE:- 3 hours</i>
<i>CIE: 30 marks</i>	<i>SEE:- 70 marks</i>
<i>Credits: 3</i>	
<i>Prerequisite: Digital Communication (PC413EC)</i>	

Course Objectives:

1. Understand operating principles of light sources and detectors used in optical transmitters and Receivers.
2. Design an optical link in view of loss and dispersion.
3. Understand various configurations, Losses and dispersion through optical fiber.

Course Outcomes: On successful completion of the course, the students will be able to

1. Analyze the losses inserted in an optical fiber
2. Study of material used and underlying principles of optical signal generation
3. Design of optical detection systems
4. Design an optical link in view of loss and dispersion.
5. Study of modes of optical communication through optical waveguides

UNIT – I

Optical fibers: Evolution of fiber optic system, Elements of Optical Fiber Transmission link, Ray Optics, Optical Fiber Modes and Configurations, Mode theory of Circular Waveguides, Overview Low frequency data transportation of Modes and Key concepts, Linearly Polarized Modes, Single Mode Fibers and Graded Index fiber

UNIT – II

Attenuation and Dispersion: Attenuation - Absorption losses, Scattering losses, Bending Losses, Core and Cladding losses, Signal Distortion in Optical Waveguides-Information Capacity determination, Group Delay, Material Dispersion, Waveguide Dispersion, Signal distortion in SM fibers-Polarization Mode dispersion, Intermodal dispersion, Pulse Broadening in Guided Index fibers, Mode Coupling

UNIT – III

Optical Sources, Amplifiers and Coupling: Direct and indirect Band gap materials, LED structures, Light source materials, Quantum efficiency, LED power, Modulation of LED, laser Diodes, Modes and Threshold condition. Rate equations, External Quantum efficiency, Resonant frequencies, Laser Diodes, Temperature effects, Introduction to Quantum laser, Fiber amplifiers, Power Launching and coupling, Lensing schemes, Fiber-to-Fiber joints, Fiber splicing.

UNIT – IV

Photo detectors & Receivers: PIN and APD diodes, Photo detector noise, SNR, Detector Response time, Avalanche Multiplication Noise, Comparison of Photo detectors, Fundamental Receiver Operation, preamplifiers, Error Sources, Receiver Configuration, Probability of Error, Quantum Limit.

UNIT – V

Digital Links and Optical Networks: Point-to-Point link system considerations -Link Power budget, Rise - time budget, Noise Effects on System Performance, Operational Principles of WDM and

Applications. Erbium-doped Amplifiers Introductory concepts of SONET/SDH Network Multiple signal interface in fibers, Bandwidth utilization, Interface with nano-electronic devices.

Suggested Reading:

1.	Gourd Keiser, "Optical Fiber Communication," 4/e, TMH, 2000.
2.	J.Senior, "Optical Communication, Principles and Practice," PHI, 1994.
3.	J.Gower, "Optical Communication System," PHI, 2001.
4.	Binh, "Digital Optical Communications," First Indian Reprint 2013, (Taylor & Francis), Yesdee Publications.
5.	MMK.Liu, Principles and Applications of Optical Communications, TMH, 2010
6	https://onlinecourses.nptel.ac.in/noc23_ee80/preview

CELLULAR AND MOBILE COMMUNICATIONS

PE515EC	
<i>Instruction: 3 periods per week</i>	<i>Duration of SEE:- 3 hours</i>
<i>CIE: 30 marks</i>	<i>SEE:- 70 marks</i>
<i>Credits: 3</i>	
<i>Prerequisite: Digital communication(PC413EC)</i>	

Course Objectives:

1. To understand the concept and implementation of frequency reuse and Handoff techniques and to analyse interference and capacity enhancement.
2. To appreciate the factors influencing outdoor and indoor propagation systems
3. To understand the concepts in various Mobile Technologies.

Course Outcomes: On successful completion of the course, the students will be able to

1. Understand the method of selection and reuse of a set of frequency channels, Base station requirement.
2. Appreciate and understand the methods of electromagnetic wave propagation in cellular communication.
3. Identify different a methods of mobile access technologies and which of them suitable for mobile cellular solutions.
4. Explain features, authentication, operational details of GSM and CDMA mobile cellular system.
5. Understand the development and limitation of the preliminary and advanced generation of mobile systems and the present trends.

UNIT – I

Basic Cellular system and its operation, frequency reuse, channel assignment strategies, Handoff process, factors influencing handoffs, handoffs in different Generations, Interference and system capacity, Cross talk, Enhancing capacity and cell coverage, Trunked radio system. Manual and Automatic Electronic Exchanges.

UNIT – II

Free space propagation model, three basic propagation mechanisms, practical link budget design using path loss models, outdoor propagation models: Durkin's model and indoor propagation model, partition losses. Small scale multipath propagation, Parameters of mobile ,multipath channels, Mobile antennas/ radiation patterns

UNIT – III

Data multiple access Technologies in Communication: FDMA, TDMA, SSMA, FHMA, CDMA, SDMA, Packet radio protocols, CSMA, Reservation protocols time Frame details.

UNIT – IV

GSM: Services and Features, System architecture, Radio Sub system, Channel Types, Frame structure and Signal processing. CDMA: Digital Cellular standard IS-95, Forward Channel, Reverse Channel.

UNIT – V

Comparison of Mobile communication Technologies: 1G, 2G and 2.5G, technology

Features of 3G and 4G and 5G, WLAN, Bluetooth, PAN, Trends in Radio and Personal Communications, UMTS system architecture and Radio Interface.
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Suggested Reading:

1.	Theodore.S. Rappaport, “Wireless Communications: Principles and Practice”, 2/e, Pearson Education, 2010.
2.	William. C.Y. Lee, “Mobile Communication Engineering,” 2/e, Mc-Graw Hill, 2008.
3.	T.L. Singal, “Wireless Communication Systems”, 1/e, TMH Publications, 2010.
4.	William.C.Y. Lee, “Mobile Cellular Telecommunications: Analog and Digital Systems”, 2/e, Mc-Graw Hill, 2011
5.	Nishith D. Tripathi and Jeffrey H. Reed, "Cellular Communications A Comprehensive and Practical Guide" Wiley 2014.
6	https://archive.nptel.ac.in/courses/108/106/106106167/#

ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

PE516EC	
<i>Instruction: 3 periods per week</i>	<i>Duration of SEE:- 3 hours</i>
<i>CIE: 30 marks</i>	<i>SEE:- 70 marks</i>
<i>Credits: 3</i>	
<i>Prerequisite: EMTL(PC405EC), AWP(PC412EC)</i>	

Course Objectives:

1. To learn the various sources of Electromagnetic Interference.
2. To familiarize the fundamentals those are essential for product design with EMC compliance.
3. To understand the various EMC pre compliance measurement.

Course Outcomes: On successful completion of the course, the students will be able to

1. Analyze the different EM coupling principles and its impact on performance of electronic system.
2. Understand the concept of EMI / EMC related to product design.
3. Have broad knowledge of various aspect of EMC and its standards.
4. Ensure that a designed system conforms itself to certain standard through a thorough understanding of various standards in different countries.
5. Have broad knowledge of various EM radiation measurement techniques.

UNIT – I

Introduction to EMI and EMC- EM environment, Historical Notes, Problems of EMI, Frequency Conservation, Assignment & spectrum, practical experiences, Occurrence of EMI, Concepts of EMI/EMC-definitions, Sources of noise, Natural and Nuclear Sources of EMI, Conducted and Radiated Emissions and Susceptibility. Introduction – EMI Testing and Compliance Tests, ESD, EMP.

UNIT – II

Conducted and radiated emission -power supply line filters-common mode and differential mode current-common mode choke- switched mode power supplies. Modeling of filter for suppression of EMI in the design, choice of various electronic components, Pulse Interference Immunity, LISN.

UNIT – III

Shielding techniques- shielding effectiveness-shield behavior for electric and magnetic field, **Grounding techniques-** signal ground-single point and multi point grounding-system ground- common impedance coupling -common mode choke-Digital circuit power distribution and grounding.

UNIT – IV

EMI Measurements: Introduction to various instruments used in the measurements and their characteristics, Radiated Interference Measurements, Conducted Interference Measurements, Pitfalls in EMI Measurements, Measurements of pulsed EMI.

UNIT – V

Contact protection- arc and glow discharge-contact protection network for inductive loads-C, RC, RCD protection circuit- inductive kick back. RF and transient immunity-transient protection network-RFI mitigation filter-power line disturbance- ESD- human body model- ESD protection in system design.

Suggested Reading:

1.	H. W. Ott, Electromagnetic Compatibility Engineering, 2nd edition, John Wiley & Sons, 2011, ISBN: 9781118210659.
2.	C. R. Paul, Introduction to Electromagnetic Compatibility, 2nd edition, Wiley India, 2010, ISBN: 9788126528752.
3.	K. L. Kaiser, Electromagnetic Compatibility Handbook, 1st edition, CRC Press, 2005. ISBN: 9780849320873.
4.	Kodali, V.P., "Engineering EMC- Principles, Measurements, Technologies and Computer Models", 2nd Ed., IEEE Press, NY, 2000.
5.	IMPACT, EMI/EMC for Engineering Colleges, RSTE , 1997.
6.	https://archive.nptel.ac.in/courses/108/106/108106138/

DIGITAL SIGNAL PROCESSORS AND ARCHITECTURE

PE517EC	
<i>Instruction: 3 periods per week</i>	<i>Duration of SEE:- 3 hours</i>
<i>CIE: 30 marks</i>	<i>SEE:- 70 marks</i>
<i>Credits: 3</i>	
<i>Prerequisite: Digital Signal Processing(PC408EC)</i>	

Course Objectives:

1. The architectures of digital signal processors and design aspects of digital signal processing algorithms.
2. The memory and external input/output peripheral interface with programmable DSP processor.
3. The realization of digital filters and fast fourier transform algorithms of the signal spectrum on host DSP processor.

Course Outcomes: On successful completion of the course, the students will be able to

1. Explain the floating point and fixed-point arithmetic number representation systems for processing signal in digital signal processor.
2. Compare the architectural features of general-purpose processors and digital signal processors.
3. Use the instruction sets of TMS320C54XX processor for implementing assembly language programs.
4. Make use of memory and input/output peripherals to interface the programmable DSP devices for increasing time response of a system
5. Analyze IIR and FIR Filters on programmable digital signal processors using Q15 Format.

UNIT – I

Introduction to digital signal processing: Digital signal-processing system, discrete Fourier Transform (DFT) and Fast Fourier transform (FFT), differences between DSP and other micro processor architectures; **Number formats:** Fixed point, floating point and block floating point formats, IEEE-754 floating point, dynamic range and precision, relation between data word size and instruction word size; Sources of error in DSP implementations: A/D conversion errors, DSP computational errors, D/A conversion errors, Q-notation.

UNIT – II

Architecture of Programmable DSPs: Multiplier and multiplier accumulator, modified bus structures and memory access in PDSPs, multiple access memory, multiport memory, SIMD, VLIW architectures, pipelining, special addressing modes in PDSPs, on-chip peripherals.

UNIT – III

Overview of TMS320c54xx processor: Architecture of TMS320C54XX DSPs, addressing modes, memory space of TMS320C54XX processors. Program control, instruction set and programming, on-chip peripherals, interrupts of TMS320C54XX processors, pipeline operation.

UNIT – IV

Interfacing memory and i/o peripherals to PDSPs :Memory space organization, external bus interfacing signals, memory interface, parallel I/O interface, programmed I/O, interrupts and I/O, direct memory access (DMA)

UNIT – V

Implementations of basic DSP algorithms The Q-notation, convolution, correlation, FIR filters, IIR filters, interpolation filters, decimation filters, an FFT algorithm for DFT filters computation of the signal spectrum.

Suggested Reading:

1.	Avatar Singh and S. Srinivasan, Digital Signal Processing Thomson Publications, 1st Edition, 2004.
2.	B. Ventakaramani, M. Bhaskar, Digital Signal Processors Architecture Programming and Applications, Tata McGraw- Hill, 1 st Edition, 2006.
3.	K Padmanabhan, R. Vijayarajeswaran, Ananthi. S, A Practical Approach to Digital Signal Processing, New Age International, 1st Edition, 2006.
4.	Ifeachor E. C., Jervis B. W, Digital Signal Processing: A practical approach, Pearson Education, PHI/, 2nd Edition, 2002
5.	Peter Pirsch, Architectures for Digital Signal Processing, John Wiley, 1st Edition, 2007.
6.	https://archive.nptel.ac.in/courses/117/105/117105145/#

EMBEDDED SYSTEMS AND IOT APPLICATIONS LAB

PC460EC	
<i>Instruction: 3 periods per week</i>	<i>Duration of SEE:- 3 hours</i>
<i>CIE: 25 marks</i>	<i>SEE:- 50 Marks</i>
<i>Credits: 1</i>	
<i>Prerequisites: Microprocessor & Microcontroller Lab(PC455EC)</i>	

Course Objectives:

1. Familiarize with the usage of IDE tools and execution of programs using ARM processor
2. Understand the usage of various devices like LCD, Temperature sensor, Buzzer, Stepper Motor by interfacing them to LPC2148.
3. Study the designing and implementation of IoT applications using Arduino/RPi

Course Outcomes: On successful completion of the course, the students will be able to

1. Understand the usage of IDE tools
2. Develop interfacing applications like display devices and input devices using ARM Processor
3. Develop program using ARM processor to read the sensor values and display them
4. Develop the IoT applications using Arduino/Raspberry Pi
5. Utilize the thingspeak cloud to display the sensor values

PART-A

Interfacing Programs using embedded C on ARM Micro controller Kit

1. Program to interface 8-Bit LED and switch interface
2. Program to implement Buzzer interface on IDE environment
3. Program to display message in a 2 line x 16 characters LCD display
4. Program to interface stepper motor Stepper motor and rotate in clockwise and anticlock wise direction
5. Program to interface a Temperature sensor LM35 and read the values and display it
6. Program to demonstrate serial communication i.e to transmit from kit and receive from PC using serial port.

PART-B

Interfacing Programs using C / Python Programming Arduino / Raspberry Pi Kit for IoT Applications

7. Interface a Push button with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed
8. Interface Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED at sensor detection.
9. Interface LCD with Arduino/Raspberry Pi and write a program to display a message on it.
10. Interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings
11. Interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
12. Interface Bluetooth unit with Arduino/Raspberry Pi and write a program to turn LED ON/OFF

when “1”/”0” is received from smart phone using Bluetooth.
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13. Program to upload temperature and humidity data to thingspeak cloud using Arduino/Raspberry Pi
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Note: A minimum of 10 experiments to be performed and at least 5 experiments from each part to be performed.

MICROWAVE LAB

PC 461 EC	
<i>Instruction: 2 periods per week</i>	<i>Duration of SEE:- 3 Hours</i>
<i>CIE: 25 marks</i>	<i>SEE:- 50 Marks</i>
<i>Credits: 1</i>	
<i>Prerequisite: EMTL (PC405EC), AWP (PC412EC)</i>	

Course Objectives:

1. Understand the characteristics of Reflex Klystron Oscillator and Gunn oscillator.
2. Measurement of frequency and wavelengths would be learnt by the student.
3. VSWR various TEES would be understood by the student.

Course Outcomes: On successful completion of the course, the students will be able to

1. Analyze frequency, Wave length, SWR and Impedance for Reflex klystron Oscillator by using its equation.
2. Evaluate of mode characteristics of Reflex klystron and V-I Characteristics of Gunn diode.
3. Analyze of the characteristics of Circulator, Isolator, Directional Coupler, Tees like (Magic tee , E & H plane tees) using the Scattering parameters.
4. Generate the Radiation pattern of different antennas like Yagi-Uda and Horn Antenna and measure the gain of the antennas.
5. Understand the characteristics of Microwave Sources.

List of experiments

1. To find and verify characteristics of Reflex Klystron oscillator, mode numbers and efficiencies of different modes
2. To find and verify characteristics of Gunn diode oscillator, Power Output Vs Frequency, Power Output Vs Bias Voltage
3. To measure and verify frequency and guide wavelength calculation using microwave bench setup.
4. To measure low and high VSWR of different components like matched terminations.
5. To measure impedance of horn antenna.
6. To measure and verify the S-parameters of Directional coupler.
7. To measure and verify the S-parameters of Tees: E plane, H plane and Magic Tee.
8. To measure and verify the S-parameters of Circulator.
9. To measure radiation patterns for basic microwave antennas like horn and parabolic reflectors in E-plane and H-plane. Also to finding the gain, bandwidth and beam width these antennas.
10. To design, Simulate and Analyze the Dipole Antenna Structure by using EM simulation software
11. To design, Simulate and Analyze a Micro strip Rectangular Patch Antenna by using EM simulation software
12. To design, Simulate and Analyze a Probe Feed Patch Antenna by using EM simulation software
13. To design, Simulate and Analyze a The Triangular Micro strip Antenna by using EM simulation software

Suggested Reading:

1.	M L Sisodia & G S Raghuvanshi, 'Basic Microwave Techniques and Laboratory Manual', New Age International (P) Limited, Publishers 2009
2.	Ramesh Garg, Prakash Bhartiya, Inder Bahl and Apisak Ittipiboon 'Microstrip Antenna Design Handbook' Artech House Publishers, 2001.

SUMMER INTERNSHIP

PW702EC	
<i>Instruction: -</i>	<i>Duration of SEE:- -</i>
<i>CIE: 50 marks</i>	<i>SEE:- -</i>
<i>Credits: 2</i>	
<i>Prerequisites: -</i>	

Course Objectives:

1. To get involved in design, development and testing practices followed in the industry.
2. To enhance technical writing skills in reporting as per the industry standards.
3. To participate in teamwork and preferably as part of a multi-disciplinary team.

Course Outcomes: On successful completion of the course, the students will be able to

1. Apply knowledge and skills learned in company/industry/organization to real-world problems.
2. Demonstrate knowledge of contemporary issues related with engineering in general.
3. Effectively use new tools and technologies for solving engineering problems.
4. Gain experience related to working practices within Industrial/R&D Environments.
5. Prepare reports and other relevant documentation.

Summer Internship is introduced as part of the curricula of encouraging students to work on problems of interest to industries. A batch of three students will be attached to a person from the Government or Private Organizations/Computer Industry/Software Companies/R&D Organization for a period of 4-6 weeks. This will be during the summer vacation following the completion of the III-year Course. One faculty coordinator will also be attached to the group of 3 students to monitor the progress and to interact with the industry coordinator (person from industry).

The course schedule will depend on the specific internship/training experience. The typical time per topic will vary depending on the internship

-Overview of company/project

-Safety training

-Discussions with project teams

-Background research, review of documents, white papers, and scientific papers

-Planning, designing, and reviewing the planned work

-Executing the plans

-Documenting progress, experiments, and other technical documentation

-Further team discussions to discuss results

-Final report writing and presentation

After the completion of the project, each student will be required to:

1. Submit a brief technical report on the project executed.

2. Present the work through a seminar talk (to be organized by the Department).

Award of sessionals are to be based on the performance of the students at the workplace and awarded by industry guide and internal guide (25 Marks) followed by presentation before the committee constituted by the department (25 Marks). One faculty member will co-ordinate the overall activity of Industry Attachment Program.

Note: Students have to undergo summer internship of 4-6 weeks at the end of VI semester and credits will be awarded after evaluation in VII semester.

MAJOR PROJECT PHASE-I

PW703EC	
<i>Instruction: 6 periods per week</i>	<i>Duration of SEE:- -</i>
<i>CIE: 50 marks</i>	<i>SEE:- -</i>
<i>Credits: 2</i>	
<i>Prerequisites: -</i>	

Course Objectives:

1. To familiarize tools and techniques of systematic literature survey and documentation.'
2. To expose the students to industry practices and team work.
3. To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes: On successful completion of the course, the students will be able to

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility.
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills.
5. Find relevant sources (e.g., library, Internet, experts) and gathers information for preparing reports and other relevant documentation.

The department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester.

The department will appoint a project coordinator who will coordinate the following:

- Collection of project topics/ descriptions from faculty members (Problems can also be invited from the industries)
- Grouping of students (max 3 in a group)
- Allotment of project guides

The aim of project work is to develop solutions to realistic problems applying the knowledge and skills obtained in different courses, new technologies and current industry practices. This requires students to understand current problems in their domain and methodologies to solve these problems. To get awareness on current problems and solution techniques, the first 4 Weeks of VII semester will be spent on special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R&D institutions. After completion of these seminars each group has to formalize the project proposal based on their own ideas or as suggested by the project guide.

Seminar schedule will be prepared by the coordinator for all the students from the 5th week to the last week of the semester which should be strictly adhered to.

Each group will be required to:
1. Submit a one-page synopsis before the seminar for display on notice board.
2. Give a 30 minutes presentation followed by 10 minutes discussion.
3. Submit a technical write-up on the talk.
At least two teachers will be associated with the Project Seminar to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.
The seminar presentation should include the following components of the project:
➤ Problem definition and specification
➤ Literature survey
➤ Broad knowledge of available techniques to solve a particular problem.
➤ Planning of the work, preparation of bar (activity) charts
➤ Presentation- oral and written.

OPEN ELECTIVE – II

FUNDAMENTALS OF IOT

OE713 EC	
<i>Instruction: 3 periods per week</i>	<i>Duration of SEE:- 3 hours</i>
<i>CIE: 30 marks</i>	<i>SEE:- 70 marks</i>
<i>Credits: 3</i>	
<i>Prerequisite: NIL</i>	

Course Objectives:

1. To discuss fundamentals of IoT and its applications and requisite infrastructure
2. To describe Internet principles and architecture and applications relevant to IoT
3. To discuss private and security aspects of IoT system

Course Outcomes: On successful completion of the course, the students will be able to

1. Understand IoT technology and research directions.
2. Comprehend various protocols and architecture of IoT
3. Design simple IoT systems with IoT reference model
4. Understand the various applications of IoT
5. Comprehend the different privacy and security approaches at IoT.

UNIT – I

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.

UNIT – II

M2M to IoT: A 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 an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

UNIT – III

IoT Architecture: State of the Art – 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.

UNIT – IV

IoT Applications: IoT Physical Devices and Endpoints: Raspberry Pi, Interfaces of Pi, Programming pi - Controlling LED and LDR using Pi, Opinions on IoT Application and Value for Industry, Home Management, Smart Cities, Smart Environment, Smart Energy, Smart Retail and Logistics, Smart Agriculture and Industry, Smart Industry and eHealth.

UNIT – V

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, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security.

Suggested Reading:

1.	Adrian McEwen, Hakim Classically, “Designing the Internet of Things”, Wiley India Publishers, 2014.
2.	Vermesan, Ovidiu and Peter Friess, eds. Internet of things: converging technologies for smart environments and integrated ecosystems. River publishers, 2013.
3.	VijayMadiseti and ArshdeepBahga, ‘Internet of Things(A Hands-onApproach)’, 1st edition, VPT, 2014.
4.	Francis DaCosta, ‘Rethinking the Internet of Things: A Scalable Approach to Connecting Everything’, 1st edition, Apress Publications, 2013.
5.	Cuno Pfister, ‘Getting Started with the Internet of Things’, O’Reilly Media, 2011.
6.	https://onlinecourses.nptel.ac.in/noc23_cs83/preview

FUNDAMENTALS OF NEURAL NETWORKS

OE714 EC	
<i>Instruction: 3 periods per week</i>	<i>Duration of SEE:- 3 hours</i>
<i>CIE: 30 marks</i>	<i>SEE:- 70 marks</i>
<i>Credits: 3</i>	
<i>Prerequisite: NIL</i>	

Course Objectives:

1. Study the functioning of biological neuron and its electronic implementation
2. Familiarize with the concepts of pattern recognition tasks as applied to Neural Networks
3. Introduce the different Feedback Neural Networks & their applications..

Course Outcomes: On successful completion of the course, the students will be able to

1. Differentiate between Biological Neuron & Artificial Neuron and different Neuron Models.
2. Analyze activation & synaptic dynamics of Neural Networks.
3. Summarize the Pattern Recognition Tasks & different Neural Network memories.
4. Solve Perceptron XOR problem & write different training algorithms for Feed Forward Neural Networks
5. Understand & train different Feedback Neural Networks and their applications.

UNIT – I

Introduction to Neural Networks: Biological Neuron and Biological Neural network, Mathematical model of Artificial Neuron, Neuron models: McCulloch-Pitts (MP) model, Perceptron model and ADALINE model, Neural Network Topologies, Classification of Classification of Neural Networks and Architectures of Feed Forward, Feedback Neural Networks.

UNIT – II

Activation, Synaptic dynamics of Neural Networks and Neuron Learning: Distinction between Activation and Synaptic dynamics of neuron models, Requirements of learning laws. Supervised and Unsupervised learning. Learning laws: Hebbian learning, Perceptron learning, Delta learning, LMS learning. Reinforcement learning. Competitive learning.

UNIT – III

Pattern Recognition Tasks: Pattern association, pattern storage (LTM & STM), Pattern clustering and feature mapping, Neural Network Memory: Auto Associative Memory, Hetero Associative Memory, Bidirectional Associative Memory. Design of logic OR, AND, NOT gates and single bit memory element using MP model.

UNIT – IV

Feed Forward Neural Networks: Single layer & Multi-layer Neural Networks, Perceptron Neural Networks solution of XOR problem, Perceptron Convergence Theorem, Back Propagation Neural Networks, its features, limitations & extensions, Kohonen Self-Organizing Networks & its applications.

UNIT – V

Feedback Neural networks: Hopfield network, capacity and energy analysis of Hopfield Neural Network & its applications, Radial Basis Function Networks, its training algorithm and applications, Stochastic Neural learning and networks, Simulated Annealing, Boltzmann machine, Boltzmann learning law.