Study Scheme of M.Tech. Electronics and Communication Engineering

Programme Name	M. Tech. Electronics and Communication Engineering
Curriculum applicable to	AY 2025-26 onwards
Curriculum Version:	1.0
Approved by / Date	BoS / 22-May-2025

SEMESTER 1st		**Contact Hours/Week**			**Maximum Marks**			**Credits**
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
25C1ECP-101	Advanced Communication Networks	3	0	0	40	60	100	3
25C1ECP-102	Wireless and Mobile Communication	3	0	0	40	60	100	3
25C1ECP-PE1-XX	Programme Elective I 01. Wireless Sensor Networks 02. Optical Networks 03. Statistical Information Processing	3	0	0	40	60	100	3
25C1ECP-PE2-XX	Programme Elective – II 01. Cognitive Radios 02. RF and Microwave Circuit Design 03. Information Theory and Coding 04. Fuzzy Logic & Systems 05. Optical Communication Systems	3	0	0	40	60	100	3
25C1ECP-111	Advanced Communication Networks Lab	0	0	4	60	40	100	2
25C1ECP-112	Wireless and Mobile Communication Lab	0	0	4	60	40	100	2
25C1CCP-01	Research Methodology and IPR	2	0	0	40	60	100	2
25C1CCP-XX	Audit Course I	2	0	0	S/US*	S/US*	100	Non-credit
Total		**16**	**0**	**8**	**320**	**380**	**800**	**18**
Total Contact Hours/Week = 24								
Total number of credits for the program will be as per guidelines given by AICTE/UGC/IKGPTU								

S/Us* - Satisfactory/Unsatisfactory

SEMESTER 2nd		Contact Hours/Week			Maximum Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
25C1ECP-201	Antennas and Radiating Systems	3	0	0	40	60	100	3
25C1ECP-202	Advanced Digital Signal Processing	3	0	0	40	60	100	3
25C1ECP-PE3-XX	Programme Elective – III 01. Satellite Communication 02. Internet of Things 03. Neural networks 04. Voice and data networks	3	0	0	40	60	100	3
25C1ECP-PE4-XX	Programme Elective – IV 01. Nano-Electronics 02. MIMO System 03. Programmable Networks – SDN, NFV 04. Evolutionary Algorithms 05. Queuing Theory	3	0	0	40	60	100	3
25C1ECP-211	Antennas and Radiating Systems lab	0	0	4	60	40	100	2
25C1ECP-212	Advanced Digital Signal Processing Lab	0	0	4	60	40	100	2
25C1ECP-213	Mini Project	0	0	4	60	40	100	2
25C1CCP-XX	Audit course II	2	0	0	S/US*	S/US*	100	Non-credit
Total		**14**	**0**	**12**	**340**	**360**	**800**	**18**
Total Contact Hours/Week = 26								
Total number of credits for the program will be as per guidelines given by AICTE/UGC/IKGPTU								

S/Us* - Satisfactory/Unsatisfactory

Details of Audit courses-I

Subject Code	Subject Name
25C1CCP-02	English for Research Paper Writing
25C1CCP-03	Disaster Management
25C1CCP-04	Sanskrit for Technical Knowledge
25C1CCP-05	Stress Management by Yoga

Details of Audit courses-II

Subject Code	Subject Name
25C1CCP-06	Value Education
25C1CCP-07	Constitution of India
25C1CCP-08	Pedagogy Studies
25C1CCP-09	Personality Development through Life Enlightenment Skills

Course title	**Advanced Communication Networks**
Course Code:	**25C1ECP-101**
Scheme and Credits	**L T P C Semester – I** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	classify advanced concepts in communication networking.
CO2	design and develop protocols for communication networks.
CO3	illustrate the mechanisms in quality of service in networking.
CO4	demonstrate the network design.

Syllabus Contents:

UNIT 1(8 hours):
Overview of Internet-Concepts, challenges and history. Overview of -ATM. TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP.

UNIT 2(7 hours):
Real Time Communications over Internet. Adaptive applications. Latency and throughput issues. Integrated Services Model (int Serv). Resource reservation in Internet. RSVP.; Characterization of Traffic by Linearly Bounded Arrival Processes (LBAP). Leaky bucket algorithm and its properties.

UNIT 3(8 hours):
Packet Scheduling Algorithms-requirements and choices. Scheduling guaranteed service connections. GPS, WFQ and Rate proportional algorithms. High speed scheduler design. Theory of Latency Rate servers and delay bounds in packet switched networks for LBAP traffic.; Active Queue Management - RED, WRED and Virtual clock. Control theoretic analysis of active queue management.

UNIT 4(7 hours):
IP address lookup-challenges. Packet classification algorithms and Flow Identification- Grid of Tries, Cross producting and controlled prefix expansion algorithms.

UNIT 5 (7 hours):
Admission control in Internet. Concept of Effective bandwidth. Measurement based admission control. Differentiated Services in Internet (Diff Serv). DiffServ architecture and frame work.

UNIT 6 (8 hours):
IPV4, IPV6, IP tunnelling, IP switching and MPLS, Overview of IP over ATM and its evolution to IP switching. MPLS architecture and framework. MPLS Protocols. Traffic Engineering issues in MPLS.

Suggested Readings/Books:

1. Jean Wairand and Pravin Varaiya, "High Performance Communications Networks", 2nd edition, 2000.
2. Jean Le Boudec and Patrick Thiran, "Network Calculus A Theory of Deterministic Queueing Systems for the Internet", Springer Veriag, 2001.
3. Zhang Wang, "Internet QoS", Morgan Kaufman, 2001.
4. Anurag Kumar, D. Manjunath and Joy Kuri, "Communication Networking: An Analytical
5. Approach" , Morgan Kaufman Publishers, 2004.
6. George Kesidis, "ATM Network Performance", Kluwer Academic, Research Papers, 2005.

Course title	**Wireless and Mobile Communication**
Course Code:	**25C1ECP-102**
Scheme and Credits	**L T P C Semester – I** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	design appropriate mobile communication systems. apply frequency-reuse concept in mobile communications, and to analyze its effects on interference, system capacity, handoff techniques
CO2	distinguish various multiple-access techniques for mobile communications e.g. FDMA, TDMA, CDMA, and their advantages and disadvantages
CO3	analyze path loss and interference for wireless telephony and their influences on a mobile communication system's performance.
CO4	analyze and design CDMA system functioning with knowledge of forward and reverse channel details, advantages and disadvantages of using the technology
CO5	explore upcoming technologies like 3G, 4G etc.

Syllabus Contents:

UNIT 1(8 hours):
Cellular Communication Fundamentals: Cellular system design, Frequency reuse, cell splitting, handover concepts, Co channel and adjacent channel interference, interference reduction techniques and methods to improve cell coverage, Frequency management and channel assignment. GSM architecture and interfaces, GSM architecture details, GSM subsystems, GSM Logical Channels, Data Encryption in GSM, Mobility Management, Call Flows in GSM.2.5 G Standards: High speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS), 2.75 G Standards: EDGE.

UNIT 2(8hours):
Spectral efficiency analysis based on calculations for Multiple access technologies: TDMA, FDMA and CDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas. Wireless network planning (Link budget and power spectrum calculations)

UNIT 3(8 hours):
Mobile Radio Propagation: Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor

Propagation Models, Signal Penetration into Buildings. Small Scale Fading and Multipath Propagation, Impulse Response Model, Multipath Measurements, Parameters of Multipath channels, Types of Small Scale Fading: Time Delay Spread; Flat, Frequency selective, Doppler Spread; Fast and Slow fading.

UNIT 4(7 hours):
Equalization, Diversity: Equalizers in a communications receiver, Algorithms for adaptive equalization, diversity techniques, space, polarization, frequency diversity, Interleaving.

UNIT 5(7 hours):
Code Division Multiple Access: Introduction to CDMA technology, IS 95 system Architecture, Air Interface, Physical and logical channels of IS 95, Forward Link and Reverse link operation, Physical and Logical channels of IS 95 CDMA, IS 95 CDMA Call Processing, soft Handoff, Evolution of IS 95 (CDMA One) to CDMA 2000, CDMA 2000 layering structure and channels
.

UNIT 6(7 hours):
Higher Generation Cellular Standards: 3G Standards: evolved EDGE, enhancements in 4G standard, Architecture and representative protocols, call flow for LTE, VoLTE, UMTS, introduction to 5G

Suggested Readings/Books:

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

Course title	**Wireless Sensor Networks**
Course Code:	**25C1ECP-PE1-01**
Scheme and Credits	**L T P C Semester – I** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	design wireless sensor network system for different applications under consideration.
CO2	understand the hardware details of different types of sensors and select right type of sensor for various applications.
CO3	understand radio standards and communication protocols to be used for wireless sensor network based systems and application.
CO4	use operating systems and programming languages for wireless sensor nodes, performance of wireless sensor networks systems and platforms.
CO5	handle special issues related to sensors like energy conservation and security challenges.

Syllabus Contents:

UNIT 1 (8 hours):
Introduction and overview of sensor network architecture and its applications, sensor network comparison with Ad Hoc Networks, Sensor node architecture with hardware and software details.

UNIT 2(8 hours):
Hardware: Examples like mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and Sun SPOT, Software (Operating Systems): tinyOS, MANTIS, Contiki, and RetOS.

UNIT 3 (8 hours):
Programming tools: C, nesC. Performance comparison of wireless sensor networks simulation and experimental platforms like open source (ns-2) and commercial (QualNet, Opnet)

UNIT 4(7 hours):
Overview of sensor network protocols (details of at least 2 important protocol per layer): Physical, MAC and routing/ Network layer protocols, node discovery protocols, multi-hop and cluster based protocols, Fundamentals of 802.15.4, Bluetooth, BLE (Bluetooth low energy), UWB.

UNIT 5 (6 hours):
Data dissemination and processing; differences compared with other database management systems, data storage; query processing.

UNIT 6 (8 hours):
Specialized features: Energy preservation and efficiency; security challenges; fault tolerance, Issues related to Localization, connectivity and topology, Sensor deployment mechanisms; coverage issues; sensor Web; sensor Grid, Open issues for future research, and Enabling technologies in wireless sensor network.

Suggested Readings/Books:

1. H. Karl and A. Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, India, 2012.
2. C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors, "Wireless Sensor Networks",Springer Verlag, 1st Indian reprint, 2010.
3. F. Zhao and L. Guibas, "Wireless Sensor Networks: An Information Processing Approach", Morgan Kaufmann, 1stIndian reprint, 2013.
4. YingshuLi, MyT. Thai, Weili Wu, "Wireless sensor Network and Applications", Springer series on signals and communication technology, 2008.

Course title	**Optical Networks**
Course Code:	**25C1ECP-PE1-02**
Scheme and Credits	**L T P C Semester – I** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	summarize the basic concepts of optical networks
CO2	describe about the SONET/SDH and architecture of optical networks
CO3	contribute in the areas of optical network and WDM network design.
CO4	recognize the network survivability by various protection schemes
CO5	implement simple optical network and understand further technology developments for future enhanced network

Syllabus Contents:

UNIT 1 (7 hours):
SONET/SDH: optical transport network, IP, routing and forwarding, multiprotocol label switching.

UNIT 2 (6 hours):
WDM network elements: optical line terminals and amplifiers, optical add/drop multiplexers, OADM architectures, reconfigurable OADM, optical cross connects.

UNIT 3 (8 hours):
Control and management: network management functions, optical layer services and interfacing, performance and fault management, configuration management, optical safety.

UNIT 4 (8 hours):
Network Survivability: protection in SONET/SDH & client layer, optical layer protection schemes

UNIT 5 (8 hours):
WDM network design: LTD and RWA problems, dimensioning wavelength routing networks, statistical dimensioning models.

UNIT 6 (8 hours):
Access networks: Optical time division multiplexing, synchronization, header processing, buffering, burst switching, test beds, Introduction to PON, GPON, AON.

Suggested Readings/Books:

1. Rajiv Ramaswami, Sivarajan, Sasaki, "Optical Networks: A Practical Perspective", MK, Elsevier, 3rd edition, 2010.
2. C. Siva Ram Murthy and Mohan Gurusamy, "WDM Optical Networks: Concepts Design, and Algorithms", PHI, EEE, 2001.

Course title	Statistical Information Processing
Course Code:	25C1ECP-PE1-03
Scheme and Credits	L T P C Semester – I 3 0 0 3
Pre-requisite (if any)	Engineering Graduate with ECE/EEE/EE/EI
Internal Marks	40
External Marks	60
Total Marks	100

Course Outcomes:

At the end of this course, students will be able to

CO1	characterize and apply probabilistic techniques in modern decision systems, such as information systems, receivers, filtering and statistical operations.
CO2	demonstrate mathematic al modelling and problem solving using such models.
CO3	comparatively evolve key results developed in this course for applications to signal processing, communications systems.
CO4	develop frameworks based in probabilistic and stochastic themes for modelling and analysis of various systems involving functionalities in decision making, statistical inference, estimation and detection.

Syllabus Contents:

UNIT 1(8 hours):
Review of random variables: Probability Concepts, distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Vector quantization, Tchebaychef inequality theorem, Central Limit theorem, Discrete &Continuous Random Variables.
Random process: Expectations, Moments, Ergodicity, Discrete-Time Random Processes Stationary process, autocorrelation and auto covariance functions, Spectral representation of random signals, Properties of power spectral density, Gaussian Process and White noise process.

UNIT 2(7 hours):
Random signal modelling: MA(q), AR(p), ARMA(p,q) models, Hidden Markov Model & its applications ,Linear System with random input , Forward and Backward Predictions, Levinson Durbin Algorithm.

UNIT 3(7 hours):
Statistical Decision Theory: Bayes' Criterion, Binary Hypothesis Testing, M-ary Hypothesis Testing, Minima Criterion, Neyman-Pearson Criterion, Composite Hypothesis Testing. Parameter Estimation Theory: Maximum Likelihood Estimation, Generalized Likelihood Ratio Test ,Some Criteria for Good Estimators, Bayes' Estimation Minimum Mean- Square Error Estimate, Minimum, Mean Absolute Value of Error Estimate Maximum A Posteriori Estimate , Multiple

Parameter Estimation Best Linear Unbiased Estimator ,Least- Square Estimation Recursive Least-Square Estimator.

UNIT 4(7 hours):
Spectral analysis: Estimated autocorrelation function, Periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Parametric method, AR(p) spectral estimation and detection of Harmonic signals.

UNIT 5(8 hours):
Information Theory and Source Coding: Introduction, Uncertainty, Information and Entropy, Source coding theorem, Huffman, Shanon Fano , Arithmetic , Adaptive coding , RLE , LZW Data compaction, , LZ-77, LZ-78. Discrete Memory less channels, Mutual information, channel capacity, Channel coding theorem, Differential entropy and mutual information for continuous ensembles.

UNIT 6(8 hours):
Application of Information Theory: Group, Ring & Field, Vector, GF addition, multiplication rules. Introduction to BCH codes, Primitive elements ,Minimal polynomials, Generator polynomials in terms of Minimal polynomials, Some examples of BCH codes,& Decoder, Reed-Solomon codes & Decoder, Implementation of Reed Solomon encoders and decoders.

Suggested Readings/Books:

1. Papoulis and S.U. Pillai, “Probability, Random Variables and Stochastic Processes”,4th Edition, McGraw-Hill, 2002.
2. D.G. Manolakis, V.K. Ingle and S.M. Kogon, “Statistical and Adaptive Signal Processing”, McGraw Hill, 2000.
3. Mourad Barkat , “Signal Detection and Estimation”, Artech House, 2nd Edition, 2005.
4. R G. Gallager, “Information theory and reliable communication”, Wiley, 1st edition, 1968.
5. F. J. MacWilliams and N. J. A. Sloane, “TheTheory of Error-Correcting Codes”, New York, North-Holland, 19

Course title	**Cognitive Radios**
Course Code:	**25C1ECP-PE2-01**
Scheme and Credits	**L T P C Semester – I** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	understand the fundamental concepts of cognitive radio networks.
CO2	develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.
CO3	understand technologies to allow an efficient use of tvws for radio communications based on two spectrum sharing business models/policies.
CO4	understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimisation techniques for better spectrum exploitation.

Syllabus Contents:

UNIT 1(8 hours):
Introduction to Cognitive Radios: Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio.

UNIT 2(7 hours):
Spectrum Sensing: Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real time secondary spectrum market).

UNIT 3(7 hours):
Optimization Techniques of Dynamic Spectrum Allocation: Linear programming, convex programming, non-linear programming, integer programming, dynamic programming, stochastic programming.

UNIT 4(8 hours):
Dynamic Spectrum Access and Management: Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

UNIT 5(8 hours):
Spectrum Trading: Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential).

UNIT 6(7 hours):
Research Challenges in Cognitive Radio: Network layer and transport layer issues, cross layer design for cognitive radio networks.

Suggested Readings/Books:

1. Ekram Hossain, Dusit Niyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press, 2009.
2. Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., 2009.
3. Bruce Fette, "Cognitive radio technology", Elsevier, 2ndedition, 2009.
4. Huseyin Arslan, "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems", Springer, 2007.
5. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, "Optimizing Wireless Communication Systems" Springer, 2009.
6. Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.

Course title	**RF and Microwave Circuit Design**
Course Code:	**25C1ECP-PE2-02**
Scheme and Credits	**L T P C Semester – I** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	understand the behaviour of RF passive components and model active components.
CO2	perform transmission line analysis.
CO3	demonstrate use of Smith Chart for high frequency circuit design.
CO4	justify the choice/selection of components from the design aspects.
CO5	contribute in the areas of RF circuit design.

Syllabus Contents:

UNIT 1 (8 hours):
Transmission Line Theory: Lumped element circuit model for transmission line, field analysis, Smith chart, quarter wave transformer, generator and load mismatch, impedance matching and tuning.

UNIT 2 (7 hours):
Microwave Network Analysis: Impedance and equivalent voltage and current, Impedance and admittance matrix, The scattering matrix, transmission matrix, Signal flow graph.

UNIT 3 (7 hours):
Microwave Components: Microwave resonators, Microwave filters, power dividers and directional couplers, Ferromagnetic devices and components.

UNIT 4 (8 hours):
Nonlinearity and Time Variance Inter-symbol interference, random process & noise, definition of sensitivity and dynamic range, conversion gain and distortion.

UNIT 5 (8 hours):
Microwave Semiconductor Devices and Modeling: PIN diode, Tunnel diodes, Varactor diode, Schottky diode, IMPATT and TRAPATT devices, transferred electron devices, Microwave BJTs, GaAs FETs, low noise and power GaAs FETs, MESFET, MOSFET, HEMT.

UNIT 6 (7 hours):
Amplifiers Design: Power gain equations, stability, impedance matching, constant gain and noise figure circles, small signal, low noise, high power and broadband amplifier, oscillators, Mixers design.

Suggested Readings/Books:

1. Matthew M. Radmanesh, "Advanced RF & Microwave Circuit Design: The Ultimate Guide to Superior Design", AuthorHouse, 2009.
2. D.M.Pozar, " Microwave engineering" ,Wiley, 4th edition, 2011.
3. R.Ludwig and P.Bretchko, "R. F. Circuit Design", Pearson Education Inc, 2009.
4. G.D. Vendelin, A.M. Pavoi, U. L. Rohde, "Microwave Circuit Design Using Linear And Non Linear Techniques", John Wiley 1990.
5. S.Y. Liao, "Microwave circuit Analysis and Amplifier Design", Prentice Hall 1987.
6. Radmanesh, "RF and Microwave Electronics Illustrated" , Pearson Education, 2004.

Course title	**Information Theory and coding**
Course Code:	**25C1ECP-PE2-03**
Scheme and Credits	**L T P C Semester – I** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	characterize and apply probabilistic techniques in modern digital communication systems, such as information systems, receivers, filtering and statistical operations
CO2	demonstrate mathematical modelling and problem solving using such models.
CO3	comparatively evolve key results developed for applications to signal processing and communications systems
CO4	list various digital modulation techniques
CO5	develop framework based in different error coding techniques.

Syllabus Contents:

UNIT1 (11 Hours)
Elements of information theory Source coding theorem, Huffman coding, Channel coding theorem, channel capacity theorem, Shannon fanon theorem, entropy

UNIT2 (11 Hours)
Sampling Process Base band and band pass sampling theorems reconstruction from samples, Practical aspects of sampling and signal recovery TDM

UNIT3 (11 Hours)
Waveform Coding Techniques PCM Channel noise and error probability DPCM and DM Coding speech at low bit rates Prediction and adaptive filters. Base band shaping for data transmission, PAM signals and their power spectra Nyquist criterion ISI and eye pattern Equalization.

UNIT 4 (12 Hours)
Digital Modulation Techniques Binary and M-ary modulation techniques, Coherent and non-coherent detection, Bit Vs symbol error probability and bandwidth efficiency. Bit error analysis, using orthogonal Signaling. Error Control Coding Rationale for coding Linbear block codes, cyclic codes and convolution codes Viterbi decoding algorithm and trellis codes.

Suggested Readings/Books:

1.. J. Dass. , S.K. Malik & P.K. Chatterjee, ,"Principles of digitals communication:, Wiley-Blackwel, 1991.
2. Vera Pless," Introduction to the theory of Error correcting codes",Edition3July 2, 1998
3. Robert G. Gallanger,"Information Theory and Reliable Communication", McGraw Hill, 1992

Course title	**Fuzzy Logic & Systems**
Course Code:	**25C1ECP-PE2-04**
Scheme and Credits	**L T P C Semester – I** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	characterize and apply fuzzy logics in modern digital communication systems, such as information systems, receivers, filtering and statistical operations.
CO2	demonstrate mathematic al modelling and problem solving using such models.
CO3	comparatively evolve key results developed in this course for applications to signal processing, communications systems.
CO4	explains the different structures of neural networks
CO5	explains various genetic algorithms and soft computing techniques..

UNIT – 1 (11 hours)
Fuzzy Logic: Fuzzy set versus crisp set, basic concepts of fuzzy sets, membership functions, basic operations on fuzzy sets and its properties. Fuzzy relations versus Crisp relation,
Fuzzy rule base system: Fuzzy propositions, formation, decomposition & aggregation of fuzzy rules, fuzzy reasoning, Fuzzy Inference Systems (FIS) – Mamdani Fuzzy Models – Sugeno Fuzzy Models – Tsukamoto Fuzzy Models, Fuzzification and Defuzzification, fuzzy decision making & Applications of fuzzy logic.

UNIT – 2 (11 hours)
Structure and Function of a single neuron: Biological neuron, artificial neuron,definition of ANN and its applications. Neural Network architecture: Single layer and multilayer feed forward networks and recurrent networks. Learning rules and equations: Perceptron, Hebb's, Delta, winner take all and out-star learning rules. Supervised Learning Network: Perceptron Networks, Adaptive Linear Neuron, Multiple Adaptive Linear Neuron, Back Propagation Network, Associative memory networks, Unsupervised Learning Networks: Competitive networks, Adaptive Resonance Theory, Kohnen Self Organizing Map

UNIT – 3 (11 hours)
Genetic algorithm : Fundamentals, basic concepts, working principle, encoding, fitness function, reproduction, Genetic modeling: selection operator, cross over,mutation operator, Stopping Condition and GA flow, Constraints in GA, Applications of GA, Classification of GA.

UNIT – 4 (12 hours)
Hybrid Soft Computing Techniques: An Introduction, Neuro-Fuzzy Hybrid Systems, Genetic Neuro-Hybrid systems, Genetic fuzzy Hybrid and fuzzy genetic hybrid systems

Suggested Readings/Books:

1. S, Rajasekaran& G.A. VijayalakshmiPai, "Neural Networks, Fuzzy Logic & Genetic Algorithms, Synthesis & applications", PHI Publication,2011
2. S.N. Sivanandam & S.N. Deepa, "Principles of Soft Computing", Wiley Publications,2007
3. Michael Negnevitsky, "Artificial Intelligence", Pearson Education, New Delhi, 2008.
4. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley, 2010

Course title	**Optical Communication Systems**
Course Code:	**25C1ECP-PE2-05**
Scheme and Credits	**L T P C Semester – I** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to learn

CO1	various skills to develop different optical networks for single user and multiuser and can also attain the maximum benefit of this domain w. r. t. maximum data rate and available bandwidth.
CO2	contribute in the areas of optical network and various optical sources, fibres.
CO3	implement simple optical network and understand further technology developments for future enhanced network.

Syllabus Contents:

UNIT I (11 hours)
Nature of light and basic fiber optic communication system, principle of light transmission through a fiber, Classification of optical fibers: Single Mode and Multi-Mode Fibers, Step Index and Graded Index Fibers, Losses in Optical Fibers; Absorption, Scattering and Dispersion, Optical Windows for Fiber Optic Transmission system.
Fiber Materials: Glass Fibers and Plastic Glass Fibers, Fiber Fabrication Methods: Outside Vapor Phase Oxidation & Vapor Phase Axial Deposition and Double Crucible Method, Optical Fiber Cables.

UNIT II(11 hours)
Optical Sources: PN junction Diode Theory, Light Emitting Diode& Laser Diode: Structure, Materials, Quantum Efficiency and Modulation. Optical Detectors: Semiconductor Photodiodes &Avalanche Photodiodes and their characteristics, responsivity and quantum efficiency.

UNIT III (11 hours)
Optical Fiber Splices & Amplifiers: Fusion and Mechanical Splicing Technique and Fiber Connectors, Working Principle of OTDR and Applications of OTDR, Optical Fiber Measurements: Attenuation, Absorption, Dispersion and Scattering, Fiber Cut- Off Wavelength and Numerical Aperture Measurement. Semiconductor and Erbium

Doped Fiber Amplifiers, Optical communication Techniques and Network Topologies: Wavelength division Multiplexing and SONET/SDH.

UNIT IV (12 hours)
Optical OFDM: Need of OFDM, Differentiate between optical and RF OFDM, problems associated with optical OFDM, Peak to Average power ratio, various applications associated with OFDM

Suggested Readings/Books:

1. Optical Fiber Communications by Gerd Keiser, 3rd Edition, McGraw-Hill International.
2. Optical Fiber Communications, Principles &Practice by John M. Senior, 3rd edition, Pearson Publishers.

Course title	**Advanced Communication Networks Lab**
Course Code:	**25C1ECP-111**
Scheme and Credits	**L T P C** **Semester – I** **0 0 4 2**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**60**
External Marks	**40**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	identify the different types of network devices and their functions within a network.
CO2	explain and build the skills of sub-netting and routing mechanisms.
CO3	examine basic protocols of computer networks, and how they can be used to assist in network design and implementation
CO4	demonstrate configuration, forwarding tables, and debugging of MPLS

List of Experiments:

1. Study of Networking Commands (Ping, Tracert, TELNET, ns lookup, net stat, ARP, RARP) and Network Configuration Files.
2. Linux Network Configuration.
3. Configuring NIC's IP Address.
4. Determining IP Address and MAC Address using if-config command.
5. Changing IP Address using if-config.
6. Static IP Address and Configuration by Editing.
7. Determining IP Address using DHCP.
8. Configuring Hostname in /etc/hosts file.
9. Design TCP iterative Client and Server application to reverse the given input sentence.
10. Design a TCP concurrent Server to convert a given text into upper case using multiplexing system call "select".
11. Design UDP Client Server to transfer a file.
12. Configure a DHCP Server to serve contiguous IP addresses to a pool of four IP devices with a default gateway and a default DNS address. Integrate the DHCP server with a BOOTP demon to automatically serve Windows and Linux OS Binaries based on client MAC address.
13. Configure DNS: Make a caching DNS client, and a DNS Proxy; implement reverse DNS and forward DNS, using TCP dump/Wireshark characterise traffic when the DNS server is up and when it is down.
14. Configure a mail server for IMAP/POP protocols and write a simple SMTP client in C/C++/Java client to send and receive mails.

15. Configure FTP Server on a Linux/Windows machine using a FTP client/SFTP client characterise file transfer rate for a cluster of small files 100k each and a video file of 700mb.Use a TFTP client and repeat the experiment.
16. Signaling and QoS of labeled paths using RSVP in MPLS.
17. Find shortest paths through provider network for RSVP and BGP.
18. Understand configuration, forwarding tables, and debugging of MPLS.

Course title	**Wireless and Mobile Communication Lab**
Course Code:	**25C1ECP-112**
Scheme and Credits	**L T P C** **Semester – I** **0 0 4 2**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**60**
External Marks	**40**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	analyse cellular concepts, GSM and CDMA networks
CO2	illustrate GSM handset by experimentation and fault insertion techniques
CO3	outline 3G communication system by means of various AT commands usage in GSM
CO4	examine CDMA concept using DSSS kit
CO5	determine and develop concepts of software radio in real time environment

List of Experiments:

1. Understanding Cellular Fundamentals like Frequency Reuse, Interference, cell splitting, multi path environment, Coverage and Capacity issues using communication software.
2. Knowing GSM and CDMA architecture, network concepts, call management, call setup, call release, Security and Power Control, Handoff Process and types, Rake Receiver etc.
3. Study of GSM handset for various signaling and fault insertion techniques (Major GSM handset sections: clock, SIM card, charging, LCD module, Keyboard, User interface).
4. To study transmitters and receiver section in mobile handset and measure frequency band signal and GMSK modulating signal.
5. To study various GSM AT Commands their use and developing new application using it. Understating of 3G Communication System with features like; transmission of voice and videocalls, SMS, MMS, TCP/IP, HTTP, GPS and File system by AT Commands in 3G network.
6. Study of DSSS technique for CDMA, observe effect of variation of types of PN codes, chip rate, spreading factor, processing gain on performance.
7. To learn and develop concepts of Software Radio in real time environment by studying the building blocks like Base band and RF section, convolution encoder, Interleaver and De- Interleaver.
8. To study and analyze different modulation techniques in time and frequency domain using SDR kit.

Course title	**Research Methodology and IPR**
Course Code:	**25C1CCP-01**
Scheme and Credits	**L T P C** **Semester – I** **2 0 0 2**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**60**
External Marks	**40**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	examine research problem formulation.
CO2	analyze research related information
CO3	follow research ethics
CO4	simplify that today's world is controlled by computer, information technology, but tomorrow world will be ruled by ideas, concept, and creativity.
CO5	explore that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about intellectual property right to be promoted among students in general & engineering in particular.
CO6	show that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Syllabus Contents:

UNIT 1 (11 hours):
Overview of Research: Meaning of Research, Objectives of research, Types of research, Research approaches, Significance of research, Criteria of good research. Defining the research problem: research problem, Necessity of defining the problem,
Technique involve in defining a problem.

UNIT 2 (11 hours):
Research Design: Need for research design, Features of a good design, Basic principles of Experimental design Data Collection: Methods of Data Collection; Primary data and Secondary Data.

UNIT 3 (11 hours):
Data preparation: Data preparation process, designing questionnaires and schedules. Descriptive statistics: Measures of central tendency, Mean,Median, Mode etc. Sampling and non-sampling errors, Testing of Hypotheses: Parametric (t, z and F) Chi Square, ANOVA, and non-parametric tests.

UNIT 4 (12 hours):
Overview of Intellectual Property: Introduction and the need for intellectual property right (IPR), Patents, Patent Law, Copyright, Trademarks, Geographical Indications, Industrial Design, Unfair Competition, Protection of IPR, Basic steps to write a research paper/ report writing, Introduction to Latex report writing, Introduction to Plagiarism.

Suggested Readings/ Books:

1. Krishnaswami K. N., Sivakumar A. I., Mathirajan M., Management Research Methodology, Pearson Education, New Delhi
2. Kothari C. R., Research Methodology Methods and Techniques, 2nd Edition, New Age International Publishers
3. Halbert, Resisting Intellectual Property, Taylor & Francis Ltd ,2007.
4. Niebel, Product Design, McGraw Hill.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, Intellectual Property in New Technological Age.
6. T. Ramappa, Intellectual Property Rights Under WT, S. Chand

Course title	**Audit Course I: English for Research Paper Writing**
Course Code:	**25C1CCP-02**
Scheme and Credits	**L T P C** **Semester – I** **2 0 0 0**
Pre-requisite (if any)	
Internal Marks	**0**
External Marks	**0**
Total Marks	**0**

Course Outcomes:

At the end of this course, students will be able to

CO1	explain the principles of effective academic writing and how to improve writing skills.
CO2	identify and apply techniques to enhance the readability and clarity of written content.
CO3	develop the ability to write each section of a research paper with appropriate structure and coherence.
CO4	analyze the essential elements and techniques required for writing a high-quality academic paper.
CO5	apply creative thinking and apply critical thinking strategies in academic and technical writing.

Detailed contents:

UNIT 1: (4 Hours)

Planning and Preparation, Word Order, Breaking up long sentences, Structuring. Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT 2: (4 Hours)

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.

UNIT 3: (4 Hours)

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT 4: (4 Hours)

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

UNIT 5: (4 Hours)
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

UNIT 6: (4 Hours)
Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

Suggested Readings/Books:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books). 2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Course title	**Antennas and Radiating Systems**
Course Code:	**25C1ECP-201**
Scheme and Credits	**L T P C** **Semester – II** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	compute the far field distance, radiation pattern and gain of an antenna for given current distribution.
CO2	estimate the input impedance, efficiency and ease of match for antennas.
CO3	compute the array factor for an array of identical antennas.
CO4	design antennas and antenna arrays for various desired radiation pattern characteristics.

Syllabus Contents:

UNIT 1 (8 hours):
Types of Antennas: Wire antennas, Aperture antennas, Micro strip antennas, Array antennas Reflector antennas, Lens antennas, Radiation Mechanism, Current distribution on thin wire antenna. Fundamental Parameters of Antennas: Radiation Pattern, Radiation Power Density, Radiation Intensity, Directivity, Gain, Antenna efficiency, Beam efficiency, Bandwidth, Polarization, Input Impedance, radiation efficiency, Antenna Vector effective length, Friis Transmission equation, Antenna Temperature.

UNIT 2 (8 hours):
Linear Wire Antennas: Infinitesimal dipole, Small dipole, Region separation, Finite length dipole, half wave dipole, Ground effects. Loop Antennas: Small Circular loop, Circular Loop of constant current, Circular loop with non uniform current.

UNIT 3 (8 hours):
LinearArrays: Two element array, N Element array: Uniform Amplitude and spacing, Broadside and End fire array, Super directivity, Planar array, Design consideration.

UNIT 4 (7 hours):
Aperture Antennas: Huygen's Field Equivalence principle, radiation equations, Rectangular Aperture, Circular Aperture. Horn Antennas: E-Plane, H-plane Sectoral horns, Pyramidal and Conical horns.

UNIT 5 (7 hours):
Micro strip Antennas: Basic Characteristics, Feeding mechanisms, Method of analysis, Rectangular Patch, Circular Patch.

UNIT 6 (7 hours):
Reflector Antennas: Plane reflector, parabolic reflector, Cassegrain reflectors, Introduction to MIMO.

Suggested Readings/Books:

1. Constantine A. Balanis, “Antenna Theory Analysis and Design”, John Wiley & Sons, 4th edition, 2016.
2. John D Kraus, Ronald J Marhefka, Ahmad S Khan, “Antennas for All Applications”, Tata McGraw-Hill, 2002.
3. R. C. Johnson and H.Jasik, “Antenna Engineering hand book”, Mc-Graw Hill, 1984.
4. I.J. Bhal and P.Bhartia, “Micro-strip antennas”, Artech house, 1980.

Course title	**Advanced Digital Signal Processing**
Course Code:	**25C1ECP-202**
Scheme and Credits	**L T P C** **Semester –II** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	summarize theory of different filters and algorithms.
CO2	illustrate theory of multirate DSP, solve numerical problems and write algorithms.
CO3	compute theory of prediction and solution of normal equations.
CO4	explain the principles of adaptive filters and estimation of PSD.
CO5	summarize theory of different filters and algorithms.

Syllabus Contents:

UNIT 1(8 hours)
Overview of DSP, Characterization in time and frequency, FFT Algorithms, Digital filter design and structures: Basic FIR/IIR filter design &structures, design techniques of linear phase FIR filters, IIR filters by impulse invariance, bilinear transformation, FIR/IIR Cascaded lattice structures, parallel realization of IIR.

UNIT 2 (8 hours)
Multi rate DSP, Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, poly phase filters, QMF, digital filter banks, Applications in sub band coding.

UNIT 3(7 hours)
Linear prediction & optimum linear filters, stationary random process, forward- backward linear prediction filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.

UNIT 4(7 hours)
Adaptive Filters, Applications, Gradient Adaptive Lattice, Minimum mean square criterion, LMS algorithm, Recursive Least Square algorithm

UNIT 5(7 hours)
Estimation of Spectra from Finite-Duration Observations of Signals. Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum-Variance Spectral Estimation, Eigen analysis Algorithms for Spectrum Estimation.

UNIT 6(8 hours)
Application of DSP & Multi rate DSP, Application to Radar, introduction to wavelets, application to image processing, design of phase shifters, DSP in speech processing & other applications

Suggested Readings/Books:

1. J.G.Proakisand D.G.Manolakis"Digital signal processing: Principles, Algorithm and Applications", 4th Edition, Prentice Hall, 2007.
2. N. J. Fliege, "Multirate Digital Signal Processing: Multirate Systems -Filter Banks – Wavelets", 1stEdition, John Wiley and Sons Ltd, 1999.
3. Bruce W. Suter, "Multirate and Wavelet Signal Processing",1stEdition, Academic Press, 1997.
4. M. H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley & Sons Inc., 2002.
5. S.Haykin, "Adaptive Filter Theory", 4thEdition, Prentice Hall, 2001.
6. D.G.Manolakis, V.K. Ingle and S.M.Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill, 2000

Course title	**Satellite Communication**
Course Code:	**25C1ECP-PE3-01**
Scheme and Credits	**L T P C** **Semester –II** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	visualize the architecture of satellite systems as a means of high speed, high range communication system.
CO2	state various aspects related to satellite systems such as orbital equations, sub-systems in a satellite, link budget, modulation and multiple access schemes.
CO3	solve numerical problems related to orbital motion and design of link budget for the given parameters and conditions.

Syllabus Contents:

UNIT 1(8 hours)
Architecture of Satellite Communication System: Principles and architecture of satellite Communication, Brief history of Satellite systems, advantages, disadvantages, applications, and frequency bands used for satellite communication and their advantages/drawbacks.

UNIT 2(8 hours)
Orbital Analysis: Orbital equations, Kepler's laws of planetary motion, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc of a satellite, concepts of Solar day and Sidereal day.

UNIT 3(8 hours)
Satellite sub-systems: Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power sub-systems, antenna sub-system.

UNIT 4(7 hours)
Typical Phenomena in Satellite Communication: Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift.

UNIT 5(7 hours)
Satellite link budget: Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget

and C/N ratio calculations in clear air and rainy conditions, Case study of Personal Communication system (satellite telephony) using LEO.

UNIT 6(7 hours)
Modulation and Multiple Access Schemes used in satellite communication. Typical case studies of VSAT, DBS-TV satellites and few recent communication satellites launched by NASA/ ISRO. GPS.

Suggested Readings/Books:

1. Timothy Pratt and Others, "Satellite Communications", Wiley India, 2nd edition,2010.
   a. S. K. Raman, "Fundamentals of Satellite Communication", Pearson Education India, 2011.
2. Tri T. Ha, "Digital Satellite Communications", Tata McGraw Hill, 2009.
3. Dennis Roddy, "Satellite Communication", McGraw Hill, 4th Edition, 2008.

Course title	**Internet of Things**
Course Code:	**25C1ECP-PE3-02**
Scheme and Credits	**L T P C** **Semester –II** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	understand what iot technologies are used for today, and what is required in certain scenarios.
CO2	understand the types of technologies that are available and in use today and can be utilized to implement iot solutions.
CO3	apply these technologies to tackle scenarios in teams of using an experimental platform for implementing prototypes and testing them as running applications

Syllabus Contents:

UNIT 1 (7 hours):
Smart cities and IoT revolution, Fractal cities, From IT to IoT, M2M and peer networking concepts, Ipv4 and IPV6.

UNIT 2 (8 hours):
Software Defined Networks SDN, From Cloud to Fog and MIST networking for IoT communications, Principles of Edge/P2P networking, Protocols to support IoT communications, modular design and abstraction, security and privacy in fog.

UNIT 3 (8 hours):
Wireless sensor networks: introduction, IOT networks (PAN, LAN and WAN), Edge resource pooling and caching, client side control and configuration.

UNIT 4 (7 hours):
Smart objects as building blocks for IoT, Open source hardware and Embedded systems platforms for IoT, Edge/gateway, IO drivers, C Programming, multithreading concepts.

UNIT 5 (7 hours):
Operating systems requirement of IoT environment, study of mbed, RIoT, and Contiki operating systems, Introductory concepts of big data for IoT applications.

UNIT 6 (8 hours):
Applications of IoT, Connected cars IoT Transportation, Smart Grid and Healthcare sectors using IoT, Security and legal considerations, IT Act 2000 and scope for IoT legislation.

Suggested Readings/Books:

1. A Bahaga, V. Madisetti, "Internet of Things- Hands on approach", VPT publisher, 2014.
2. McEwen, H. Cassimally, "Designing the Internet of Things", Wiley, 2013.
3. CunoPfister, "Getting started with Internet of Things", Maker Media, 1st edition, 2011.
4. Samuel Greenguard, "Internet of things", MIT Press, 2015.

Webresources :

5. http://www.datamation.com/open-source/35-open-source-tools-for-the-internet-of-things-
6. https://developer.mbed.org/handbook/AnalogIn
7. http://www.libelium.com/50_sensor_applications/
8. M2MLabs Mainspring http://www.m2mlabs.com/framework
9. Node-RED http://nodered.org/

Course title	**Neural Networks**
Course Code:	**25C1ECP-PE3-03**
Scheme and Credits	**L T P C Semester –II** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	this subject is helpful to explore the functional components of neural network classifiers or controllers, and the functional components of fuzzy logic classifiers or controllers
CO2	this course will also discuss to develop and implement a basic trainable neural network or a fuzzy logic system for vlsi, computing application or biomedical application

UNIT 1 (12 hours):
Neural Networks: History, overview of biological Neuro-system, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms-perceptions, Training rules, Delta, Back Propagation Algorithm, Multilayer Perception Model, Hopfield Networks, Associative Memories, Applications of Artificial Neural Networks.

UNIT 2 (11 hours):
Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation.
Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations.
Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations.

UNIT 3 (11 hours):
Fuzzy Logic: Classical Logic, Multi valued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Linguistic Hedges, Uncertainty based Information: Information & Uncertainty, Non specificity of Fuzzy & Crisp Sets, Fuzziness of Fuzzy Sets.

UNIT 4 (11 hours):
Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks,
Applications of Fuzzy Logic: Medicine, Economics etc. Genetic Algorithm: An Overview, GA in problem solving, Implementation of GA

Suggested Readings/Books:

1. AI & Expert system by Janki Raman &MacMillen.
2. Artificial Intelligence, by Knight, TMH, 1991.
3. Artificial Intelligence by G.F luger, Pearson education, 2003.
4. Artificial Intelligence, by Patricks henry & Winston, Pearson education, 2001.
5. Artificial Intelligence, by Nilsson, Morgon, &Kufmann Pub.

Course title	**Voice and Data Networks**
Course Code:	**25C1ECP-PE3-04**
Scheme and Credits	**L T P C Semester –II** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	protocol, algorithms, trade-offs rationale.
CO2	routing, transport, DNS resolutions
CO3	network extensions and next generation architectures

Syllabus Contents:

UNIT 1(8 hours):
Network Design Issues, Network Performance Issues, Network Terminology, centralized and distributed approaches for networks design, Issues in design of voice and data networks.

UNIT 2(8 hours):
Layered and Layer less Communication, Cross layer design of Networks, Voice Networks (wired and wireless) and Switching, Circuit Switching and Packet Switching, Statistical Multiplexing.

UNIT 3(8 hours):
Data Networks and their Design, Link layer design- Link adaptation, Link Layer Protocols, Retransmission. Mechanisms (ARQ), Hybrid ARQ (HARQ), Go Back N, Selective Repeat protocols and their analysis.

UNIT 4(7 hours):
Queuing Models of Networks , Traffic Models , Little's Theorem, Markov chains, M/M/1 and other Markov systems, Multiple Access Protocols , Aloha System , Carrier Sensing , Examples of Local area networks,

UNIT 5(7 hours):
Inter-networking, Bridging, Global Internet , IP protocol and addressing , Sub netting , Classless Inter domain Routing (CIDR) , IP address lookup , Routing in Internet. End to End Protocols, TCP and UDP. Congestion Control , Additive Increase/Multiplicative Decrease , Slow Start, Fast Retransmit/ Fast Recovery,

UNIT 6(7 hours):
Congestion avoidance, RED TCP Throughput Analysis, Quality of Service in Packet Networks. Network Calculus, Packet Scheduling Algorithms.

Suggested Readings/Books:

1. D. Bertsekas and R. Gallager, "Data Networks", 2ndEdition, Prentice Hall, 1992.
2. L. Peterson and B. S. Davie, "Computer Networks: A Systems Approach",5th Edition, Morgan Kaufman, 2011.
3. Kumar, D. Manjunath and J. Kuri, "Communication Networking: An analytical approach", 1stmEdition, Morgan Kaufman, 2004.
4. Walrand, "Communications Network: A First Course", 2nd,Edition, McGraw Hill, 2002.
5. Leonard Kleinrock, "Queueing Systems, Volume I: Theory", 1stEdition, John Wiley and Sons, 1975.
6. Aaron Kershenbaum, "Telecommunication Network Design Algorithms", McGraw Hill, 1993.
7. Vijay Ahuja, "Design and Analysis of Computer Communication Networks", McGraw Hill, 1987

Course title	**Nano Electronics**
Course Code:	**25C1ECP-PE4-01**
Scheme and Credits	**L T P C** **Semester –II** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	analyze the concepts of Nano sciences and scale of Nano technology.
CO2	examine formation of Nano tubes applications & properties
CO3	summarize Nano –electronics advance instruments and their characteristics
CO4	compare connectivity of Nano devices with electronics

Syllabus Contents:
UNIT 1 (11 hours):
Basics and Scale of Nanotechnology: Introduction – Scientific revolutions – Time and length scale in structures, Definition of a nano-system , Top down and bottom up approaches – Evolution of band structures and Fermi surface – introduction to semi conducting Nanoparticles, introduction to quantum Dots, wells, wires, Dimensionality and size dependent phenomena – Fraction of surface atoms – Surface energy and surface stress, Misconceptions of Nanotechnology.

UNIT 2 (12 hours):
The carbon age and nanotubes: New forms of carbon, Types of nanotubes, Formation of nanotubes, methods and reactants- Arcing in the presence of cobalt, Laser method, Chemical vapor deposition method, ball milling, properties of Nanotubes Electrical properties, vibrational properties, Mechanical properties, applications of Nanotubes in electronics, hydrogen storage, materials, space elevators.

UNIT 3 (11 hours):
Characterization Techniques in Nano-electronics: Principle, construction and working: Electron microscopy (SEM and TEM), Infrared and Raman Spectroscopy, Photoemission and X-RD spectroscopy, AFMs, Magnetic force microscope.

UNIT 4 (11 hours):
Nano-scale Devices: Introduction: Quantum Electron Devices; High Electron Mobility Transistor, Quantum Interference Transistor, Single Electron Transistor and Carbon Nanotube Transistor, DNA Computing; Structure of DNA, Basic Operation on DNA and DNA Computer.

Suggested Readings/Books:

1. C.P.Polle and F.J.Owens, "Introduction to Nanotechnology" Willey India Pvt. Ltd, Edition 2011.
2. Daniel Minoli 'Nanotechnology Applications to Telecommunications and Networking" Willey India Pvt. Ltd, Edition 2011.

Course title	**MIMO Systems**
Course Code:	**25C1ECP-PE4-02**
Scheme and Credits	**L T P C** **Semester –II** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	understand channel modelling and propagation, MIMO Capacity, space-time coding, MIMO receivers, MIMO for multi-carrier systems (e.g. MIMO-OFDM), multi-user communications, multi-user MIMO.
CO2	understand cooperative and coordinated multi-cell MIMO, introduction to MIMO in 4G (LTE,LTE-Advanced, WiMAX).
CO3	perform mathematical modelling and analysis of MIMO systems.

Syllabus Contents:

UNIT 1(7 hours):
Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems.

UNIT 2(7 hours):
Diversity, Exploiting multipath diversity, Transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing, Spectral efficiency and capacity, Transmitting independent streams in parallel, Mathematical notation

UNIT 3(8 hours):
The generic MIMO problem, Singular Value Decomposition, Eigenvalues and eigenvectors, Equalising MIMO systems, Disadvantages of equalising MIMO systems, Predistortion in MIMO systems, Disadvantages of pre-distortion in MIMO systems, Pre-coding and combining in MIMO systems, Advantages of pre-coding and combining, Disadvantages of precoding and combining, Channel state information.

UNIT 4(7 hours):
Codebooks for MIMO, Beamforming, Beamforming principles, Increased spectrum efficiency, Interference cancellation, Switched beamformer, Adaptive beamformer, Narrowband beamformer, Wideband beamformer

UNIT 5(8 hours):
Case study: MIMO in LTE, Codewords to layers mapping, Pre-coding for spatial multiplexing, Pre-coding for transmit diversity, Beamforming in LTE, Cyclic delay diversity based pre-coding, Pre-coding codebooks, Propagation Channels, Time & frequency channel dispersion, AWGN and multipath propagation channels, Delay spread values and time variations, Fast and slow fading environments, Complex baseband multipath channels, Narrowband and wideband channels, MIMO channel models

UNIT 6(8 hours):
Channel Estimation, Channel estimation techniques, Estimation and tracking, Training based channel estimation, Blind channel estimation, Channel estimation architectures, Iterative channel estimation, MMSE channel estimation, Correlative channel sounding, Channel estimation in single carrier systems, Channel estimation for CDMA, Channel estimation for OFDM.

Suggested Readings/Books:

1. Claude Oestges, Bruno Clerckx, "MIMO Wireless Communications : From Real-world Propagation to Space-time Code Design",Academic Press, 1stedition, 2010.
2. Mohinder Janakiraman, “Space - Time Codes and MIMO Systems”, Artech House Publishers, 2004.

Course title	**Programmable Networks - SDN, NFV**
Course Code:	**25C1ECP-PE4-03**
Scheme and Credits	**L T P C** **Semester –II** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	understand advanced concepts in programmable networks.
CO2	understand software defined networking, an emerging internet architectural framework.
CO3	implement the main concepts, architectures, algorithms, protocols and applications in SDN and NFV.

Syllabus Contents:

UNIT 1(8 hours):
Introduction to Programmable Networks, History and Evolution of Software Defined Networking (SDN), Fundamental Characteristics of SDN, Separation of Control Plane and Data Plane, Active Networking.

UNIT 2(7 hours):
Control and Data Plane Separation: Concepts, Advantages and Disadvantages, the basics of Open Flow protocol.

UNIT 3(7 hours):
Network Virtualization: Concepts, Applications, Existing Network Virtualization Framework, Mininet A simulation environment for SDN.

UNIT 4(8 hours):
Control Plane: Overview, Existing SDN Controllers including Floodlight and Open Daylight projects. Customization of Control Plane: Switching and Firewall Implementation using SDN Concepts. Data Plane: Software-based and Hadrware-based; Programmable Network Hardware.

UNIT 5(8 hours):
Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs. Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications.

UNIT 6(7 hours):
Data Center Networks: Packet, Optical and Wireless Architectures, Network Topologies. Use Cases of SDNs: Data Centers, Internet Exchange Points, Backbone Networks, Home Networks, Traffic Engineering.

Suggested Readings/Books:

1. Thomas D. Nadeau, Ken Gray, "SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies", O'Reilly Media, August 2013.
2. Paul Goransson, Chuck Black, Timothy Culver. "Software Defined Networks: A Comprehensive Approach", Morgan Kaufmann Publishers, 2016.
3. Fei Hu, "Network Innovation through OpenFlow and SDN: Principles and Design", CRC Press, 2014.
4. Vivek Tiwari, "SDN and OpenFlow for Beginners", Amazon Digital Services, Inc., ASIN: , 2013.
5. Nick Feamster, Jennifer Rexford and Ellen Zegura, "The Road to SDN: An Intellectual History of Programmable Networks" ACM CCR April 2014.
6. Open Networking Foundation (ONF) Documents, https://www.opennetworking.org, 2015.
7. OpenFlow standards, http://www.openflow.org, 2015.

Course title	**Evolutionary Algorithms**
Course Code:	**25C1ECP-PE4-04**
Scheme and Credits	**L T P C** **Semester –II** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	understand concept of optimisation techniques.
CO2	to work on some applications
CO3	understand various computing techniques.

Syllabus Contents

UNIT 1(12 hours):
Introduction to Optimization What is optimization, categories of optimization, minimum seeking algorithms.

UNIT 2(11 hours):
Natural Optimization Methods Simulated annealing, evolutionary algorithms (GAs, EP, ES, GP, PSO, BBO etc.), a simple evolutionary algorithm, Selection Schemes, Crossovers, Mutation, Applications Muti-Objective Evolutionary Optimization Multi-Objective Optimization Problem, Principles of Multi-Objective Optimization, Difference with Single- Objective Optimization, Dominance and Pareto-Optimality, Some applications of Multi- Objective Evolutionary Algorithms

UNIT 3(11 hours):
High Performance Computing for Evolutionary Algorithms Some HPC paradigms viz. Cluster computing, GPU computing

UNIT 4(11 hours):
Some Case Studies for Engineering Design

Suggested Readings/Books:
1.Kalyanmoy Deb, “Multi Objective Optimization using Evolutionary Algorithms”, John Wiley and Sons, 2001.
2.David A Coley, “An introduction to Genetic Algorithms for Scientists and Engineers”, World Scientific Publishing Company, 1997.
3.Mitsuo Gen, Runwei Cheng, “Genetic Algorithms and Engineering Design”, WileyInterscience, 1997.
4.Thomas Back, “Evolutionary Algorithms in Theory and Practice: Evolution Strategies, Evolutionary Programming, Genetic Algorithms”, Oxford University Press, 1996.

Course title	**Queuing Theory**
Course Code:	**25C1ECP-PE4-05**
Scheme and Credits	**L T P C Semester –II** **3 0 0 3**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**40**
External Marks	**60**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	examine possibilities for queuing in particular application
CO2	able to apply available jackson and non jackson models for different models.

Syllabus Contents

UNIT 1(12 hours):
Introduction. Description of the Queuing Problem, Characteristics of Queuing processes, Notation, Measuring System Performance, Some General Results, Simple Data Bookkeeping for Queues, Poisson Process and the Exponential Distribution, Markovian Property of the Exponential Distribution, Stochastic Processes and Markov Chains.

UNIT 2. (11 hours):
Simple Markovian Queueing Models, Birth Death Processes, Single-Server Queues (M/M/1), Multi-Server Queues (M/M/c), Choosing the Number of Servers, Queues with Truncation (M/M/c/K), Erlang?s Loss Formula (M/M/c/c), Queues with Unlimited Service (M/M/1),Finite Source Queues, State-Dependent Service, Queues with Impatience, Transient Behavior, Busy-Period Analysis.

UNIT 3. (11 hours):
Networks, Series, and Cyclic Queues, Series Queues , Open Jackson Networks, Closed Jackson Networks, Cyclic Queues, Extensions of Jackson Networks, Non-Jackson Networks.

UNIT 4. (11 hours):
General Arrival or Service Patterns, General Service, Single Server (M/G/1), General Service, Multi-Server (M/G/c/ú, M/G/1), General Input (G/M/1, G/M/c).

Suggested Readings/Books:

1. Wiley: Fundamentals of Queueing Theory, 4th Edition Queueing Systems, Volume I
2. Introduction to Queueing Theory and Stochastic Teletraffic Models, Moshe ,Copyright M. Zukerman 2000–2018.
3. Fundamentals of Queueing Theory, Fourth Edition, Donald Gross George Mason University Fairfax, Virginia John F. Shortie George Mason University Fairfax, Virginia James M. Thompson Freddie Mac Corporation McLean, Virginia Carl M. Harris ~ WILEY A JOHN WILEY & SONS, INC., PUBLICATION

Course title	**Antennas and Radiating Systems Lab**
Course Code:	**25C1ECP-211**
Scheme and Credits	**L T P C Semester –II** **0 0 4 2**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**60**
External Marks	**40**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	determine specifications, design, construct and test antenna.
CO2	explore and use tools for designing, analyzing and testing antennas. these tools include
CO3	antenna design and analysis software, network analyzers, spectrum analyzers, and antenna pattern measurement techniques.
CO4	examine antenna design for real time application

List of Experiments:

1. Simulation of half wave dipole antenna.
2. Simulation of change of the radius and length of dipole wire on frequency of resonance of antenna.
3. Simulation of quarter wave, full wave antenna and comparison of their parameters.
4. Simulation of monopole antenna with and without ground plane.
5. Study the effect of the height of the monopole antenna on the radiation characteristics of the antenna.
6. Simulation of a half wave dipole antenna array.
7. Study the effect of change in distance between elements of array on radiation pattern of dipole array.
8. Study the effect of the variation of phase difference 'beta' between the elements of the array on the radiation pattern of the dipole array.
9. Case study.

Course title	**Advanced Digital Signal Processing lab**
Course Code:	**25C1ECP-212**
Scheme and Credits	**L T P C Semester –II** **0 0 4 2**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**60**
External Marks	**40**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	design different digital filters in software
CO2	apply various transforms in time and frequency
CO3	perform decimation and interpolation
CO4	inspect IIR filters in software

List of Experiments:

1. Basic Signal Representation
2. Correlation Auto And Cross
3. Stability Using Hurwitz Routh Criteria
4. Sampling FFT Of Input Sequence
5. Butterworth Lowpass And Highpass Filter Design
6. Chebychev Type I,II Filter
7. State Space Matrix from Differential Equation
8. Normal Equation Using Levinson Durbin
9. Decimation And Interpolation Using Rationale Factors
10. Maximally Decimated Analysis DFT Filter
11. Cascade Digital IIR Filter Realization
12. Convolution And M Fold Decimation &PSD Estimator
13. Estimation Of PSD
14. Inverse Z Transform
15. Group Delay Calculation
16. Seperation Of T/F
17. Parallel Realization of IIR filter

Course title	**Mini Project**
Course Code:	**25C1ECP-213**
Scheme and Credits	**L T P C Semester –II** **0 0 4 2**
Pre-requisite (if any)	**Engineering Graduate with ECE/EEE/EE/EI**
Internal Marks	**60**
External Marks	**40**
Total Marks	**100**

Course Outcomes:

At the end of this course, students will be able to

CO1	design different circuits/ networks in hardware/software
CO2	apply various transforms in time and frequency
CO3	perform decimation and interpolation
CO4	may apply various optimisation techniques

Each student will be required to complete a Mini Project and submit a Project Report on a topic on any of the areas of modern technology related to Electronics Engineering including interdisciplinary fields. The title and objectives of the Mini Project will be chosen by the student in consultation with the Project Guide allocated to each student. The student will be required to present a talk to an audience of Faculty/Students in open defense in front of the **Project Evaluation Committee** having Project Guide as one of its members. The Head of Department will constitute the Project Evaluation Committee for the purpose of evaluation for internal assessment.

Course title	**Audit Course II: Value Education**
Course Code:	**25C1CCP – 06**
Scheme and Credits	**L T P C** **Semester – II** **2 0 0 0**
Pre-requisite (if any)	
Internal Marks	**0**
External Marks	**0**
Total Marks	**0**

Course Outcomes:

At the end of this course, students will be able to

CO1	explain the importance of social values, individual attitudes, and work ethics in personal and professional life.
CO2	apply key human values such as honesty, truthfulness, patriotism, and discipline through real-life scenarios and reflective practices.
CO3	analyze personal behavior and personality traits to cultivate a positive mindset and eliminate self-destructive habits.
CO4	evaluate different moral and non-moral values using philosophical and ethical standards to develop a balanced worldview.
CO5	develop a value-based lifestyle by integrating principles from various religions, self-management techniques, and ethical teachings.

Detailed contents:

UNIT 1: (4 Lectures)
Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements.

UNIT 2: (6 Lectures)
Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National UNITy. Patriotism, Love for nature, Discipline.

UNIT 3: (6 Lectures)
Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

UNIT 4: (6 Lectures)
Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

Suggested Readings/Books:

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi, 2024.