Course Structure & Syllabus of Ph.D. ECE

Applicable for Batch: 2021 Onwards

DIT UNIVERSITY

Dehradun

Detailed Course Structure & Syllabus

of

Ph.D. in ECE

Approved by the Academic Council at its 17th Meeting held on 24.03.2021

Course Structure & Syllabus of Ph.D. ECE

Applicable for Batch: 2021 Onwards

Course Category	Course Code	Course Name	Periods			Credits
			L	T	P	
UC	MB901	Research Methodology	4	0	0	4
-	CPE-RPE	Research Publication & Ethics	2	0	0	2
DE		Elective 1	4	0	0	4
DE		Elective 2	4	0	0	4
DC	EC901	Seminar	0	0	2	1
		Total Credits				**15**

List of Electives

S.No.	Subject Code	Course
1.	EC941	Advanced Digital Modulation
2.	EC942	Advanced Data Communication Networks
3.	EC943	Wireless Communication & Networks
4.	EC944	Coding for Reliable Communication
5.	EC945	Advanced Satellite Communication
6.	EC946	Spread Spectrum Communication
7.	EC947	Wireless Mobile Antenna & Smart Antenna
8.	EC948	Principle of Secure Communication
9.	EC949	Wireless Network Security
10.	EC951	Detection and Estimation Theory
11.	EC952	Wireless Ad – hoc Networks
12.	EC953	Advanced Microwave Communication
13.	EC954	Random Variable, Stochastic Process & Queuing Theory
14.	EC955	Advance Digital Signal Processing
15.	EC956	Speech Processing
16.	EC957	DSP Processors and Architecture
17.	EC958	Digital Image Processing
18.	EC959	Optoelectronic Device
19.	EC961	Optical Communication Networks
20.	EC962	Embedded System Design
21.	EC963	Mobile Radio Propagation Channels
22.	EC964	OFDM for Wireless Communications Systems
23.	EC965	Advances in Wireless Communication Systems

24.	EC966	Wearable sensors technology
25.	EC967	Nanoscale Devices
26.	EC968	Digital VLSI Design
27.	EC969	Analog VLSI Design
28.	EE604	Soft Computing (Common with PhD EE)
29.	EE603	Advanced Instrumentation (Common with PhD EE)
30.	EE601	Advanced Control Systems (Common with PhD EE)

Note: Apart from above listed Elective courses, Research Scholar may choose any course across departments being offered at PG level, if it is required/suggested by the Research Committee.

Course Structure & Syllabus of Ph.D. ECE

Applicable for Batch: 2021 Onwards

Subject Code	MB901	Subject Title	Research Methodology						
LTP	4 0 0	Credit	4	Subject Category	UC	Year	1st	Semester	I / II

UNIT – I

Fundamentals of Research: Defining research, Objectives of research, types, research process, deductive and inductive reasoning;

Identifying and formulating a research problem, Literature review: Search for existing literature (World Wide Web, Online data bases), Review the literature selected (Case studies, review articles and Meta-analysis), Develop a theoretical and conceptual framework, Writing up the review,

Definition of variables: Concepts, indicators and variables, Types of variables, Types of measurement scales, Constructing the Hypothesis- Null(Research) and alternative, one-tailed and two-tailed testing, errors in testing. Ethical and Moral Issues in Research, Plagiarism, tools to avoid plagiarism – Intellectual Property Rights – Copy right laws – Patent rights

UNIT – II

Research Design: Design of Experiments: Research Designs -Exploratory, Descriptive and Experimental, Experimental designs- Types of Experimental Designs

UNIT – III

Sampling, Sampling distribution, and Data Collection: Sampling distribution, Normal and binomial distribution, Reasons for sampling, sampling technique, sampling errors. Sources of Data-Primary Data, Secondary Data, Data Collection methods

UNIT – IV

Statistical Data Analysis: Descriptive and inferential statistical analysis. Testing of hypothesis with Z-test, T-test and its variants, Chi-square test, ANOVA, Correlation, Regression Analysis, Introduction to data analysis data using SPSS20.0

UNIT – V

Research Report: Writing a research report- Developing an outline, Formats of Report writing, Key elements-Objective, Introduction, Design or Rationale of work, Experimental Methods, Procedures, Measurements, Results, Discussion, Conclusion, Referencing and various formats for reference writing of books and research papers, Writing a Research Proposal.

Books Recommended:

1. Ganesan R, Research Methodology for Engineers , MJP Publishers, Chennai. 2011
2. C.R.Kothari, “Research Methodology”, 5th edition, New Age Publication,
3. Cooper, “Business Research Methods”, 9th edition, Tata McGraw hills publication
4. Walpole R.A., Myers R.H., Myers S.L. and Ye, King: Probability & Statistics for Engineers and Scientists, Pearson Prentice Hall, Pearson Education, Inc. 2007.
5. Anderson B.H., Dursaton, and Poole M.: Thesis and assignment writing, Wiley Eastern 1997.
6. Bordens K.S. and Abbott, B.b.: Research Design and Methods, McGraw Hill, 2008.
7. Morris R Cohen: An Introduction to logic and Scientific Method (Allied Publishers) – P 197-222; 391–403

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC941	Subject Title	ADVANCED DIGITAL MODULATION						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. The subject provides understanding of advancement in digital modulation systems.
2. The subject provides in depth knowledge of digitization techniques for analog messages and networks, channel coding, encryption and wireless communication.

UNIT 1: BASEBAND DIGITAL TRANSMISSION

Power Spectra of Digital PAM, Spectral Shaping by Preceding, Transmission Limitations of Digital PAM, M-ary Error Probabilities, Design of Matched Filters of Digital PAM, Nyquist Pulse Shaping, Optimum Terminal Filters, Equalization, Correlative Coding, Synchronization techniques in digital transmission.

UNIT 2: DIGITIZATION TECHNIQUES FOR ANALOG MESSAGES AND NETWORKS

PCM versus Analog Modulation, Delta-Sigma Modulation, Adaptive Delta Modulation, Differential PCM, LPC Speech Synthesis, Digital Multiplexers (ISDN, Optical SDH/SONET). Case studies related to Digitalization Techniques in communication Networks.

UNIT 3: CHANNEL CODING AND ENCRYPTION

Error Detection and Correction, Code Vectors, FEC Systems, ARQ Systems, Matrix Representation of Block Codes, Syndrome Decoding, Cyclic Codes, M-ary Codes, Convolution Codes, Convolution Encoding, Distance and Coding Gain, Decoding Methods, Turbo Codes, Data Encryption Standard, Rivest-Shamir-Adleman System, Case studies based on use of Channel coding techniques for optimization.

UNIT 4: BANDPASS DIGITAL TRANSMISSION

Coherent and non-coherent binary systems (OOK, BPSK, CPFSK, MSK), Quadrature-Carrier Systems, M-ary PSK Systems, M-ary QAM Systems, Comparison of Digital Modulation Systems, Trellis-Coded Modulation, Hard Versus Soft Decisions, Case studies on Comparison of Digital Modulation Systems

UNIT 5: TERRESTRIAL BASED WIRELESS COMMUNICATION

Terrestrial based wireless communication using smart antenna, Bulter matrix, side lobe canceller in smart antenna application, look at switched beam smart antenna. Deterministic signals, random noise and coherent noise (pseudo) combining in an array antenna.

Course Outcomes: At the end of the course student will be able to

CO1. understand the operation, theoretical analysis and design of baseband, pass band digital transmission systems

CO2. Understand the concepts of channel coding, encryption and wireless communication

CO3. do research in the digital modulation systems.

TEXT BOOKS:

1. A. Bruce Carlson, P.B. Crilly, Communication Systems, Tata McGraw Hill, 4th edition

REFERENCE BOOKS:

1. John G. Proakis, Digital Communication – 4th ed, Mc-Graw Hill publication.
2. Simon Haykin, Digital Communication, John Wiley, 1988

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC942	Subject Title	ADVANCED DATA COMMUNICATION NETWORKS					
LTP	4 0 0	Credit	4	Subject Category	DC	Year	1st	Semester	I/II

Course Objectives:

1. The subject provides understanding of advancement in data communication networks.
2. The subject provides in depth knowledge to analyze network, transport and higher layers.

UNIT 1. INTRODUCTION

Introduction of data networks: network elements, protocols, and applications, Protocols: OSI reference model, Physical Layer and Access Network Technologies: SONET, DSL, cable, PON ATM Protocols and Services, Physical, ATM, and AAL layers: functions and PDU formats ATM services. Local Area Networks: Ethernet, Fast Ethernet, Switched Ethernet, Gigabit Ethernet, Access control protocol, Performance analysis

UNIT 2. FRAME RELAY:

Frame format and functions, congestion control. Point-to-Point Protocol: PPP format and operations, Packet over SONET, Multi-Protocol Label switching: MPLS protocol, forwarding and control components, MPLS fast- reroute, Pseudo-wire emulation

UNIT 3. NETWORK LAYER

Internet Protocol Suite, Protocol model, Network layer protocols: IPv4, IPv6, ICMP, Transport layer protocols: TCP, UDP, RTP, Application protocols: Telnet, DNS, FTP, RTSP, HTTP, SNMP

Internet Routing: Unicast routing protocols: RIP, OSPF, IS-IS, BGP, Multicast routing protocols: DVMRP, MOSPF,CBT, PIM,

UNIT 4. TRANSPORT AND HIGHER LAYERS

Router/Switch Design: Architectures: single stage, multi-interconnect network, Performance analysis: queuing delay and cell loss ratio

UNIT 5. QOS AND TRAFFIC MANAGEMENT

QOS: QOS Protocols: IntServ/RSVP, DiffServ, MPLS, SBM, Queuing and scheduling disciplines, Congestion control techniques. Traffic Management: Network dimensioning, Call admission control, Usage parameter control/ Network parameter control, MPLS- Traffic engineering. Voice over IP: Codecs, Network architecture & protocols.

Course Outcomes: At the end of the course student will be able to

CO1. compare and analyze the fundamental principles of various digital communication networks and their protocol architectures.

CO2. examine the congestion control issues and traffic management.

CO3. do research in the advanced data communication networks.

TEXT BOOKS:

1. Computer Networks: A. S. Tanenbaum, 4th Edution, PHI (For I, II and III)

Reference Books:

1. An engineering Approach to Computer Networking, S. Keshav, Person Edition.
2. Computer Networking a top – Down Approach Featuring the Internet, J. F. Kurose, K. W. Ross, PearsonEducation.

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC943	**Subject Title**	**WIRELESS COMMUNICATION & NETWORKS**					
LTP	4 0 0	**Credit**	4	**Subject Category**	DC	**Year**	1st	**Semester**	I/II

Course Objectives:

1. To get an understanding of advance techniques for emerging wireless systems.
2. The subject provides in depth knowledge to analyze cellular concept, multi-access techniques of wireless communication networks.

UNIT 1: INTRODUCTION TO WIRELESS COMMUNICATION SYSTEMS

Evaluation of Mobile Radio Comm. – Examples of wireless comm. Systems – Cordless Telephone system – cellular Telephone systems – Comparison & Trends. Modern wireless comm. systems - 2nd and 3rd Generation wireless networks, WLL, WLANS.

UNIT 2: CELLULAR CONCEPT

System design fundaments – Frequency re – use Channel assignment and hand off strategies – Interference and system capacity – trunking and grade of services – Importing coverage and capacity in cellular systems. Radio Propagation and Cellular Engineering. Concepts – Fundamental Radio Propagation – Propagation Characteristics, Models of Multi – parts faded radio signals – Industry Standards for Propagation Models.

UNIT 3: MULTI-ACCESS TECHNIQUES OF WIRELESS COMMUNICATION

Introduction – FDMA, TEMA – Spread Spectrum multiple access: FHMA, CDMA, SDMA, Packet Radio – Protocols, Capture effect in packet Radio, Capacity of cellular system.

UNIT 4: WIRELESS NETWORKS

Introduction – Development of wireless networks, Traffic routing in wireless networks: CKT switching, Packet Switching, X.25 protocols – Wireless data services – Common Channel signaling (CCS) – ISDN – Signaling system no (S7): Network services part, User part, Signaling Traffic, Performance.

UNIT 5: WIRELESS SYSTEM AND STANDARDS

AMPS, GSM, CDMA digital cellular standards.

Course Outcomes: At the end of the course student will be able to

CO1. discuss the Wireless networking environment and Performance issues.
CO2. analyze the Capture effect in packet Radio and CDMA.
CO3. do research in the wireless communication networks

TEXT BOOKS:

1. Wireless Communications Principles and Practice, Second Edition – Theodore S. Rappaport Pearson EducationInc.,
2. Wireless Digital Communication – Modulation, 2 Spread Spectrum Applications – Dr. KamiloFeher, PHI.

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC944	**Subject Title**	**CODING FOR RELIABLE COMMUNICATION**					
LTP	4 0 0	**Credit**	4	**Subject Category**	DE	**Year**	1st	**Semester**	I/II

Course Objectives:

1. To provide rigorous foundations in information and channel capacity and source encoding.
2. The subject provides in depth knowledge to analyze and compare discrete and continuous communication channels.

UNIT 1: INFORMATION AND CHANNELS CAPACITY:

Measure of information – information content of message – average information content of symbol m log independent sequence – Markov statistical model for information source – Entropy and information rate Markov channel capacity theorem some properties.

UNIT 2: SOURCE ENCODING:

Shannon's first fundamental theory – Noiseless coding – source with finite memory Shannon's second fundamental theorem on coding for memory less noise channels Shannon's encoding algorithm.

UNIT 3: DISCRETE COMMUNICATION CHANNELS:

Discrete communication channel's – rate of information transmission over a discrete channel – capacity of discrete memory less channel – discrete channel with memory – discrete channel with continuous noise – discrete channel with discrete noise.

UNIT 4: CONTINUOUS COMMUNICATION CHANNELS:

Continuous channels – Shannon – Harthley Theorem implication – continuous channels with continuous noise– Efficiencies of different communication system.

UNIT 5: ERROR CORRECTING CODES:

Galois field, Vector spaces and Matrices – block codes, binary cycle code – multiples Error correcting codes – Majority logic coding – Burst error correcting code – Tow dimensional Codes – ARQ – performance of coeds.

Course Outcomes: At the end of the course student will be able to

CO1. discuss the information and channel capacity and source encoding and Performance issues.

CO2. Compare and analyze the discrete and continuous communication channels.

CO3. do research in the reliable communication.

TEXT BOOKS:

1. J. Das, S. K. Mulick, P. K. Chatterjee, principles of Digital Communication, Wiley Estate limited 1986.

REFERNCE BOOKS:

1. K. Sam Shanmugham 'Digital and Analog Communication System', John Wiely& Sons 1985.
2. J. Viterbi and J.H.K. Omura, Principle of digital communication and coding. McGraw hill.

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC945	Subject Title	ADVANCED SATELLITE COMMUNICATION					
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. To introduce various aspects in the design of systems for satellite communication.
2. The subject provides in depth knowledge to analyze satellite access and link design.

UNIT 1: SATELLITE ORBITS

Elements of Satellite Communication. Orbital mechanics, look angle and orbit determination, launches & launch vehicle, orbital effects, Geostationary Orbit, Comparison of LEO, MEO and GEO.

UNIT 2: SPACE SEGMENT AND SATELLITE LINK DESIGN

Introduction; attitude and orbit control system; telemetry, tracking and command; power systems, communication subsystems, antenna subsystem, equipment reliability and space qualification.

UNIT 3: SATELLITE ACCESS

Modulation and multiplexing techniques for satellite links Introduction, space segment access methods, TDMA, FDMA, CDMA, SDMA, assignment methods, Case study on capacity analysis.

UNIT 4: SATELLITE LINK DESIGN

Introduction, general link design equation, system noise temperature, uplink design, downlink design, complete link design, effects of rain. Case Study on satellite link design.

UNIT 5: EARTH SEGMENT AND RELATED APPLICATION OF SATELLITES

Earth Station Technology-- Terrestrial Interface, Transmitter and Receiver, Types of earth stations, Earth Station architecture and design considerations, Introduction to communication satellites, satellite telephony, satellite television, satellite radio, satellite data communication services. Case study on QoS analysis of mobile satellite systems.

Course Outcomes: At the end of the course student will be able to

CO1. understand how analog and digital technologies are used for satellite communication networks.

CO2. to learn the design of satellite links.

CO3. do research in the advanced satellite communication.

TEXT BOOKS:

1. Dennis Roddy, 'Satellite Communication', McGraw Hill International, 4th Edition, 2006.
2. Wilbur L. Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, 'Satellite Communication Systems Engineering', Prentice Hall/Pearson, 2007.

REFERENCES:

1. N.Agarwal, 'Design of Geosynchronous Space Craft, Prentice Hall, 1986.
2. Bruce R. Elbert, 'The Satellite Communication Applications' Hand Book, Artech House, Bostan London, 1997.
3. Tri T. Ha, 'Digital Satellite Communication', II edition, 1990.

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC946	Subject Title	SPREAD SPECTRUM SYSTEM						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. To introduce the basic concepts of spread spectrum communications.
2. To familiarize with several spread spectrum techniques and its performance in jamming environments.

UNIT 1. PSEUDO – NOISE GENERATOR:

Forms of spread spectrum (SS) – Communication – advantage off spectrum spreading example of early models-processing, games and other fundamentals parameter jamming methods- liner feedback shift register sequence generation – M sequences and then statistical properness – correlation properness – nonpeers sequence – gold sequence.

UNIT 2. SPREAD SPECTRUM TECHNIQUE:

Coherent direct sequence system model of DS / BPSK system m – coded bit probability forartary, jammer wave font – chenof bound – performance under constant power board band noise jammer – pulse jammar – partial band jammar – multi tone jammar coded DS / BPSK system.

UNIT 3. FREQUENCY HOPPING SS SYSTEM:

Non coherent FH system model – coherent FH system – frequency synthesis – performance of FH QPK and FH DPSK system in presence of partial band jamming – Time hoping SS technique.

UNIT 4. SYNCHRONIZATION OF RECEIVER:

Acquisition and tracking in DS and receiver sequentially estimation matches filter techniques of acquisition and tracking delay locked loop Tau – Dither loop.

UNIT 5. APPLICATION:

Code division multiple access in satellite communication, antijam military communication low – probability interrupt communication – mobile communication.

Course Outcomes: At the end of the course student will be able to

CO1. Describe the types and advantages of spread spectrum modulation formats.
CO2. Perform analysis on the performance of spread spectrum modulation formats.
CO3. do research in the spread spectrum systems.

TEXT BOOKS:

1. R. C. Dixaon, Spread Spectrum System, Johan Wiley. 1984
2.M. K. Sinon J. K. Omura, R. A. sachets and B. K. Levitt, spread spectrum communication, Vol.-I,vol II computerscience press USA
3. G. R. and Mc Gillian, modern communication and spread spectrum.

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC947	Subject Title	WIRELESS MOBILE AND SMART ANTENNA						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. Develop and apply the mathematical tools to analyze radiation characteristics of different antennas.
2. Understand the concept of smart antenna and beam forming techniques by using cellular radio system and its evolution.

UNIT 1. PLANNER ANTENNAS

Planner antennas for mobile phone, two separate patches with dual feed design. Different patch micro strip type, patch with LC resonators, triple frequency PIFA type.

UNIT 2. MONOPOLE ANTENNA

Very low-profile monopoles for internal mobile phone antenna. Branch line planner monopole, Branch patch monopole, Printed inverted F – type.

UNIT 3. BASE STATION ANTENNA FOR CELLULAR COMMUNICATION SYSTEMS:

Antenna for single band operations and for multi band operations. Antennas for dual polarized operations using different feeds.

UNIT 4. ANTENNAS FOR WLAN APPLICATIONS:

WLAN access point antennas, surface mountable antenna, printed monopole antennas for dual band operations. Dielectric resonator antenna.

UNIT 5. INTEGRATION OF ANTENNAS:

Different operating bands, DCS and WLAN, DCS and GPS antennas.

Course Outcomes: At the end of the course student will be able to

CO1. understand the concept of planner, monopole antennas and base station antenna for cellular communication systems.

CO2. Develop the mathematical tool to analyze radiation characteristics of antennas for wireless applications

CO3. do research in the spread spectrum systems.

TEXT BOOK:

1. Kin. Lu. Wong “Planar antennas for wireless communications,” WILEY inter Science.

Reference Books:

1. Software Radio A Modern Approach to Radio Engineering, J. H. Reed, Pearson Education.
2. Wireless and Cellular Communications, William C. Y. Lee, McGraw-Hill
3. Wireless Communications, Principles and Practices, Rappaport, PHI
4. Smart Antenna, T. K. Sarkar

Course Structure & Syllabus of Ph.D. ECE

Applicable for Batch: 2021 Onwards

Subject Code	EC948	Subject Title	PRINCIPLES OF SECURE COMMUNICATION						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. To understand basics of Cryptography and Network Security
2. To be able to secure a message over insecure channel by various means.

UNIT 1 DIRECT SEQUENCE SPREAD SPECTRUM SYSTEMS:

Model of SS digital communication system, direct sequence spread spectrum signal, error rate performance of the decoder, processing gain and jamming margin, uncoded DSSS signals, applications of DSSS signals in anti- jamming, low detectability signal transmission, code division multiple access and multipath channels, effect of pulsed interference on DSSS systems, Generation of PN sequences using m sequence and Gold sequences, excision of narrowband interference in DSSS systems, acquisition and tracking of DSSS system.

UNIT 2 FREQUENCY HOPPED SPREAD SPECTRUM SYSTEMS:

Basic concepts, slow and fast frequency hopping, performance of FHSS in AW GN and partial band interference, FHSS in CDMA system, Time hopping and hybrid SS system, acquisition and tracking of FH SS systems.

UNIT 3 CRYPTOGRAPHIC TECHNIQUES:

Classical encryption technique, Symmetric cipher model, cryptography and cryptanalysts, Substitution techniques, transposition techniques

UNIT 4 BLOCK CIPHER AND DATA ENCRYPTION STANDARD:

Block cipher principle, data encryption standard (DES) strength of DES, differential and linear cryptanalysts, block cipher design principles, simplified advanced encryption standard (S-AES), multiple encryption and triple DES, Block cipher modes of operation, stream ciphers and RC4 algorithm

UNIT 5 PUBLIC KEY CRYPTOGRAPHY:

Prime numbers, Fermat and Euler's theorem, Chinese remainder theorem, discrete algorithms, principles of public key cryptosystems, RSA algorithm, key management Diffie-Hellman key exchange, message authentication requirements and functions.

Course Outcomes: At the end of the course student will be able to

CO1. Provide security of the data over the network.
CO2. Implement various networking protocols.
CO3. Do research in the emerging areas of cryptography and network security.

TEXT BOOKS:

1. Digital Communication by J.G. Proakis McGraw Hill 2nd Ed.
2. Cryptography and Network Security by W. Stallivgs 4th Ed., PHI
3. Digital Communication by Simon Haykin, Wiley.
4. Principle of Communication systems by Taub& Schilling TMH.
5. Cryptography and secure Communications by M.Y. Rhee, Mc Graw Hill

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC949	Subject Title	WIRELESS NETWORK SECURITY					
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. The course will provide knowledge of information security technology and methods for communication systems that provide services for mobile users by wireless access networks.
2. Knowledge and understanding of security mechanisms and protocols in wireless communication networks.

UNIT 1. INTRODUCTION& REVIEW

Wireless Communications vs. Networking, 802.11 Framing, Mobility & Roaming

UNIT 2. SECURITY MODELS

Wireless Network Vulnerabilities and IDS/IPS Security Context, Security Architecture, War Driving, War Riding, War Walking, &War Chalking, Scanning, Denial of Service, Man-in-the-Middle, "Evil Twin" Access Points

UNIT 3. PREVIOUS 802.11 SECURITY

MAC Address Filtering, 64, 128, and 256-bit WEP, SSID-Based Attempts, VPN-Based Solutions, IPsec, Issues & Weaknesses

UNIT 4. WPA COMPONENTS

802.1x & 802.1aa, Extensible Authentication Protocol, TKIP, WPA-PSK

UNIT 5. 802.11I (WPA2)

Transitional Secure Network, Robust Secure Network, EAP, LEAP, PEAP, EAP-FAST, TLS & TTLS, AES, CCMP, Authentication Servers- RADIUS, Kerberos

Course Outcomes: At the end of the course student will be able to

CO1. Understand design principles, mechanisms, and solutions used in wireless network security to obtain secrecy, integrity, authentication, privacy, crypto key distribution, and access control

CO2. Understanding of WPA components.

CO3. Do research in the emerging areas of wireless network security.

TEXT BOOKS AND REFERENCES:

1. Introduction to cryptography – H Delfs H. Hneber – 2002 Springer
2. Introduction to cryptography – J. A. Buchamann – 2001 Springer
3. Information Security and Crytography – ICISC 2001. K Kim, Ed 2002 vol 2288 Springer
4. Understanding data comm./ and network shay vikas, Thomas Pub
5. Information security and cryptography. ISISC 2000 by D Won Vol 2015 etc 2001 Springer

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC951	Subject Title	DETECTION AND ESTIMATION THEORY					
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. To Analyze the need for estimation techniques in Communication and Signal Processing
2. To analyze estimation problems and apply suitable estimation and detection techniques.

UNIT 1. STOCHASTIC SIGNAL:

Stochastic signal / orthogonal representation pf signal random process, Markov process. Correlation. Function, power spectral density, Tcheloycheffi Inequality.

UNIT 2. DETECTION:

Detection, presences of noise, correlator, optimum filter, matched filter.

UNIT 3 HYPOTHESIS TESTING:

Weighed probabilities and hypothesis testing, composite hypothesis, likelihood ratio detection Sequential detection.

UNIT 4 ESTIMATION:

Principles of estimation, properties of estimator. Comar – Rao bound, Bye's maximum likelihood and currenttrends.

UNIT 5. ADAPTIVE ARRAY:

Compensation of an Adaptive Array, current Trends in Adaptive Array.

Course Outcomes: At the end of the course student will be able to

CO1. Implement the estimation techniques in Communication and Signal Processing problems and acquire expertise in Classical and Bayesian estimation techniques for parameters and signals, and Detection of signals in the presence of white Gaussian noise

CO2. Conduct in-depth analysis of estimation problems and apply suitable estimation and detection techniques that meet the constraints of the problem such as performance, bandwidth and power overheads and computational complexity

CO3. Do research in the emerging areas of detection and estimation theory.

TEXT BOOKS:

1. Robert A. Monzmgo and Thomas W. Miller Introduction to adaptive array john Willey and Sons 1980.

REFERENCE BOOKS:

1. L. E. Hudsom. Adaptive Principal Paragons Ltd. 1981.

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC952	Subject Title	WIRELESS AD-HOC NETWORKS						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. Understand need for ad hoc networks.
2. Explain the constraints of physical layer that affect the design and performance of ad hoc network.

UNIT 1. INTRODUCTION TO ADHOC NETWORKS:

Need for ad-hoc networks, Applications, variations- Fully symmetric, Asymmetric environment, Asymmetric responsibility, Traffic variations, Mobility Patterns, Challenges, Hidden terminal problem, Exposed terminal problem, Routing in Ad-hoc.

UNIT2. UNICAST, MULTICAST ROUTING:

Types of routing protocols- proactive, reactive and Hybrid protocol, Flooding of Data, Advantages & disadvantages, Dynamic source Routing (DSR), Location Aided Routing (LAR), and Distance Routing Effect Algorithm for Mobility (DREAM), Geographic Distance Routing (GEDIR), Query Localization, Broadcast Storm Problem, Ad Hoc On-Demand Distance Vector Routing (AODV), Link Reversal Algorithm, Partial Reversal Method.

UNIT 3. PARTITION, GEOCAST ROUTING, POWER AWARE ROUTING:

Temporally-Ordered Routing Algorithm(TORA), Core-Extraction Distributed Ad Hoc Routing (CEDAR), Link State Routing, Optimized Link State Routing (OLSR), Destination-Sequenced Distance-Vector (DSDV), Zone Routing Protocol (ZRP), Power-Aware Routing.

UNIT 4. MEDIUM ACCESS CONTROL:

Security Issues, Implementation Issues, Introduction, Background, Fundamentals of MAC Protocols.UNIT 5.

DISTRIBUTED ALGORITHMS, STANDARDS ACTIVITIES, OPEN PROBLEMS:

Vulnerabilities of Mobile Adhoc Networks, Potential Attacks, Attack Prevention Techniques, Intrusion Detection Techniques, Introduction, Background, Range of Applications, Examples of Category 2 WSN Applications, Examples of Category I WSN applications, Another Taxonomy of VSN Technology.

Course Outcomes: At the end of the course student will be able to

CO1. Understand the challenges in design of wireless ad hoc networks

CO2. Understand and analyze proposed protocols at MAC and routing layers of ad hoc networks.

CO3. Do research in the emerging areas of wireless ad-hoc networks.

TEXT BOOKS:

1. Prasant Mohapatra and Srihanamurthy, “Ad Hoc Networks Technologies and Protocols”, Springer, SpringerInternational Edition, 2009.

REFERENCE BOOKS:

1. Kazem Sohraby, Daniel Minoli, Taieb Znati, “Wireless Sensor Networks”, A John Wiley & Sons Inc.,Publication-2007.

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC953	Subject Title	ADVANCED MICROWAVE COMMUNICATION						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. An understanding of advanced microwave waveguides, passive & active devices, tubes and network analysis.
2. An ability to study effect on radio wave propagation.

UNIT 1: MICROWAVE AND MILLIMETER WAVE DEVICES:

Overview of microwave and millimeter wave vacuum tube devices, limitations of microwave vacuum tubes, gyration vacuum tube devices. Advances in microwave and millimeter wave solid state devices, Gunn devices, oscillator using Gunn diode, and injection locked oscillators, IMPATT devices, and microwave and mm wave performance of IMPATT. Other solid-state devices like Tunnel diode, BARITT and TRAPAT.

UNIT 2. MICROWAVE AND MM WAVE CIRCUITS:

Review of scattering matrix concept in the light of vector network analyzer, impedance matching network, couplers, power dividers, resonators and filters. Detectors, mixers, attenuators, phase shifters, amplifier and oscillator, Ferrite based circuits.

UNIT 3. ANTENNAS:

Hertzian dipole, loop antenna, helical antenna, frequency independent antenna: Du-Hamel principle, log spiral and log periodic dipole antenna array. Babinet principle, waveguide slot antenna, microstrip antenna, horn antenna, parabolic reflector.Antenna arrays and phased array antenna. Antenna measurement.

UNIT 4. MICROWAVE AND MM WAVE PROPAGATION:

Overview of basic radio wave propagation mechanisms, Friis transmission formula, plane earth propagation model, troposcatter systems, ionosphere propagation, duct propagation, microwave radio link and calculation of link budget.

UNIT 5. EFFECT ON RADIO WAVE PROPAGATION

Effect on radio wave propagation due to rain, fog, snow, ice, atmospheric gases, Earth's magnetic field.

Course Outcomes: At the end of the course student will be able to

CO1. Explain different types of waveguides and their respective modes of propagation.
CO2. Analyze typical microwave networks using impedance, admittance, transmission and scattering matrix representations.
CO3. Do research in the emerging areas of advanced microwave communication.

TEXT BOOK:

1. David M Pozar, Microwave Engineering, John Wiley & Sons
2. R E Collin, Antenna & Radio wave Propagation, McGraw Hill Book Co.
3. Jordan &Balman, Electromagnetic waves & Radiating System
4. R E Collin, Microwave Engineering, McGraw Hill CO.

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC954	Subject Title	RANDOM VARIABLE, STOCHASTIC PROCESS AND QUEUING THEORY					
LTP	4 0 0	Credit	4	Subject Category	DC	Year	1st	Semester	I/II

Course Objectives:

1. The subject introduces the probability, random process and the linear algebra that are required for the theoretical analysis of the communication systems.
2. To provide the ideas of formulating mathematical modeling and their optimum solution in the context of practical problems in queuing theory.

UNIT 1: THEORY OF PROBABILITY & RANDOM VARIABLE

THEORY OF PROBABILITY: Axioms of probability: set theory, probability space, conditional, probability. CONCEPT OF RANDOM VARIABLE: Introduction, distribution and density functions, specific random variables, conditionaldistributions.

UNIT 2: MULTIPLE RANDOM VARIABLES:

Bivariate distributions, one function of two random variables, two functions of two random variables, joint moments, joint characteristic functions, conditional distributions Multiple random variables, sequences of random variables

UNIT 3: CONCEPT OF STOCHASTIC PROCESSES & RANDOM WALKS AND APPLICATION

Definition, systems with stochastic inputs, power spectrum, discrete-time processes. RANDOM WALKS AND OTHER APPLICATIONS: random walks, Poisson points and shot noise, cyclo-stationary Processes, band-limited processes and sampling theory, deterministic signals in noise.

UNIT 4: SPECTRAL REPRESENTATION AND ESTIMATION:

Factorization and innovations, finite-order systems and state variables, spectral representation of random processes, ergodicity, spectrum estimation. MEAN SQUARE ESTIMATION: prediction, filtering and prediction, Kalman filters. Entropy: Basic concepts, random variables and stochastic processes, MEM.

UNIT 5: MARKOV CHAIN & QUEING THEORY:

Introduction, higher transition probabilities and the Chapman-Kolmogorov equation, classification of states, stationary distributions and limiting probabilities, transient states and absorption probabilities, branching processes. Markov processes. QUEUING THEORY: Characteristics of Queuing Theory, Queuing Models, Birth & Death Process, Little's Theorem.

Course Outcomes: At the end of the course student will be able to

CO1. solve the problem associated with transformation of random variables.
CO2. solve the problem associated with MARKOV chain & queuing theory.
CO3. Do research in the emerging areas of random variable, stochastic process and queuing theory.

TEXT BOOKS:

1. Probability, Random Variables and Stochastic Processes/A. Papoulis & S. U. Pillai / 4th ed. /TMH
2. Probability, Random Variables & Random Signal Principles/Peyton Z. Peebles, Jr. / TMH
3. Probability& Queuing Theory, R. H. Chitale, Technical Publication Pune

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC955	Subject Title	ADVANCE DIGITAL SIGNAL PROCESSING						
LTP	4 0 0	Credit	4	Subject Category	DC	Year	1st	Semester	I/II

Course Objectives:

1. At the completion of this course, the student should have in depth knowledge of processing digital signals.
2. Understanding of multi-rate digital signal processing and finite word length effects.

UNIT 1: FAST FOURIER TRANSFORMS:

Fast Fourier transforms (FFT) - Radix-2 decimation-in-time and decimation-in-frequency FPT Algorithms, Inverse FFT and FFT with general Radix-N

UNIT 2: REALIZATION OF DIGITAL FILTERS:

Applications of Z - transforms, solution of difference equations of digital filters, System function. Stability criterion. Frequency response of stable systems, Realization of digital filters - Direct, Canonic, Cascade and Parallel forms

UNIT 3: IIR & FIR DIGITAL FILTERS:

Analog filter approximations - Butterworth and Chebyshev, Design of IIR Digital filters from analog filters. Step and Impulse invariant techniques. Bilinear transformation method, Spectral transformations. Characteristics of FIR Digital Filters. Frequency response. Design of FIR Filters: Fourier Method. Digital Filters using Window Techniques, Frequency Sampling technique, Case study on Comparison of various IIR & FIR filters

UNIT 4: MULTIRATE DIGITAL SIGNAL PROCESSING:

Introduction, Down sampling, Decimation. Up sampling, Interpolation, Sampling Rate Conversion, conversion of band pass signals. Concept of re-sampling. Case study on

Applications of multi rate signal processing

UNIT 5: FINITE WORD LENGTH EFFECTS:

Limit cycles. Overflow oscillations. Round-off noise in I.IR digital filters. Computational output round off noise. Methods to prevent overflow. Trade-off between round-off and overflow noise. Measurement of coefficient quantization effects through pole-zero movement. Dead band effects.

Course Outcomes: At the end of the course student will be able to

CO1. Comprehend the DFTs and FFTs.
CO2. Design and analyze the digital filters.
CO3. Do research in the emerging areas of advance digital signal processing.

TEXT BOOKS:

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris Manolakis. Pearson Education / PHI. 2007.
2. Discrete Time Signal Processing-A. V. Oppenheim and R.W. Schaffer. PHI, 2009
3. Fundamentals of Digital Signal Processing – Loney Ludeman. John Wiley, 2009
4. Digital Signal Processing- S. Palani- Ane Books Pvt. Ltd., 2013

REFERENCE BOOKS:

1. Digital Signal Processing - Fundamentals and Applications - Li Tan, Elsevier. 2008
2. Fundamentals of Digital Signal Processing using Matlab - Robert J. Schilling. Sandra L, Harris, Thomson. 2007
3. Digital Signal Processing - S. Salivahanan. A. Vallavaraj and CGnanapriya.TMH.2009

Course Structure & Syllabus of Ph.D. ECE

Applicable for Batch: 2021 Onwards

Subject Code	EC956	Subject Title	SPEECH PROCESSING						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. To understand the basic principles of sound and speech production and perception.
2. To understand basic principles of speech recognition, synthesis and dialogue systems.

UNIT 1. DIGITAL MODELS FOR THE SPEECH SIGNAL:

The process of speech production – Acoustic theory of speech production – Lossless tube digital models for speech signals.

UNIT 2. TIME DOMAIN MODELS FOR SPEECH PROCESSING:

Time dependent processing of speech short time energy & average magnitude, zero crossing rate, pitch period estimation short time auto correlation function, median smoothing and speech processing. Digital representation of speech waveform quantization – instantaneous and adaptive delta modulation, DPCM, Comparison of system.

UNIT 3. SHORT TIME FOURIER ANALYSIS:

Basic model short time analysis and synthesis of speech, implementation of filter bank summation methods using FFT, pitch detection, analysis – by – synthesis. Analysis – synthesis systems. Homomorphic speech processing complex cepstum approach, pitch detection format detection, Homomorphic vocoder.

UNIT 4. LINEAR PREDICTIVE CODING OF SPEECH:

Principles of linear predictive analysis, solution of LPC Equation; prediction error signal, frequency DOMAIN REPRESENTATION OF lPC ANALYSIS, Relation between the various speech parameter Synthesis of speech from LP parameters and applications.

UNIT 5. SPEECH CODING:

Sub – band coding, transform coding channel Vocoder, format Vocoder, ceptral Vocoder, LP Vocoders. Vector quantizer coders.

Course Outcomes: At the end of the course student will be able to

CO1. Perform time and frequency domain text-to-speech synthesis.

CO2. Understand signal digitization and basic signal processing in time and frequency domains.

CO3. Do research in the emerging areas of speech processing.

TEXT BOOKS:

1. L. R. Rabiner& R. W. Schafer: Digital Processing of Speech Signals, PH.
2. Papamichalis, Practical approach to speech coding, PHI 1987.
3. OWENS, Signal Processing of Speech.
4. DEKKAR& PROAKIS, Digital Speech Processing.

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC957	Subject Title	DSP PROCESSORS AND ARCHITECTURES					
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. To give an exposure to the various fixed point & a floating point DSP architectures and to develop applications using these processors.
2. Acquire knowledge of DSP computational building blocks and DSP architecture/processor.

UNIT 1: INTRODUCTION TO DIGITAL SIGNAL PROCESSING:

Introduction, A Digital signal – processing system, the sampling process, discrete time sequences. Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), linear time – invariant systems, Digital filters, Decimation and interpolation, Analysis and Design tool for DSP Systems MATLAB, DSP using MATLAB.

UNIT 2: COMPUTATIONAL ACCURACY IN DSP IMPLEMENTATIONS:

Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational error, D/A Conversion Errors, Compensating filter.

UNIT 3: ARCHITECTURES FOR PROGRAMMABLE DSP DEVICES

Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External interfacing.

UNIV 4: EXECUTION CONTROL AND PIPELING

Hardware looping, Interrupts, Stacks, Relative Branch support, Pipeling and Performance, Pipline Depth, Interlocking, Branching effects, Interrupts effects, Pipeline Programming models.

UNIT 5: PROGRAMMABLE DIGITAL SIGNAL PROCESSORS

Commercial Digital signal – processing Devices, Data Addressing modes of TMS320C54XXDSPs, Data Addressing modes of TMS320C54XX Processors, memory space of TMS320C54XX Processors, Program Control TMS320C54XX instructions and Programming, On – Chip Peripherals, Interrupts of TMS320C54XX processors, Pipeline Operation of TMS320C54XX Processors.

Course Outcomes: At the end of the course student will be able to

CO1. Illustrate the features of on-chip peripheral devices and it's interfacing along with its programming details.
CO2. Analyze and learn to implement the signal processing algorithms in DSPs.
CO3. Do research in the emerging areas of DSP processors and architectures.

TEXT BOOKS:

1. Digital signal processing – Avtar Singh and S. Srinivasan, Thomson Publications, 2004.
2. DSP Processor Fundamentals, Architectures & Features – Lapsley et al. S. Chand & Co 2000.

REFERENCE BOOKS:

1. Digital Signal Processors, Architecture, Programming and Applicaions – B. VenkataRamani and M. Bhaskar,TMH, 2004.
2. Digital Signal Processing – Johatham Stein, John Wiley, 2005.

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC958	Subject Title	Digital Image Processing						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. To introduce the concepts of image processing and basic analytical methods to be used in image processing.
2. To familiarize students with image enhancement and restoration techniques. And to explain different image compression techniques.
3. To introduce segmentation and morphological processing techniques.

UNIT 1

Introduction: Fundamental steps in DIP, elements of DIP, Simple image model, Sampling & quantization, basic relationships between Pixels, Color image model.

UNIT 2

Image Transforms: One-dimensional & Two-dimensional DFT, Cosine, Sine, Hadamard, Haar, and Slant & KLtransforms.

Image Enhancement: Introduction, point operations, Histogram modeling, spatial operations, Transformoperations.

UNIT 3

Image Restoration: Introduction, Image observation models, Inverse & Wiener filtering, difference between enhancement & restoration Restoration-spatial filtering, Noise reduction in frequency domain.

UNIT 4

Image Compression: Introduction, Pixel coding, Predictive coding, Transform coding, Inter-frame coding.

UNIT 5

Image Segmentation: Introduction, Spatial feature extraction, Transforms features, Edge detection, Boundary extraction, Segmentation techniques.

Course Outcomes: At the end of the course student will be able to

CO1. Explain the fundamentals of digital image and its processing.
CO2. Elucidate the mathematical modelling of image restoration and compression.
CO3. Do research in the emerging areas of Digital Image Processing.

TEXT/REFERENCE BOOKS:

1.Digital Image Processing, Rafael C. Conzalez Richard E Woods, 2nd Ed.TMH
2.Pratt "Digital Image Processing" 4th Edition, John Wiley(India) 3.Fundamentals of Digital Image Processing, Anil K Jain.

Course Structure & Syllabus of Ph.D. ECE

Applicable for Batch: 2021 Onwards

Subject Code	EC959	Subject Title	OPTOELECTRONIC DEVICES					
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. Explain key concepts in quantum and statistical mechanics relevant to physical, electrical and optoelectronic properties of materials and their applications to optoelectronic devices and photonic integrated circuits.
2. describe fundamental and applied aspects of optoelectronic device physics and its applications.
3. analyze optoelectronic device characteristics in detail using concepts from quantum mechanics and solid-state physics

UNIT 1. INTRODUCTION TO OPTICAL WAVE GUIDES:

Integrated optic – Substrate materials for optical integrated circuits – Optical wave guide modes – theory of planer wave guides – symmetric and symmetric slab wave guides – channel waveguides – strip loaded waveguides – losses in optical waveguides. Transverse couplers – prism couplers – Grating Tapered couplers –Fiber to waveguides couplers.

UNIT2. ELECTRO OPTIC MODULATORS:

Characteristics of switches and modulators – Electro optic effect – Single and dual channel wave guides – electro-optic modulator – Mach Zehnder type electro – optic modulator – Comparison of waveguides modulators.

UNIT 3. ACOUSTO – OPTIC MODULATOR:

Principle of acoust0 – optic effect – Raman – Nath type modulator – Bragg type deflectors and switches acousto-optic frequency shifters.

UNIT 4. MAGNETO OPTIC DEVICES:

Characteristics of magneto Optic effect – Non – reciprocal waveguides – Interaction between magnetic spin wave and Optic wave – Optical isolator – Optical isolator – Optical filter.

UNIT 5. NON-LINEAR FIBER OPTICS AND APPLICATIONS:

Fiber non linarites – Optical solutions – Nonlinear birefringence effects – Optical pulse compression – RF spectrum analyzer – Analog to digital converter – integrated optic Doppler velocimeter Opto-electronic integrated circuits – Opto-microwave applications.

Course Outcomes: At the end of the course student will be able to

CO1. Acquire fundamental understanding of the basic physics behind optoelectronic devices.

CO2. Acquire detailed knowledge of solar cells and optoelectronic modulation and switching devices.

CO3. Do research in the emerging areas of optoelectronic devices.

TEXT BOOKS:

1. R. G. hullsperger. Integrated Optics: Theory and Technology springer, verlag series, 1991.
2. G. P. Agarwal, Nonlinear Optics, Academic Press, 1989.

REFERENCE BOOKS:

1. J.wilson& J.F.B. Hawkes, Optoelectronics: An introduction prentice hall Inter nation's series, 1983.
2. L. J. Pinsion. Electro optics, John Willy & sons, 1085.
3. L. Sharupic. N. Tugliv, Optoelectronics, MIR Publishers. 1987.

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC961	Subject Title	OPTICAL COMMUNICATION NETWORKS						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures.
2. To understand the WDM concepts and components, and optical networks.

UNIT 1: OPTICAL FIBER:

Optical fiber modes and configuration, Mode theory of circular waveguide, Single mode fiber, Attenuation and distortion in optical waveguide, Design optimization of single mode fiber.

UNIT 2: OPTICAL SOURCES AND DETECTORS:

LED: structure, materials, efficiency, and modulation. LASER: lasing action, threshold condition, rate equation, efficiency, modulation. Light source linearity, noises. PHOTODIODES: structure and principle of working, Photodetector noise, SNR.

UNIT 3: OPTICAL RECEIVER AND TRANSMISSION SYSTEMS:

Fundamental receiver operation and detailed performance calculations. Point to point link analysis, Noise effects on system performance. Carrier to noise ration evaluation for analog link

UNIT 4: WDM CONCEPTS AND COMPONENTS:

Operational principle of WDM, Passive components: Couplers, Multiplexers & Filters, Tunable sources. Semiconductor Optical Amplifier: pumping and amplifier gain, EDFA, Wavelength converters.

UNIT 5: OPTICAL NETWORKS:

Basic networks, network topologies. SONET / SDH: transmission formats and speed, optical interface, SONET/SDH rings. Broadcast-and-select WDM networks, Wavelength routed networks: optical cross connect, nonlinear effects on network performance.

Course Outcomes: At the end of the course student will be able to

CO1. Describe about the SONET/SDH and architecture of Optical Transport Network.
CO2. Discuss the elements of WDM networks and its potential applications.
CO3. Do research in the emerging areas of optical networks.

TEXT BOOKS:

1. Gerd Keiser, “Optical Fiber Communication”, McGraw Hill, Third Edition,
2. G.P Agrawal, “Fiber Optic Communication Systems”, John Wiley and Sons,Fourth Edition, 2010.
3. Rajiv Ramaswami and Kumar N. Sivarajan, “Optical Networks: A Practical Perspective”, Harcourt Asia Pte Ltd., Second Edition 2006

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC962	Subject Title	EMBEDDED SYSTEM DESIGN						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. To introduce the Building Blocks of Embedded Systems.
2. To understand the various Embedded Development Strategies.
3. To introduce Basics of Real time operating system and example tutorials to discuss on one real time operating system tool.

Unit 1 - EMBEDDED ARCHITECTURE

Embedded Computers – Characteristics of Embedded Computing, Applications – Challenges in Embedded Computing system design Embedded, memories – Embedded System design process – Requirements – Specification – Architectural Design – Designing Hardware and Software Components – System Integration –Design Example, IDE, hardware software co-designing.

Unit 2 EMBEDDED PROCESSOR AND COMPUTING PLATFORM

MSP 430 RISC Controllers, parallel I/O, external interrupts. ARM processor fundamentals – introduction to ARM and THUMB instruction set--processor and memory organization – CPU Bus configuration – ARM Bus –Memory devices – Input/output devices – Component interfacing – designing with microprocessor development and debugging –Design Example.

Unit 3 INTERFACING

Sensors and interfacing techniques, Analog interfacing and data acquisition, Timing generation and measurements, --Distributed Embedded Architecture – Networks for Embedded Systems- serial bus protocols like I2C, RS485, CAN and USB--wireless protocols and interfacing of IRDA and SMART card – Design Example wireless protocols and interfacing of IRDA and SMART card – Serial communications: I2C – CAN Bus – Design Example

Unit 4 REAL TIME CONCEPTS

Real-time concepts, hard and soft real time systems, real-time operating systems, Required RTOS services/capabilities (in contrast with traditional OS). Resource Management/scheduling paradigms: static priorities, static schedules, dynamic scheduling, Real-world issues: blocking, unpredictability, interrupts, caching, Examples of OSs for embedded systems, Task & data, Task & states, Shared data problems, messages, mailbox, queues & pipes.

Unit 5 SYSTEM DESIGN

Design Methodologies – Requirement Analysis – Specification – System Analysis and Architecture Design – modeling techniques --Testing and debugging ---Quality Assurance – Design Example: Data base applications (smart cards), process-control (Fuzzy logic), robotics (wireless), CCD camera (data compression), network appliances (e-server) (any one).

Course Outcomes: At the end of the course student will be able to

CO1. Acquire a basic knowledge about programming and system control to perform a specific task.

CO2. Acquire knowledge about devices and buses used in embedded networking.

CO3. Do research in the emerging areas of embedded system design.

TEXT and REFERENCE BOOKS:

1. Introduction to Embedded Systems, Jonathan W. Valvano , Cengage 2009,
2. ARM System Developer's Guide, 1st Edition, Sloss & Symes& Wright , 2004, Morgan Kaufmann
3. Embedded Real Time Systems: Concepts, Design & Programming, Dr.K.V.K.K. Prasad, Dreamtech Publication.
4. Introduction to embedded systems, Shibu K V, 2009, McGraw-Hill

Course Structure & Syllabus of Ph.D. ECE

Applicable for Batch: 2021 Onwards

Subject Code	EC963	Subject Title	MOBILE RADIO PROPAGATION CHANNELS						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. To expose the students to understand mobile radio communication principles.
2. To study the recent trends adopted in cellular systems and wireless standards.

Unit 1: Fundamentals of VHF and UHF Propagation

Introduction, Propagation in free space, Propagation over a reflecting surface, the reflection coefficient of the Earth, Propagation over a curved reflecting surface, Propagation over a plane reflecting surface, Ground roughness. The effect of the atmosphere, Atmospheric ducting and non-standard refraction.

Unit 2: Propagation over Irregular Terrain and Built-up Areas

Propagation over Irregular Terrain: Introduction, Huygens' principle, Diffraction over terrain obstacles, Diffraction over real obstacles, Multiple knife-edge diffraction, Path loss prediction models. Propagation in Built-up Areas: Introduction, Propagation prediction techniques, Microcellular systems.

Unit 3: Characterization of Multipath Phenomena

Introduction, the nature of multipath propagation, Short-term fading, the scattering model, Angle of arrival and signal spectra, the received signal envelope, the received signal phase, Baseband power spectrum, LCR and AFD, The PDF of phase difference, Random FM, Rician fading, Spatial correlation of field components, the signal received at the base station,15 Signal variability, Statistics of the fast fading, Statistics of the local mean, large area statistics.

Unit 4: Wideband Channel Characterization

Introduction, Frequency-selective fading, Characterization of deterministic channels, randomly time-variant linear channels, Classification of practical channels, Channel characterization using the scattering function, Mobile radio channel Characterization, Man-made Noise and Interference.

Unit 5: Mitigation of Multipath Effects and Radio Planning

Introduction, Diversity reception, Basic diversity methods: Selection diversity, Maximal ratio combining, Equal-gain combining, Improvements from diversity, Envelope probability distributions, LCR and AFD, Random FM, Switched diversity, Practical diversity systems, Time diversity, Diversity on hand-portable equipment, Interleaving, Channel equalization, Non-linear equalizers, Channel coding. Planning Radio Networks: Cellular systems, Radio coverage, Planning tools, Self-regulating networks, modelling and survey analysis.

Course Outcomes: At the end of the course student will be able to

- CO1. discuss the cellular system design and technical challenges.
- CO2. analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling.
- CO3. Do research in the emerging areas of mobile radio propagation channels.

TEXT BOOK:

1. The Mobile Radio Propagation Channel. Second Edition. J. D. Parsons,2000 John Wiley & Sons Ltd., Print ISBN 0-471-98857-X

REFERENCE BOOKS:

1. Jakes W.C. Microwave Mobile Communications. (ed.) (1974) John Wiley, New York.
2. Parsons J.D. and Gardiner J.G. (1988) Mobile Communication Systems. Blackie, Glasgow.

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC964	Subject Title	OFDM FOR WIRELESS COMMUNICATIONS SYSTEMS						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. To impart knowledge about OFDM principles and its Implementation.
2. To understand coding and interleaving techniques to reduce channel effects

Unit 1: Introduction

Wireless Technology in the Future, WANs, WLANs, WPANs, WB-PANs, The Next Generation Networks, Orthogonal Frequency-Division Multiplexing, History of OFDM

Unit 2: Appropriate Channel Model for OFDM Systems:

Introduction, Characterization of the Mobile Radio Channel, Components of a Multipath Channel Model, Variation of Channel Parameters Due to Bandwidth Limitation, FD Channel Modeling, The WSSUS Channel Model, FD Channel Simulation, Application to Millimeter-Wave Radio Channels.

Unit 3: Basics of OFDM and Synchronization:

OFDM Introduction and System Model and Block Diagram, Design of the OFDM Signal, OFDM System Model, Synchronization Errors, Performance of an Uncoded OFDM System, Mathematical Modeling, Analytical Evaluation of the BER, Performance Results.

Unit 4: The Peak Power Problem

Introduction, Distribution of the PAP Ratio, Clipping and Peak Windowing, Required Backoff with a Non ideal Power Amplifier, Coding and Scrambling, Peak Cancellation, PAPR Reduction Codes, Generating Complementary Codes, Minimum Distance of Complementary Codes, Maximum-Likelihood Decoding of Complementary Codes, Suboptimal Decoding of Complementary Codes, Large Code Lengths, Symbol Scrambling.

Unit 5: A Novel Hybrid OFDM Concept

Introduction, Detailed Structure of Various Multiple-Access Schemes, Basic Principles of MC-CDMA, Analytical Performance in Fading Channels and Simulation in AWGN Channels, Performance in Fading Channels with Perfect Estimation, Performance in Fading Channels with Realistic Estimation.

Course Outcomes: At the end of the course student will be able to

CO1. Describe the principles of OFDM and its Implementation.

CO2. Implement the coding and interleaving procedure to mitigate the channel effects.

CO3. Do research in the emerging areas of OFDM for wireless communications systems.

TEXT BOOK:

1.OFDM for wireless communications systems, Ramjee Prasad, Artech House universal personal communications series) ISBN 1-58053-796-0.

REFERENCE BOOKS:

1. OFDM for Wireless Multimedia Communications, Richard Van Nee, Artech House Universal Personal Communications, ISBN-13: 978-0890065303.

Course Structure & Syllabus of Ph.D. ECE

Applicable for Batch: 2021 Onwards

Subject Code	EC965	Subject Title	ADVANCES IN WIRELESS COMMUNICATION SYSTEMS						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. This module introduces students some basic concepts in radio communications and the state of the art wireless and mobile systems, including their applications.
2. Understanding of SDR, Cognitive radio, OFDM and MIMO.

Unit 1: SOFTWARE DEFINED RADIO

Operating principles- Ideal concept, Receiver architecture, Joint Tactical Radio System, Amateur Radio or Home Use, spectrum management, Resource management

Unit 2: COGNITIVE RADIO

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. Case studies on cross-layer design for cognitive radio networks.

Unit 3: OFDM PRINCIPLES

Motivation for Multi Carrier Vs. Single Carrier, OFDM Introduction and System Model and Block Diagram, Design of the OFDM Signal, OFDM System Model, Synchronization Errors, Performance of an Uncoded OFDM System, Mathematical Modeling, Analytical Evaluation of the BER, PAPR.

Unit 4: MIMO BASICS

Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems, Spectral efficiency and capacity, transmitting independent streams in parallel, the generic MIMO problem, Singular Value Decomposition, Predistortion in MIMO systems, Precoding and combining in MIMO systems.

Unit 5: LTE vs. WI-MAX

Review of ceullar generations, 3GPP evolution towards LTE/LTE-Advanced standardization, LTE/LTE-Advanced Radio Resource Management, Radio network deployment and frequency planning, Spectrum management, 4G Mobile WiMAX (IEEE 802.16m-2011), Femto cells in advanced WiMAX systems, WiMAX Interworking with LTE/LTE-Advanced networks, Mobile IP, IEEE 802.21 for seamless, Mobility, Introduction to 5G.

Unit 6: Introduction to Cooperative Communications

Brief History of Cooperative and Relay Channels- Characteristics of Wireless Channels -Techniques to Exploit Spatial Diversity-Capacity of Wireless -Diversity-and-Multiplexing Tradeoff- Decode-and-Forward Relaying Schemes

Course Outcomes: At the end of the course student will be able to

CO1. Acquire knowledge of SDR, Cognitive radio, OFDM and MIMO.
CO2. Compare the LTE and WI-MAX technologies.
CO3. Do research in the area of wireless communication systems.

TEXT BOOKS:

1. Mitola III, J., "Cognitive Radio Architecture: The Engineering Foundation of Radio XML", Wiley- Interscience. 2006
2. Pietrzyk, S., "OFDMA for Broadband Wireless Access", Artech House. 2006
3. Gilsic, S.G., "Advanced Wireless Networks: 4G Technology", John Wiley & Sons. 2006

REFERENCE BOOKS:

1. Y.W. Peter Hong, Wan-Jen Huang C.-C. Jay Kuo, "Cooperative Communications and Networking", Springer edition,2013
2. Yan Zhang, Hsiao-Hwa Chen, Mohsen Guizani, "Cooperative Wireless Communications", CRC Press, 2014

Course Structure & Syllabus of Ph.D. ECE

Applicable for Batch: 2021 Onwards

Subject Code	EC966	Subject Title	WEARABLE SENSORS TECHNOLOGY						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. To produce skilled graduates with exposure to current era of Wearable sensors and deeper understanding of the subject components. The graduates will eventually be contributing to variety of domains including smart environment monitoring, healthcare, and smart wearable.

UNIT-1

WEARABLE COMPUTING -History of wearable computing, Commercialization: Advances in sensor technologies, multidevice computing paradigm, ubiquitous computing and context awareness, Possible innovations, Understand the technology ecosystem for latest wearable devices, software modeling. 8hr.

UNIT-2

WIRELESS BODY AREA NETWORKS- Overview of Body: Centric Wireless Communications, Introduction to Wireless Body Area Network, Antennas & radio propagation for body-centric wireless communications. Measurements and practical considerations, Body-Worn RF Flexible& Mm-wave antennas for Medical Sensing and Communications, applications for healthcare, security and sports. 8hr.

UNIT-3

WIRELESS BODY AREA APPLICATION- Wireless Patient Monitoring in a Clinical Setting, Network and Medium Access Control Protocol Design for Wireless Body Area Networks, Channel Modeling of Narrowband Body-Centric Wireless Communication Systems, Wireless Body Area Network Implementations for Ambulatory Health Monitoring, Power Management in Body Area Networks for Health Care Applications. 7 hr.

UNIT-4

WBAN Antenna Design -Antenna Design and Propagation for WBAN Applications, Coexistence Issues with Wireless Body Area Networks, Wireless Power and Data Telemetry for Wearable and Implantable Electronics, Ultra-Wideband for Wireless Body Area Networks. 8hr.

UNIT-5

TEXT SECURITY AND RISKS IN WEARABLE TECHNOLOGIES -Purpose, Scope, and Technical Considerations of Wearable Technologies, Wearable Computers, Health and Fitness Wearables, The Promise and Perils of Wearable Technologies, Management of Security Issues in Wearable Technology. 8hr.

Course Outcomes: At the end of the course student will be able to

- CO1. Understanding of Purpose, Scope, and technical Considerations of Wearable Technologies, Wearable Computers, Health and Fitness Wearables.
- CO2. Development and use of emerging Wearable Sensors & Computing.
- CO3. Do research in the area of wearable sensors technology.

TEXT BOOKS:

1. Huan-Bang Li, Kamya Yekeh Yazdandoost Bin-Zhen, “Wireless Body Area Networks”, River Publishers, 2010.
2. Muhannad Quwaider Subir Biswas, “Wireless Body Area Networks”

REFERENCES:

1. Burnette E., “Hello, Android: Introducing Google's Mobile Development Platform”, Pragmatic Bookshelf, 2010.
2. Edward Sazonov and Michael R. Neuman, “Wearable Sensors: Fundamentals, Implementation and Applications”, 1st Edition, Elsevier.
3. Steele J, “The Android Developer's Cookbook: Building Applications with the Android SDK”, Addison-Wesley Professional, 2010.
4. Mark Andrew Hanson, Amy Nicole Miller, “Wireless Body Area Sensor Network Technology For Motion Based Health Assessment”

5. Mehmet Rasti Yuce, Jamil Y. Khan, “Wireless Body Area Network: Technology, Implementation And Application”
6. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, “Principles of Mobile Computing”, Springer, 2003.
7. C.K. Toh, “AdHoc Mobile Wireless Networks”, First Edition, Pearson Education, 2002.
8. Terrance J. Dishongh and Michael Mcgrath, “Wireless Sensor Networks for Healthcare Applications”, Artech House; First edition, October 30, 2009, ISBN – 978- 1596933057.
9. Wearable Technologies: Concepts, Methodologies, Tools, and Applications, 2018.

Course Structure & Syllabus of Ph.D. ECE
Applicable for Batch: 2021 Onwards

Subject Code	EC967	**Subject Title**	**NANOSCALE DEVICES**						
LTP	4 0 0	**Credit**	4	**Subject Category**	DE	**Year**	1st	**Semester**	I/II

Course Objectives:

1. To provide knowledge of device physics/operation, technologies and issues in nanoscale CMOS and other emerging devices.

Unit 1: Long Channel MOSFETs:
History; Introduction – MOSFET as a barrier-controlled device; MOSFET I-V characteristics; Drain current models, MOSFET scaling; subthreshold characteristics; substrate bias and temperature dependence, MOSFET electrostatics – energy band picture, 1D electrostatic Poisson-Boltzmann equation, depletion approximation, onset of inversion, gate voltage and surface potential, static and mobile charges.

Unit 2: Short Channel Effects:
Charge sharing; channel length modulation; DIBL; GIDL; velocity saturation; MOSFET breakdown; concepts of high-K/metal gate

Unit 3: Advanced planar and 3D transistors:
FDSOI, DG-ETSOI; FINFETs, Nanowires.

Unit 4: Nanoscale transport:

Bottom-up approach, Landauer's formalism, Ballistic and diffusive transport – modes, IV characteristics, conductance, voltage drop and heat dissipation, ballistic MOSFET, ballistic injection velocity, Virtual Source Model

Unit 5: Current topics and open issues:
Strained Si technology, NEGF, Thermoelectric effects and thermoelectric devices, Quantum dot devices – quantum capacitance, IV characteristics, self-consistent method.

Course Outcomes: At the end of the course student will be able to

CO1. Understand the advanced MOSFETs and their SCE's.
CO2. Understand the Nanoscale transport.
CO3. Do research in the area of nanoscale devices.

Text and Suggested Books:

1. Selected Journal and Conference papers
2. Mark Lundstorm, "Fundamentals of Nanotransistors," World Scientific. 2016
3. Tak H. Ning and Yuan Taur, "Fundamentals of Modern VLSI Devices" Pearson Education India Pvt. Ltd. 2015
4. Donald A. Neamen, "Semiconductor Physics and Devices", McGraw Hill Higher Education 2002
5. S. M. Sze and Kwok K. Ng, "Physics of Semiconductor Devices," Wiley 2008

Course Structure & Syllabus of Ph.D. ECE

Applicable for Batch: 2021 Onwards

Subject Code	EC968	Subject Title	DIGITAL VLSI DESIGN						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. To acquaint the students with the fundamental concepts of digital VLSI circuit design.

Unit 1: Review of MOSFET operation and CMOS process flow:

MOS Threshold voltage, MOSFET I-V characteristics: long and short channel, MOSFET capacitances, lumped and distributed RC model for interconnects, transmissionlines, CMOS process flow, Layout and design rules.

Unit 2: CMOS inverter

Static characteristics, power consumption, dynamic characteristics

Unit 3: Combinational logic:

Transistor sizing in static CMOS logic gates, static CMOS logic gate sizing considering method of logical effort, dynamiclogic, pass-transistor logic, common mode and other cross-coupled logic

Unit 4: Sequential logic

Static latches and flip-flops (FFs), dynamic latches and FFs, sense-amplifier based FFs, NORA-CMOS, Schmitt trigger, monostable and astable circuits.

Unit 5: Memories and array structures:

MOS-ROM, SRAM cell, memory

Unit 5: Course Project:

SPICE based project on a digital VLSI sub-system design

Unit 6: Timing issues

Timing fundamentals, clock distribution, jitter, self-timed circuit design, synchronizers and arbiters, basic building blocks of PLLs, clock synthesis and synchronization using PLLs.

Course Outcomes: At the end of the course student will be able to

CO1. Understand the basic Physics and Modelling of MOSFETs.

CO2. Learn the basics of Fabrication and Layout of CMOS Integrated Circuits.

CO3. Do research in the area of digital VLSI Design.

Text Books:

1. Kang, Sung-Mo, Yusuf Leblebici, and Chulwoo Kim. *CMOS digital integrated circuits: analysis & design*. McGraw-Hill Higher Education, 2014.
2. Weste, Neil HE, and Kainran Eshraghian. *Principles of CMOS VLSI design: A systems perspective*. Pearson Education Asia, 2001.

Reference Books:

1. Baker, Jacob R., Harry W. Li, and David E. Boyce. *CMOS Circuit Design, Layout and Simulation*, Prentice-Hall of India, 2000.
2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective," Prentics Hall, 2003
3. Ivan Sutherland, R. Sproull and D. Harris, "Logical Effort: Designing Fast CMOS Circuits", Morgan Kaufmann, 1999

Course Structure & Syllabus of Ph.D. ECE

Applicable for Batch: 2021 Onwards

Subject Code	EC969	Subject Title	ANALOG VLSI DESIGN						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1st	Semester	I/II

Course Objectives:

1. To acquaint the students with the fundamental concepts of analog VLSI circuit design.

Unit 1: Basic consideration in analog VLSI design

Basic Concepts, Common Source Stage, Source Follower, Common Gate Stage, Cascode Stage.

Unit 2: **Differential Amplifiers**

Single Ended and Differential Operation, Basic Differential Pair, Common-Mode Response, Differential Pair with MOS loads, Gilbert Cell. Passive and Active Current Mirrors – Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors.

Unit 3: Frequency Response of Amplifiers

General Considerations, Common Source Stage, Source Followers, Common Gate Stage, Cascode Stage, Differential Pair. Noise – Types of Noise, Representation of Noise in circuits, Noise in single stage amplifiers, Noise in Differential
Pairs. CMOS comparators.

Unit 4: Feedback Amplifiers

General Considerations, Feedback Topologies, Effect of Loading. Operational Amplifiers – General Considerations, One Stage Op Amps, Two Stage Op Amps, Gain Boosting, Common – Mode Feedback, Input Range limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps. Stability and Frequency Compensation. Mixed signal circuits.

Unit 5: MOS circuit components

Switched capacitor filters realization by MOS technology.

Course Outcomes: At the end of the course student will be able to

- CO1. Apply knowledge of mathematics, science, and engineering to design and analysis of analog integrated circuits.
- CO2. Identify, formulates, and solves engineering problems in the area of analog integrated circuits.
- CO3. Do research in the area of analog VLSI design.

Text Books:

1. Razavi, Behzad. Design of Analog CMOS Integrated Circuits. McGraw-Hill Higher Education, 2001.
2. Johns, David A., and Ken Martin. Analog integrated circuit design. John Wiley & Sons, 2008.

Reference Books:

1. Gray, Paul R., et al. Analysis and design of analog integrated circuits. Wiley, 2001.