Heritage Institute of Technology

M.Tech. – Electronics and Communication Engineering

CURRICULUM STRUCTURE

RELEASE DATE: July, 2018 : Ver1.0

May, 2019 : Ver1.1

April, 2021 : Ver. 1.2

August, 2022 : Ver. 1.3

1st. Year, Semester I

A. Theory								
Sl No	**Course Type**	**Code**	**Course Title**	**Contact Hrs/Week**				**Credits**
				L	T	P	Total	
1	Professional Core 1	**ECEN5101**	Antenna and Radiating Systems	3	0	0	3	3
2	Professional Core 2	**ECEN5102**	Wireless and Mobile Communication	3	0	0	3	3
3	Professional Elective I (Prog. Specific Professional Elective)	**ECEN5131**	Wireless Ad Hoc and Sensor Networks	3	0	0	3	3
		ECEN5132	Photonics and Optical Communication Networks					
		ECEN5133	Statistical Process in Communication					
4	Professional Elective II (Prog. Specific Professional Elective)	**ECEN5141**	Satellite Communication and applications	3	0	0	3	3
		ECEN5142	Multimedia Communication					
		ECEN5143	Cryptography and Network Security					
5	Mgt. Group	**ECEN5103**	Research Methodology and IPR	2	0	0	2	2
6	Audit 1	**DIMA5116**	Disaster Management	2	0	0	2	0
		INCO5117	Constitution of India					
		PDLS5118	Personality Development					
		YOGA5119	Stress Management by Yoga					
		SANS5120	Sanskrit for Technical Knowledge					
Total Theory				16	0	0	16	14

B. Practical								
1	Professional lab1	**ECEN5151**	Antenna and Radiating Systems lab	0	0	4	4	2
2	Professional lab2	**ECEN5152**	Wireless and Mobile Communication lab	0	0	4	4	2
Total Practical				**0**	**0**	8	8	**4**
Total for Semester				**16**	**0**	**8**	**24**	**18**

1st. Year, Semester II

A. Theory								
Sl No	**Course Type**	**Code**	**Course Title**	**Contact Hrs/Week**				**Credits**
				L	T	P	Total	
1	Professional Core 3	**ECEN5201**	Advanced Digital Communication Techniques	3	0	0	3	3
2	Professional Core 4	**ECEN5202**	Advanced DSP and applications	3	0	0	3	3
3	Professional Elective III (Prog. Specific Professional Elective)	**ECEN5231**	Telecommunication Systems and Engineering	3	0	0	3	3
		ECEN5232	Image Processing and Pattern Recognition					
4	Professional Elective IV (Prog. Specific Professional Elective)	**ECEN5241**	Cognitive Radios and networks	3	0	0	3	3
		ECEN5242	Microwave Measurement and Instrumentation					
		ECEN5243	Design of Communication Equipments and Systems					
5		**ECEN5293**	Term Paper and Seminar	0	0	4	4	2
6	Aud 2	**Any course from Professional Elective III or Professional Elective IV buckets**	Audit Course 2	2	0	0	2	0
Total Theory				**14**	**0**	**4**	**18**	**14**

B. Practical								
1	Professional lab 3	**ECEN5252**	Advanced DSP and applications lab	0	0	4	4	2
2	Professional lab 4	**ECEN5253**	Design and Simulation lab	0	0	4	4	2
Total Practical				**0**	**0**	8	**8**	**4**
Total for Semester				**14**	**0**	**12**	**26**	**18**

2nd. Year, Semester I

A. Theory								
Sl No	**Course Type**	**Code**	**Course Title**	**Contact Hrs/Week**				**Credits**
				L	T	P	Total	
1	Professional Elective V (Prog. Specific Professional Elective)	**ECEN6131**	Remote Sensing and applications	3	0	0	3	3
		ECEN6132	Internet of Things (IoT) and applications					
		ECEN6133	MIMO Systems					
2	Open Elective	**MATH6121**	Optimization Techniques	3	0	0	3	3
		CSEN6121	Business Analytics					
		ECEN 6125	Design and Technology for Photonic Integrated Circuit					
		AEIE6123	Intelligent Control					
Total of Theory				**6**	**0**	**0**	**6**	**6**

B. Sessional								
1	Dissertation	**ECEN6195**	Dissertation Phase I	0	0	20	20	10
Total of Semester				**6**	**0**	**20**	**26**	**16**

OPEN ELECTIVES TO BE OFFERED BY ECE DEPARTMENT (3rd. Semester):

Course Type	Code	Course Title	Contact Hours/Week				Credits
			L	T	P	Total	
Open Elective	**ECEN6121**	AD HOC Networks and Uses	3	0	0	3	3
	ECEN6122	Embedded Systems					
	ECEN6123	Cognitive Radios					
	ECEN6124	Automation in VLSI Design					

2nd. Year, Semester II

Sl No	Course Type/Code	Code	Course Title	Contact Hrs/Week				Credits
				L	T	P	Total	
1	Dissertation	**ECEN6295**	Dissertation Phase II	0	0	32	32	14
2	Viva Voce	**ECEN6297**	Comprehensive Viva Voce	-	-	-	-	2
Total of Semester						**32**	**32**	**16**

Total Credits: 68

First Year Syllabus

First Year, First Semester:

Course Title: Antenna and Radiating Systems					
Course Code : ECEN5101					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

Students will come to know about:

1. Antenna – Radiation, VSWR, aperture and their importance.

2. Types of antennae and antenna arrays including microstrip antenna.

3. Testing principles of antennae.

4. EMI and EMC and associated hazards.

5. Different propagation phenomena.

6. QoS of radio links and their analysis.

Module- I [8L]
A. Review of Maxwell's Equation; Radiation of e.m waves and introducing Antenna; Vector Potential and Retarded Vector Potential; Radiation fields of a Hertzian dipole(electric); Duality Principle, Radiation fields due to short magnetic dipole.
B. Antenna Characteristics: Radiation Pattern, Beam Width; Radiation Resistance and efficiency; Directivity and Gain; Impedance, VSWR, Polarization; Effective height and Receive Aperture; Noise Temperature of Antenna

Module- II [8L]
A. Review of basic wire based antennas, Characteristics and properties of : Travelling Wave Antenna, Helical Antenna, Folded Dipole, Yagi-Uda Array, Loop Antenna, Electrically Short Antennas, Broad Band Antenna
B. Antenna Arrays: electric Field due to 2 element arrays, N element Arrays; Pattern Multiplication; Phased array.

Module- III [8L]
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A. Radiation from apertures, general formulas for scattering and diffraction in and effective area of apertures. Different kind of aperture antennas. Reflector antennas. Appropriate methods for solving reflector antenna problems. Primary feed system design.

B. Microstrip Antenna(MSA),Active Integrated MSA, Compact MSA with enhanced gain, Broadband Antenna(MSA), Dual frequency & Dual polarized MSA Application of broadcasting, microwave links, satellite communication and radio astronomy.

Module- IV [8L]

A. Methods of Propagation: Ground Wave Propagation, Components of ground wave, Field strength dependence on physical factors. Sky wave Propagation;Space wave propagation. Friis Transmission Formula, SNR of a Radio Link.

B. Basic Terms and Definitions, A Summary of EMI and Related instruments, Error Analysis, Conducted Emission Test procedures, Radiated Emission Test Procedures, Radiated – Susceptibility Test Procedures. LISN

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References:

1. R.E Collin, Antennas & Radio wave propagation (McGraw-Hill Book Co.)
2. Jordan and Balmain, Electromagnetic Waves and Radiating Systems (PrenticeHall of India)
3. M.L Skolink, Introduction to radar systems (McGraw-Hill BookCo.)
4. P Bhartia and I.J. Bhal, Millimeter wave Engineering &Applications
5. Albart Smith, Radio Engineering Principle and Applications
6. M. Dolukhanov, Propagation of Radio Waves (Mir Publication)
7. R.Garg,P.Bhartia,Indu Bhal,A.Ittipibom ; Microstrip Antenna Design hand book –Artech House
8. Girish Kumar & K.P.Roy—Broad band Microstrip Antenna-=Artech. House
9. Kin. Lu. Wong ; Compact and Broadband Microstrip Antenna—John Willey & Sons.

Course Title: WIRELESS and MOBILE COMMUNICATION					
Course Code : ECEN 5102					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

1. The students will understand the challenges of wireless and mobile communication.
2. They will be able to analyse the factors like fading, SNR.
3. The students should be able to explain the working of a cellular system- both GSM and CDMA.
4. They will have knowledge about protocols like TCP/IP.
5. The students will be able to apply suitable routing for a transfer.
6. They will be able to analyse performance of cellular and other wireless networks.

Module I: [8 L]

Introduction - evolution of wireless and mobile radio communications, mobile radio systems around the world, trends in cellular radio and personal communication, first generation (1G), second generation (2G), third generation (3G) and 4G mobile cellular networks, Concept of SDR and UMTS.

Cellular concept – Limitations of conventional mobile system, Introduction to mobile cellular communication, concept of frequency reuse, cluster size, cellular system architecture, channel assignment strategies, call handoff strategies - hard

handoff and soft handoff, prioritizing handoff; interference and system capacity, improving capacity in cellular systems – cell splitting, sectoring, microcell zone concept.

Module II: [10 L]

Different mobile communication systems – GSM services and features, system architecture, GSM radio subsystem, GSM channel types, location updating and call setup, WAP, SCSD, GPRS, EDGE, 3G W-CDMA; CDMA digital cellular standard, comparison between GSM and CDMA, 3G CDMA 2000, IMT-2000.

Module III: [10 L]

Radio Channels and their Characterisation – Different propagation models – Hata , Okimura models, Free space propagation, Multipath propagation, diversity techniques, Co-channel interference, Propagation effects - scattering, ground reflection, fading, Log-normal shadowing.

Wireless networks – Advantages and applications of Wireless LAN, WLAN technology – RF and IR wireless LAN, diffuse, quasi diffuse and point-to-point IR wireless LAN, IEEE802.11 and its architecture, Physical layer, MAC layer, Introduction to WIFI, HIPERLAN2, Bluetooth – Bluetooth architecture.

Module IV: [6 L]

Mobile network and transport layer – Introduction to Mobile IP, requirements, IP packet delivery, Agent discovery, Registration, Tunneling and encapsulation, Optimization, Reverse tunneling; Mobile adhoc networks – Routing, Destination sequence distance vector, Dynamic source routing and Alternative metrics; Traditional TCP – Congestion control, Slow start, Fast retransmit / fast recovery, Implications of mobility; classical TCP improvements – Indirect TCP, Snooping TCP, Mobile TCP,Fast retransmit.

Future of mobile communication – 3G to 4G.

References:

1. Theodore S. Rappaport, Wireless communications: principles and practice, PHI / Pearson education.

2. J. Schiller, Mobile communications, Addison-Wesley.

3. William C. Y. Lee, Mobile cellular telecommunication – analog and digital systems, McGraw Hill, 2nd ed.

4. Wang, Wireless communication System, Pearson Education

5. Talukdar, Mobile computing, TMH

6. J.W.Mark, W. Zhuang, Wireless Communication and Networking, PHI

7. A. Santamaria et al, Wireless LAN systems, Artech House.

8. Stallings, Wireless Communication & Networks, Pearson Education

9. K. Feher, Wireless digital communications, Prentice Hall of India.

9. Roy Blake, Wireless communication technology, Thomson Delmer.

Course Title : WIRELESS AD HOC AND SENSOR NETWORKS					
Course Code : ECEN5131					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course outcomes:

1. Students will develop the ability to apply knowledge of mathematics, science and engineering in the areas of communication engineering.
2. They will be able to analyze a situation and interpret a data in ad hoc networks.
3. Students will acquire knowledge to learn and apply modeling based approach through the extensive use of simulator tools.
4. Students will be able to understand and develop ability to participate in research work.
5. They will be able to apply suitable algorithm for a route.
6. The students will understand the security requirements for networks.

Module I: [10 L]

Ad hoc wireless Network: Introduction, Basic concept on ad hoc network, static and mobile ad hoc network, transmitter-receiver constraints, Applications.

MAC protocol: Hidden terminal, Exposed terminal, IEEE802.11 in ad hoc mode.

Routing protocols: Proactive, Reactive and hybrid routing protocol, Destination sequenced distance vector algorithm, Dynamic source routing, Ad hoc on-demand routing, Location aided routing, Link reversal routing.

Module II: [10L]

Analysis of TCP performance in wireless ad hoc network: TCP window management and problems, different solution schemes, QoS in wireless ad hoc network – analysis of degradation of receiver sensitivity, practical solutions.

Achieving energy efficiency in wireless ad hoc network: Different schemes to increase the lifetime of the node in ad hoc network – MAC layer protocol, Routing protocol.

Module III: [8 L]

Localization Management: Location acquisition technique, location sensing technique, location aware routing protocol. Primary and secondary source , Different principles like weighted centriod algorithm to locate sources. Security for wireless ad hoc network: Security goals, threats and challenges, Different schemes of security in ad hoc network, routing security. Spectrum utilization – Generic Access Network (GAN) and other methods

Module IV: [6 L]

Sensors- sensor networking, WSN, hardware and software platforms, OS for WSN, distributed sensor network, healthcare monitoring, environmental sensing, industrial monitoring, smart city concept.

Reading:

1.”Ad Hoc Wireless Networks – Architectures and Protocols” - C.Siva Ram Murthy and B.S. Manoj – Pearson Education

2. Mobile Ad Hoc Networking – Stefano Basagni, Marco Conti, Silvia Giardano, Ivan Stojmenovic – Wiley India

3.”Ad Hoc Mobile Wireless Networks : Principles Protocols and Applications” – Basavaraju – Aurbach Publications

4. Security and Quality of Service in Ad Hoc Wireless Networks – Amitabh Misra – Cambridge University Press

5.”Ad Hoc Mobile Wireless Networks – Protocols and Systems” - Chai K. Toh – Prentice Hall

Course Title: PHOTONICS AND OPTICAL COMMUNICATION NETWORKS					
Course Code : ECEN5132					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	4	**0**	**0**	**4**	**4**

Course Outcomes:

1. Students will know about the different modes, devices,detectors, amplifiers using optical fiber communication.

2. They will have knowledge about various types of systems with their strengths and weaknesses.

3. The students will know about different types of optical networks.

4. They will understand the requirements of repeaters and amplifiers and their parameters.

5. The students will be able to choose type of fiber for typical applications.

6. They will be able to integrate the fiber optics with other networks.

Module I: Photonics: [10 L]

o Introduction to Photonic materials and Photonic Devices.

o Optical waveguides., Optical Fiber Modes and Configurations

o Optical fibers - application specific optical fibres, Photonic Bandgap Optical Fibers.

o Graded Index and Single Mode Fibers.

o Optical couplers;

o Fiber.Bragg gratings

o Electro-optic devices

o Semiconductor lasers and light-emitting diodes

o Photodetectors PIN, Photodiodes and Avalanche Photodiodes.

o Optical Amplifiers- doped fiber amplifier.

Module II: Optical Communication: [8 L]

o Analog and Digital Optical Transmitters and Receivers concepts,

o Loss- limited and dispersion- limited lightwave systems,

o Long-haul systems with In-Line Amplifiers,

o Dispersion compensation techniques in optical communication systems,

o Power budget and rise-time.

Module III: Coherent lightwave systems: [8 L]

o Modulation and Demodulation schemes for coherent communication,

o System performance issues.

Multichannel Lightwave systems:

o WDM components and devices,

o Multiplexing techniques and system performance considerations.

Module IV: Optical Networks: [10 L]

o Network topologies,

o SONET/SDH,

o Broadcast-and- Select WDM Networks- single-hop networks, multihop Networks,

o Wavelength routed networks,

o Photonic packet switching

o Soliton Communication

References:

1. Keiser, G. , Optical Fiber Communications, Mcgraw Hill

2. John Senior, Optical Fiber Communications: Principles and Practice, Prentice Hall

3. Ajoy Ghatak & K. Thyagarajan, Cambridge University Press

4. Govind R. Agrawal, Fiber Optic Communication Systems, Wiley

Course Title: STATISTICAL PROCESS IN COMMUNICATION					
Course Code : ECEN5133					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

1. Students will know about the different matrices and filters used in communication systems.

2. They will have knowledge about modeling of signals.

3. The students will know about techniques of detection.

4. The students will be able to differentiate between filters.

5. They will learn about signal properties and processes.

6. The students will learn about stochastic models for possible application.

Module I: [10 L]

Revision of linear algebra:

Special matrix forms – diagonal matrix, exchange matrix, triangular matrix, Toeplitz matrix, Hankel matrix, symmetric matrix,

parametric matrix, centro symmetric matrix.

Eigen values, Eigen value solutions.

Random process:

Definition and description of random processes with practical examples.

Time average, ensemble average, covariance, autocorrelation, cross correlation.

Stationary process, ergodic process, WSS process, power spectrum of random processes.

Filtering of random processes – filtering of white noise, spectral shaping filter, spectral factorization.

Special random processes – Autoregressive moving average process, autoregressive process, moving average process, harmonic process.

Module II: [10 L]

Signal modeling:

Least square method, Pade approximation method, filter design using Pade approximation, Prony's method of signal

modeling, filter design using Prony's method, FIR least square inverse filter, iterative prefilters,

Stochastic models – ARMA model, AR model, MA model.

Module III: [9 L]

Binary symmetric channel:

Principle, properties, bit error properties.

Theories and hypothesis:

Decision theory, Bay's likelihood ratio, ideal observer strategy, Neyman-Pearson strategy, Bay's strategy for single and multiple sample values, optimum linear estimation composite hypothesis testing, optimum detection with incomplete knowledge of the signal, adaptive detection and estimation.

Module IV: [9 L]

Filters:

Principle of optimum filter, matched filter, achievable bit error rate.

FIR Wiener filter – principle and design.

Linear prediction in noise, noise cancellation

IIR Wiener filter – causal, non causal.Kalman filter.

References:

1. Digital communication, 4th ed. - J. G. Proakis, MGH International edition.

2. Digital and Analog Communication Systems, 7th ed. – Leon W. Couch, PHI.

3. Digital Communication – Zeimer, Tranter.

4. Statistical digital signal processing and modeling, - Monson N. Hays – Wiley.

Course Title: SATELLITE COMMUNICATION and APPLICATIONS					
Course Code : ECEN5141					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

After end of the course, the students will be able to:

1. Describe and explain about the orbits, different parameters of a satellite system and subsystems.
2. Discuss about earth stations, satellite transponder and satellite links design.
3. Explain and compare different Multiple Access Techniques.
4. Analyze DAMA, Speech interpolation and Satellite packet communication.
5. Compare propagation effects, VSAT systems, Direct Broadcast Television and Radio.
6. Assess Mobile satellite network, Satellite Navigation and the global positioning system.

Module I: [8 L]

Introductory topics**:**

A brief history of satellite communication, future scope and present scenario.

Orbital Mechanism: Orbits, look angle, orbital period and velocity, azimuth and orbital inclination, coverage angle, orbital perturbation, mechanism of satellite placement in geostationary orbit. Indian Satellite scenario. Satellite Subsystems: Communication, telemetry, tracking & command, power, attitude & orbital control, antenna subsystems.

Module II: [10 L]

Earth Station: Fundamentals & general system architecture, Earth station antenna, gain, poynting loss, G/T variation and it's measurement, antenna tracking, power amplifier, low noise amplifier, up converter, down converter, transponder hopping, polarization hopping, redundancy configuration.

Satellite transponder: transponder model, transponder channelization, Transponder frequency plans, Effect of fading.

Satellite Link Design: Basic link analysis, interference analysis and attenuation due to rain, link with and without frequency reuse.

Module III: [9 L]

Multiple Access Techniques:

Frequency Division Multiple Access: SPADE, FDM-FM-FDMA, Companded FDM-FM-FDMA and SSB-AM-FDMA, intermodulation products in FDMA, optimized carrier-to-intermodulation plus noise ratio.

Time division Multiple Access: Principle, TDMA frame structure, TDMA Burst structure, TDMA Superframe structure, Frame acquisition and synchronization. TDMA timing. Demand Assignment Multiple Access and Digital Speech interpolation. ERLANG B Formula. Type of demand assignment, DAMA characteristics, Real time frame reconfiguration, DAMA interfaces, SCPC-DAMA, Digital Speech interpolation. Satellite packet communication.

Module IV: [9 L]

Propagation effects: Propagation effects and their impact on satellite earth link.

Introduction to VSAT systems: low earth orbit and non-geostationary satellite systems. Direct broadcast Television and Radio. Satellite Navigation and the global positioning system. Network configuration, multi-access and networking, network error control, polling VSAT network.

Mobile satellite network: Operating environment. MSAT network concept, CDMA MSAT relink.

References:

1. Tri T. Ha, Digital Satellite Communication, TMH.

2. Timothy Pratt, Charles Bostian, Teremy Allnutt, Satellite Communication, John Wiley & Sons.

3. J. J. Spilker, Jr., Digital Communication by Satellite, Prentice Hall.

4. Bruce R. Elbert, Satellite Communication Applications Hand Book, Artech House

Course Title: MULTIMEDIA COMMUNICATION					
Course Code : ECEN5142					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

1. Students will know about the different media classification, media characteristics.

2. They will have knowledge about various types of compression coding and memory systems.

3. The students will know about different architectures used and media modeling.

4. They will learn about management of resources and project management.

5. The students will be able to analyse synchronization problems.

6. They will be producing films with confidence.

Module I: [10 L]

Multimedia Introduction: Media and Data Streams, Classification of media and Properties of multimedia system. Sound, Images & Video : Speech synthesis, Speech Recognition, Raster display, Image recognition, TV, HDTV, Speech transmission, Image transmission.

Module II: [10 L]

Compression : Huffman Coding, Runlength coding, JPEG, MPEG, DVI, H.261

Storage Media : CDDA, CDROM, CDROM (XA)

Multimedia Operating system: Resource Management, Process Management: EDF

Module III: [9 L]

Rate monotonic Algorithms. System Architecture: Quick Time, MDBMS.

Synchronization: Lip & Pointer Synchronization, Synchronization Reference Model, Case Study.

Module IV: (9 L)

Multimedia Communications: Delay compensation, QoS negotiation protocols, Architectures and Issues for Distributed Multimedia Systems, Prototype Multimedia systems: Video-on-Demand, Video conferencing. Multimedia Information: Delay-sensitive and Time-based Media data Modeling

References:

1. Ralf Steinmetz and KlaraNahrstedt, “Multimedia: Computing, Communications and Applications”, Prentice Hall PTR, 1995.

2. Franklin Kuo, Wolfgnag and J.J. Garsia, “Multimedia Communications, Protocols and Applications”, Prentice Hall PTR 1998.

Course Title: CRYPTOGRAPHY AND NETWORK SECURITY					
Course Code : ECEN5143					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

1. Students will know about the basics and different standards used.

2. They will have knowledge about important cryptography techniques.

3. The students will know about algorithms applied for encryption.

4. They will acquire knowledge about security challenges and some concepts in web security.

5. The students will understand security systems using VPN and Firewalls.

6. They will be able to develop new algorithms.

Module I: [12 L]

Introduction: Principles of security, Overview of network security and cryptography, OSI Security architecture, model for network security, classification of attacks (Reply, Reflection, Man – in – the – middle), Virus, Worm, Trojan Horse, Spam etc.

Symmetric ciphers: Algorithm types and modes, classical encryption techniques, block ciphers and Data Encryption Standard (DES), Advanced Encryption Standard (AES), Contemporary Symmetric Ciphers, and confidentiality using symmetric encryption

Module II: [9 L]

Public Key Cryptography: Public key Infrastructure (PKI), RSA, key management, Diffe-Hellman key exchange, elliptic curve arithmetic, elliptic curve cryptography.

Message Authentication and Hash Functions: Authentication requirements, authentication functions, message authentication codes

Module III: [9 L]

Hash functions, security of Hash functions and MACs. Hash Algorithms: MD5 Message Digest Algorithm, Secure Hash Algorithm, Digital Signature Algorithm, Digital Signature Standard. Network Security Applications: Authentication Applications (Kerberos), Electronic Mail Security (SMIME), IP Security (IPSec)

Module IV: [8 L]

Web Security (SSL and TLS), E – cash and Secure Electronic Transaction (SET), System security using Firewalls and VPNs. Advance Applications of Network Security: Smart cards and security, Enterprise Application Security, Biometric Authentication, Database Access Control, Security and Privacy Issues in RFIDs

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References:

1. William Stallings, Cryptography and Network Security—Principles and Applications, Pearson Edu.
2. Atul Kahate, Cryptography and Network Security, Tata McGraw Hill.
3. Trappe & Washington, Introduction to Cryptography with Coding theory, Pearson Education.
4. William Stallings, Network Security Essentials, Pearson Education.
5. Kaufman, Perlman & Speciner, Network Security, Pearson Education.
6. Behrouz A. Forouzan, , Cryptography and Network Security, McGraw – Hill

Course Title :Antenna and Radiating Systems Laboratory					
Course Code : ECEN5151					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	4	4	2

Course Outcomes:

Students will know about the different experimental set-ups to measure various parameters related to antennae. They will study radiation pattern for antenna, will acquire practical knowledge about Smith chart and stub matching. The students will also learn to study spectral analysis of signals.

At least, 8 experiments are to be carried out.

1. Plotting of Standing Wave Pattern along a transmission line when the line is open-circuited, short-circuited and terminated by a resistive load at the load end.

2. Measurement of Input Impedance of a terminated coaxial line using shift in minima technique.

3. Study of Smith chart on MATLAB platform.

4. Simulation study of Smith chart - Single and double stub matching.

5. Radiation Pattern study of dipole antenna.

6. Radiation Pattern study of a folded-dipole antenna.

7. Radiation pattern study of Helical Antenna.

8. Parametric study (Gain, Directivity, HPBW and FNBW) of three, five and seven element Yagi Uda configurations.

9. Radiation pattern study of a Pyramidal Horn Antenna.

10. Spectrum analysis of different analog signals (sine, triangular, square) using spectrum analyzer.

Course Title : Wireless and Mobile Communication Laboratory					
Course Code : ECEN5152					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**4**	**4**	**2**

Course Outcomes:

- The students will be able to correlate different theories of wireless communication and fiber optics with practical experiments
- They will understand operations of repeater station, GPS and GSM cellular systems
- They will learn the procedures for testing radio parameters
- Students will learn working of fiber optic links
- They will understand bending losses, NA

List of Experiments:

1. Study of working of Repeater stations with the help of Satellite communication system

2. Study of Global system for Mobile (GSM) system along with waveforms of different timing signals

3. Study of Global Positioning System (GPS) and plotting of active satellites with SNR etc.

4. Measurement of some important receiver parameters of a radio receiver like:

i) SNR ;ii) Distortion with ISM band radio.

5. Measurement of some important transmitter parameters of a radio receiver like:

   VSWR for i) different antennae and ii) at different frequencies with ISM band radio.

6. Measurement of propagation loss, bending loss and connector loss in an optical fiber

7. Study of LASER characteristics
8. Measurement of wavelength of an optical fiber source
9. Study of a fiber optic analog link, study of PAM
10. Study of Frequency Division Multiplexing (FDM) and De multiplexing
11. Study of a fiber optic data link and study of TDM
12. Measurement of numerical aperture of an optical fiber

At least, 8 experiments are to be carried out in the semester.

Course Title : Research Methodology & IPR					
Course Code : ECEN5103					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	2	**0**	**0**	**2**	**2**

Research Methodology and IPR

Course Outcomes:

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

1. Understand research problem formulation
2. Analyze research related information
3. Follow research ethics
4. Understand the ultimate importance of ideas, concept and creativity
5. Importance of IPR for individuals and nations
6. Appreciate that IPR protection provides incentive to inventors for further research work

Syllabus Contents:

Module I (6L)
Meaning of research problem, Sources of research problem, Criteria and characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problems, data collection, analysis, interpretation, necessary instrumentations.

Module II (6L)
Effective literature studies approaches and analysis

Plagiarism, Research ethics

Module III (6L)
Effective technical writing, how to write report, Paper

Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Module IV (6L)
Nature of Intellectual Property: Patents, Design, Trade and Copyright, Process of Patenting and Development: technological research, innovation, patenting, and development. International Scenario: International cooperation on Intellectual property. Procedure for grants of patents, Patenting under PCT.

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical indication.

New developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge case studies, IPR and IITs.

References:

- Stuart Melville and Wayne Goddard, "Research and methodology: An introduction for science & engineering students'"
- Wayne Goddard and Stuart Melville, "Research and methodology: An introduction"
- Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007
- Mayall, "Industrial Design", McGraw Hill, 1992
- Niebel, "Product Design", McGraw Hill, 1974
- Asimov, "Introduction to Design", Prentice Hall, 1962
- Robert P. Merges, Peter S. Menell, Mark A Lemley, "Intellectual Property in New Technological Age", 2016
- T. Ramappa, "Intellectual Property Rights Under WTO", S Chand, 2008

Course Title : Audit Course 1					
Course Code : DIMA5116					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	2	**0**	**0**	**2**	**0**

DISASTER MANAGEMENT

Course Outcomes: -Students will be able to:

1. learn to demonstrate a critical understanding of key concepts in disaster riskreduction and humanitarian response.
2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Syllabus

	Units	CONTENTS	Hours
Module -I	1	**Introduction on Disaster** Disaster: Definition Types of Disaster • Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc. • Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism	3

		etc.
		
		• Differences, Nature and Magnitude
		• Factors Contributing to Disaster Impact and Severity
		• Repercussions of various types of Disasters
		  o Economic Damage
		  o Loss of Human and Animal Life
		  o Destruction of Ecosystem
		  o Outbreaks of Disease and Epidemics
		  o War and Conflict
		Natural Disaster-prone areas in INDIA
		
		• Areas prone to
		  o Earthquake
		  o Floods and Droughts,
		  o Landslides and Avalanches;
		  o Cyclonic And Coastal Hazards such as Tsunami;
		Trends of major Disasters and their Impact on India
		
		• Lessons Learnt from Recent Disasters	

	2	**Introduction to Disaster Management** What is Disaster Management Different Phases of Disasters Disaster Management Cycles Disaster Management Components • Hazard Analysis • Vulnerability Analysis • Prevention and Mitigation • Preparedness • Prediction and Warning • Response • Recovery Disaster Management Act, 2005 National Disaster Management Structure Organizations involved in Disaster Management	3
Module -II	1	**Overview on Hazard Analysis and Vulnerability Analysis** **Disaster Preparedness** • Disaster Risk Assessment, People's Participation in Risk Assessment • Disaster Risk Reduction • Preparedness Plans • Community preparedness: Emergency Exercises/ Trainings/Mock	3

		Drills	

	2	**Disaster Prediction and Warning**
		• Activities
		  o Tracking of disaster
		  o Warning mechanisms
		  o Organizational response
		  o Public education
		  o Communication
		  o Evacuation planning
		• Current tools and models used for Prediction and Early Warnings of Disaster
		  o Application of Remote Sensing
		  o Data From Meteorological and other agencies
		  o Smartphone/ Web based Apps for Disaster Preparedness and Early Warning used in different parts of Globe
			3

Module -III	1	**Disaster Response**
		• Crisis Management: The Four Emotional Stages of Disaster
		  o Heroic Phase
		  o Honeymoon Phase
		  o Disillusionment Phase
		  o Reconstruction Phase
		• Need for Coordinated Disaster Response
		  o Search, Rescue, Evacuation, Medical Response and Logistic Management
		  o Psychological Response and Management (Trauma, Stress, Rumor and Panic)
		• Role of Government, International and NGO Bodies
			3

	2	**Post-disaster Situation Awareness** • Need for Situation Awareness in Post Disaster scenario • Challenges in communication of situational data from affected areas • Need for community-driven disaster management for reliable situation awareness • Crowd-sourcing of situational data: Issues and challenges **Post-disaster Damage and Need Assessment** • Current Trends and Practices – RAPID Damage and Need Assessment • SPHERE standards in Disaster Response • ICT based techniques for Post-disaster damage and need assessment	3
Module -IV	1	**Rehabilitation, Reconstructions and Recovery** • Reconstruction and Rehabilitation as a Means of Development. • Post Disaster effects and Remedial Measures	3

		• Creation of Long-term Job Opportunities and • Livelihood Options • Disaster Resistant House Construction • Sanitation and Hygiene • Education and Awareness • Dealing with Victims' Psychology • Long-term Counter Disaster Planning	
	2	**Disaster Mitigation** • Meaning, Concept and Strategies of Disaster Mitigation • Emerging Trends in Mitigation • Structural Mitigation and Non-Structural Mitigation • Programs of Disaster Mitigation In India	3

SUGGESTED READINGS:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal book Company.
2. Sahni, Pardeep et.al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall of India, New Delhi.
3. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

Course Name : Sanskrit for Technical Knowledge					
Course Code: SANS5120					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	2	**0**	**0**	**2**	**0**

Course Objectives

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects
4. Enhancing the memory power
5. The engineering scholars equipped with Sanskrit will be able to explore the
6. Huge knowledge from ancient literature

Course Outcomes:

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

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

Module I (6L)

- Alphabets in Sanskrit,
- Past/Present/Future Tense,

Module II (6L)

- Simple Sentences
- Order

Module III (6L)

- Introduction of roots
- Technical information about Sanskrit Literature

Module IV (6L)

- Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

References

1. “Abhyaspustakam” – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi

2. “Teach Yourself Sanskrit” Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit

Sansthanam, New Delhi Publication

3. “India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Name : Personality Development through Life Enlightenment Skills					
Course Code: PDLS5118					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	2	**0**	**0**	**2**	**0**

Course Objectives

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Course Outcomes:

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

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.

Module I (6L)
Neetisatakam-Holistic development of personality

- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)

Module II (6L)
Approach to day to day work and duties.

- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)
- Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48,

Module III (6L)
Statements of basic knowledge.

- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.
- Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18

Module IV (6L)
Personality of Role model.

- Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39

- Chapter18 – Verses 37,38,63

References

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication 2. Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Course Name : Constitution of India					
Course Code: INCO5117					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	2	**0**	**0**	**2**	**0**

Course Objectives

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution

Course Outcomes:

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

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

Module I (8L)

- History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working)
- Philosophy of the Indian Constitution: Preamble, Salient Features

Module II (4L)

- Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

Module III (4L)

- Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

Module IV (8L)

- Local Administration: District's Administration head: Role and Importance; Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation; Pachayati raj:

Introduction, PRI: ZilaPachayat; Elected officials and their roles; CEO ZilaPachayat: Position and role; Block level: Organizational Hierarchy (Different departments); Village level: Role of Elected and Appointed officials, Importance of grass root democracy

- Election Commission: Election Commission: Role and Functioning; Chief Election Commissioner and Election Commissioners; State Election Commission: Role and Functioning; Institute and Bodies for the welfare of SC/ST/OBC and women.

References

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Name : Stress Management by Yoga					
Course Code: YOGA5119					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	2	**0**	**0**	**2**	**0**

Course Objectives

1.To achieve overall health of body and mind

2.To overcome stress

Course Outcomes:

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

1.Develop healthy mind in a healthy body thus improving social health also

2.Improve efficiency

Module I (6L)

- Definitions of Eight parts of yog. (Ashtanga)

Module II (6L)

Yam and Niyam.

Do`s and Don'ts in life.

- Ahinsa, satya, astheya, bramhacharya and aparigraha
- Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Module III (6L)
Asan and Pranayam

- Various yog poses and their benefits for mind & body

Module IV (6L)

- Regularization of breathing techniques and its effects-Types of pranayam

References

1. ‘Yogic Asanas for Group Tarining-Part-I” :Janardan Swami Yogabhyasi Mandal, Nagpur
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

First Year, Second Semester (M.Tech, ECE)

Course Title: ADVANCED DIGITAL COMMUNICATION TECHNIQUES					
Course Code : ECEN5201					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

1. Students will learn about the transmission techniques, synchronization in digital communication.

2. They will know about the modulation schemes, OFDM etc.

3. The students will acquire knowledge about the CDMA in details.

4. The students will have clear idea about estimation and detection schemes. They will be able to design reliable channel codings.

5. They will understand the differences between coding schemes.

6. The students will be able to analyse the digital communication quality.

Module – I [9 L]

Review of random variables and random processes

Review of baseband digital signal transmission –PCM DM ADM ADPCM. Inter Symbol Interference (ISI)

Nyquist criteria for no ISI in band limited channel

Parametric decoding: Sub-band coding APC LPC voice excited vocoder

Synchronization – Symbol and Frame synchronization

Equalizer: Linear equalization Decision feedback equalizer iterative equalizer and decoding

Module – II [9 L]

Digital Modulation:

Review of modulation schemes – BPSK DPSK QPSK M-ary PSK QASK MSK BFSK M-ary FSK –

principles transmitters receivers signal space presentation bandwidth efficiency

GMSK Orthogonal frequency division multiplexing (OFDM) – principle generation and detection

Bit error performance of bandpass signal – Narrow band noise model Error performance of BASK BPSK

BFSK MSK Comparison of bandwidth efficiency and error performance of modulation schemes

Module – III [9 L]

Multiplexing and multiple access : TDM/TDMA FDM/FDMA Space DMA ALOHA –slotted ALOHA and reservation ALOHA CSMA-CD CSMA- CA basic techniques and comparative performances

Spread spectrum modulation: Principle of DSS, processing gain jamming margin single tone interference probability of error

Principle of frequency hopped spread spectrum (FHSS) – slow frequency and fast frequency hopping

Principle of CDMA Multiple access interference (MAI) and limit of simultaneous users

Digital cellular CDMA system – forward and reverse link error rate performance

Module – IV [9 L]

Optimum Detection and Estimation:

Noise vector in signal space Bayes detection of received signal, optimum M-ary receiver design

Decision region and minimum error probability

Optimum detection of 16 QAM signal, MPSK signal orthogonal and bi orthogonal signal

Decision criterion: maximum likelihood Neyman Pearson and Minimax decision criterion

Estimation: Linear estimation – simple mean Linear mean squared error Wiener filter

Non linear estimation: Bayes estimation MAP ML estimates

Introduction to source coding (Hofmann and Shanon).

Introduction to error control coding (Linear Block Code and Convolution).

References:

1. Digital Communications 4th edition J G Proakis MGH international Edition
2. Principle of Communication Systems Taub and Schilling 7th edition TMH
3. Digital Communications :Fundamentals and Applications 2nd edn 2008 Bernard Sklar and Pabitra Kumar Ray Pearson Education
4. Principle of Digital Communications Simon Haykin Wiley Student Edition
5. Digital Communications Zeimer and Tranter CRC Press
6. Analog and digital Communication, B.P. Lathi, Oxford University Press.

Course Title: ADVANCED DIGITAL SIGNAL PROCESSING(DSP) and APPLICATIONS					
Course Code : ECEN5202					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

1. Students will know about the different transforms applied in signal processing.

2. They will have knowledge about LTI systems, Digital filters.

3. The students will know about multi- rate processing, wavelet transforms.

4. They will solve problems on FFT and DFT.

5. The students will know about the comparison of filters.

6. They will be able to apply the knowledge of wavelets.

Prerequisite: The student must be conversant with frequency domain analysis of discrete time signals and systems. They will be familiar with the various kind of adaptive filter design technique. Multirate Signal Processing fundamentals and applications of Wavelet Transforms will be covered.

Module I: [8 L]

Frequency Domain Analysis of Discrete Time Domain Signals and Systems: 6L

The concept of frequency in continuous time and discrete time signals. Fourier series for discrete periodic signals, Fourier Transform of discrete aperiodic signals, Power spectral densities of discrete aperiodic signals, Relationship between Fourier Transform and Z-Transform. Properties of Fourier Transform in discrete time domain; Time reversal, convolution, correlation, Wiener-Khintchine theorem, frequency shifting, modulation, windowing theorem, differentiation in digital frequency domain.Symmetry property for various types of signals.

Module II: [10 L]

Frequency Domain Characteristics of LTI Systems

Response to complex exponential signals, steady state and transient response to sinusoidal signals, steady state response to periodic signals, response to aperiodic signals. Relation between system function H (z) and frequency response function h(w). Input-output correlation function and spectra, correlation functions and power spectra for random input signals.

Invertibility of LTI systems, minimum/maximum/mixed phase systems, homomorphic systems and homomorphic deconvolution.DFT & FFT.Computation of DFT and it's properties, computation of DFT via FFT, chirp z-transform.

Module III: [9 L]

Design of Digital Filters

Design of FIR filters, Effect of various windows, Effect of finite register length, statistical analysis, stability effect, frequency sampling, Optimization Algorithm.

Adaptive Filters design, Single input, multiple input, State-Space Kalman Filter, Extended Kalman Filter, Unscented Kalman Filter Sample-Adaptive Filters, Recursive Least Square (RLS) Adaptive Filters, The Steepest-Descent Method, LMS Filter.

Power Spectrum

Estimation of Power Spectrum and Correlation, Non-parametric and Parametric methods, Minimum Variation Estimation methods, Eigen Analysis algorithm, Power Spectrum analysis using DFT, Maximum Entropy Spectral Estimation, Model-Based

Power Spectral Estimation.

Module IV: [8 L]

Multirate Signal Processing

Sampling Rate Conversion; Decimation and Interpolation; Time and Frequency Domain Characterization; Filters in Sampling Rate Alteration Systems; Multi-rate Design of Decimator and Interpolator; Poly-phase Techniques; Poly-phase Down-sampler and Interpolator; Poly-phase Filter Design; Two-channel QMF Banks. Alias free FIR and IIR QMF Banks; Perfect Reconstruction

Two-channel FIR Filter Banks; M-Channel Filter Banks Design; Cosine-Modulated M-channel Filter Banks Design;Wavelet Transforms

Fourier Transform and its limitations, Short Time Fourier Transform, Continuous Wavelet Transform, Discretization of the Continuous Wavelet Transform, Multiresolution Approximations; Wavelet and Scaling Function Coefficients, Orthonormality of

Compactly Supported Wavelets, Bi-orthogonal Decomposition, Harr Wavelets, The Daubechies Wavelets Construction, Fast Wavelet Transform and Image Compression, Denoising using Wavelets, Perfect Reconstruction Filter bank design using Wavelets.

References:

1. Discrete – Time Signal Processing by A.V. Oppenheim and R. W. Schafer, with J. R. Buck (Prentice- Hall, 1998)

2. Digital Signal Processing Using MATLAB by V. K. Ingle and J. G. Proakis (Books/Cole,2000)

3. Digital Signal Processing: A Computer Based Approach by S.K. Mitra (Second edition , McGraw-Hill, 2001)

4. Digital Signal Processing: Principles, Algorithms and Applications by J. G. Proakis and D. G. Manolakis.

5. Digital Filter Design and Analysis, Antino, TMH.

6. Digital Signal Processing- Rabiner and Gold, PHI

Course Title: TELECOMMUNICATION SYSTEMS & ENGINEERING					
Course Code : ECEN5231					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

The students, after completing the course, will be able to:

1. Define and describe the different telephone networks, ADSL etc.
2. Recognize digital telephone systems, SONET and SDH and Digital Network Synchronization.
3. Compare local area networks- features and parameters.
4. Explain the various 802.11 standards and their applications.
5. Analyze ISDN and its operation.
6. Explain ATM networks and operations and B-ISDN.

Module I: Telephone Network [12 L]

• Introductory terminology;

Grade of Service, QoS, Blocking Network, Lost call handling. Erlang and Poisson Traffic formulas one-way and both-way circuits.

• Local Networks – subscriber loop design, shape and size of a serving area, voice Frequency Repeaters, Tandem Routing, Dimensioning of Trunks

• Switching & Signaling for analog Telephone networks: Switching concepts – Cross-bar switching . Signaling concepts: Supervisory signaling – E & M signaling – In-band & out-of-band signaling

• Design of long distance links: Design essentials for LOS Microwave systems, Path analysis or Link Budget, Fading , Diversity and Hot stand-by operation, VSAT networks, concept of Last Mile

Broadband connectivity – ADSL & HDSL

Module II: Digital Telephone Systems [12 L]

• PCM – PCM line Codes – Regenerative repeaters – Signal to noise ratio for PCM signals – North American DS1 – the European E1 digital hierarchy – Filter – distortion – echo – cross talk – SONET and SDH – PCM Switching :'Time – space – Time Switch – 'Space – Time – Space' Switch – Digital Network Synchronization – Digital loss

Module III: Local Area Networks [6 L]

• LAN topologies – overview of IEEE / ANSI LAN protocols – WLANS – different 802.11standards

Module IV: ISDN [8 L]

• ISDN - background & goals of ISDN – protocols – structures – ISDN and OSI

• ATM and B-ISDN – User-Network interface (UNI) configuration and architecture – ATM cell structure – cell delineation algorithm – ATM layering & B-ISDN . Advantages of BISDN

References:

1. Wiley Series in Telecommunications and Signal Processing by Roger L. Freeman

2. Telecommunication System Engineering, By N. N. Deb.

3. Telecommunication Switching, Viswanathan.

4. Telecommunication, Fraser.

Course Title: IMAGE PROCESSING AND PATTERN RECOGNITION					
Course Code : ECEN5232					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

1. Students will know about the basics of image processing, spatial filtering etc.

2. They will have knowledge about techniques applied for pattern recognition.

3. The students will know about image clustering and face recognition.

4. They will be able to classify and predict.

5. The students will acquire knowledge about identifying objects correctly.

6. They will earn the potential to develop new applications.

Module I: [10 L]

Image Processing Basics: Image definition, a simple image formation model, basic concepts of image sampling and quantization, representing a digital image, concept of pixel/ pel, spatial and gray level resolution, some basic relationships between pixels : Neighbors of a pixel, Adjacency, Connectivity, Path, Connected component, Connected component labeling. Distance measures: the three essential properties, Euclidean, City-Block and Chess-Board distance, concept of image operations on a pixel basis.

Popular image processing methodologies: Spatial domain technique : contrast stretching, basic point processing, thresholding function, concept of mask/ sub image, mask processing/ filtering, gray-level slicing, bit-plane slicing.

Basics of spatial filtering : convolution mask/kernel, concept of sliding mask throughout the image-space, smoothing(averaging) filter/ low pass filter. Image segmentation by global and local gray level thresholding, region growing, region splitting and merging techniques. Morphological algorithms: thinning, thickening, skeletons.

Color image processing: Perception of color: color fundamentals. Two popular color models: RGB & HSI, concept of RGB & HSI space and their conceptual relationships, mathematical conversion from RGB to HSI space and vice versa.

Module II: [10 L]

Pattern Recognition

Basics of pattern recognition: Concept of a pattern: feature, feature vectors and classifiers. Importance of pattern recognition. Basic concept of fuzzy pattern recognition, linearly separable and inseparable classes, classes with some overlapping regions, convex and non-convex paradigm in this aspect.

Clustering: Basic concept of cluster analysis. Similarity (Proximity) metrics (indices) and clustering criteria. Partitional clustering: Extraction of natural groups that are inherent in some data set by hard c-means (k-means), fuzzy cmeans.

Concept of getting stuck to a local optimum (in objective functional space) by k-means and fuzzy c-means due to their initiation/ starting point. Fuzzy cluster validity index: Xie-Beni index.

Classification and prediction: Definition of classification and prediction. Basic task of a classifier. Concept of training & testing data and overfitting. Bayes classification: Bayes' Theorem, Naïve Bayesian classification. Classification by Back propagation: Multilayer Perception (MLP) neural network and Back propagation algorithm.

Global optimization techniques: Genetic Algorithms (Gas): Cycle of genetic algorithms, selection (Roulette wheel and Tourment) crossover, mutation, evaluation of fitness function, incorporation of elitism in GAs. Multi-objective

optimization using GAs. Simulated Annealing (SA): Analogy with physical annealing process, concept of energy and mechanism of energy minimization using SA, Necessity of an uphill movement during the process. Hybridization with partitional clustering techniques.

Module III:[9 L]

Image clustering applications: Mechanism of extracting pixel-patterns from a gray-scale image in various ways: e.g. forming feature space (like a two column matrix) treating the gray-value of center-pixel (of a local window) as the first feature and averaged value over a square-shaped local window (3x3 or 5x5 or like that) as the second feature, construction of high-dimensional feature space: e.g. treating all the pixel-gray-values of a local window as features (i.e. for 3x3 window 9-dimensional feature space will result). Application of partitional clusterings in the above mentioned feature-space to recognize the objects in the concerned image.

Module IV: [9 L]

Applications in multispectral and multitemporal remotely sensed imagery: Identification of different land cover types from multispectral remote image data using supervised/ unsupervised classification: Clustering by Histogram peak selection & and its limitation in this context (i.e. remote image analysis). Unsupervised Change Detection using

squared-error clustering methodologies: The algorithm, process, key challenges, error estimations like missed alarms, false alarms and overall error, need of ground truth.

Image mining: Need, Image search and retrieval. Bottleneck of Text based image mining/ retrieval, Visual feature based image mining: Content-based image retrieval (CBIR).

Image based face recognition: Basic technique for Eigen face generation & recognition.

References:

1. R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, Pearson Education Asia, 2004

2. S.K. Pal, A.Ghosh, and M.K. Kundu, *Soft Computing for Image Processing*, Physica

3. Verlag, (Springer), Heidelberg,1999.

4. R. O. Duda, P.E. Hart and D. G. Stork, *Pattern Classification*, John Wiley & Sons (Low Priced Edition).

5. Anil K. Jain and R.C.Dubes, *Algorithms for Clustering Data*, Prentice Hall.

6. S. Theodoridis and K. Koutroumbus, *Pattern Recognition*, Elsevier.

7. A. Ghosh, S. Dehuri, and S. Ghosh (editors). *Multi-Objective Evolutionary*

8. *Algorithms for Knowledge Discovery from Databases*. Springer, Berlin,

9. 2008.

10. Anil K. Jain, *Fundamentals of Digital Picture Processing*, Prentice Hall.

Course Title : COGNITIVE RADIOS AND NETWORKS					
Course Code : ECEN5241					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

The following outcomes (COs) are expected from the students after completion of the course –

1. An ability to apply knowledge of mathematics, science and engineering in the emerging areas of RF communication.
2. An ability to analyze a performance in a radio net.
3. An ability to learn and apply modular approach in design.
4. An ability to understand emerging research work in new areas of cognitive radios and spectrum hole sensing.
5. Development of a passion to pursue next generation wireless communication.
6. An power of analysis to apply correct technique in locating radios in networks.

Module I: [8 L]

INTRODUCTION TO SOFTWARE DEFINED RADIO

Definitions and potential benefits, software radio architecture evolution, technology tradeoffs and architecture implications. Differences between software enable radio and software defined radio. Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules.

Module II: [8 L]

COGNITIVE RADIO TECHNOLOGY

Introduction – Radio flexibility and capability – Aware – Adaptive – Comparison of Radio capabilities and Properties – Available Technologies – IEEE 802 Cognitive Radio related activities – Application, position awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques.

Module III: [10 L]

COGNITIVE RADIO DESIGN AND CHALLENGES

Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture. Design Challenges associated with CR – Hardware requirements – Hidden primary user problem – detecting spread spectrum primary users – sensing duration and frequency – security

Module IV: [8 L]

SPECTRUM SENSING

Spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design, applications of cognitive radios to optimize spectrum utilization, to reduce transmit power reduction and to improve data rate even in noisy conditions. Matched filter – waveform based sensing – cyclostationary based sensing – Energy detector based sensing – Radio Identifier – Cooperative sensing- other sensing methods.

TOTAL: 34 PERIODS

Reading:

1. Joseph Mitola III, "Software Radio Architecture: Object-Oriented Approaches to wireless system Engineering", John Wiley & Sons Ltd. 2000

2. Thomas W. Rondeau, Charles W. Bostain, "Artificial Intelligence in Wireless communication", ARTECH HOUSE. 2009.

3. Bruce A. Fette, "Cognitive Radio Technology", Elsevier, 2009.

4. Ian F. Akyildiz, Won- Yeol Lee, Mehmet C. Vuran, Shantidev Mohanty, "Next generation / dynamic spectrum access / cognitive radio wireless networks: A Survey" Elsevier Computer Networks, May 2006

5. Simon Haykin, "Cognitive Radio: Brain-Empowered Wireless Communication", IEEE Journal on selected areas in communications, Feb 2005.

6. Markus Dilinger, Kambiz Madani, Nancy Alonistioti, "Software Defined Radio", John Wiley, 2003

7. Huseyin Arslan,"Cognitive Radio, SDR and Adaptive System", Springer, 2007.

8. Bruce A. Fette, "Cognitive Radio Technology", Elsevier, 2009.

Course Title: MICROWAVE MEASUREMENT AND INSTRUMENTATION					
Course Code : ECEN5242					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

At the end of the course, the students will acquire the following.

1. Knowledge about the microwave measurement procedures

2. Ability to analyse instruments like spectrum analyzer, Vector Network analyzer etc.

3. Ability to measure microwave power.

4. Idea about techniques to measure power.

5. Capability to analyse problem in measurement procedure and improve.

6. Knowledge about special procedure like TDR.

MODULE I : [10 L]

Introduction to Radio Frequency and Microwave Measurement.

: Microwave Detectors and Sensors. Different types of microwave detectors, their functions and applications. Microwave sensors – working principles and applications

Microwave Power Measurement- Low Power Measurement- Bolometer technique. High Power Measurement – Calorimetric method

MODULE II : [10 L]

Microwave Attenuation Measurement

Microwave Frequency Measurement. Slotted Line technique. Wave meter method - Absorption and Transmission type wave meter

Microwave Impedance Measurement – Slotted Line technique to measure VSWR and unknown Load Impedance. Application of Smith chart in transmission line measurement

MODULE III : [9 L]

Microwave Cavity parameter measurement. – Cavity Q measurement by Slotted Line technique. Swept Frequency method Decrement methodMeasurement of Dielectric constant of a solid and liquid at microwave frequency by Waveguide method.

Cavity perturbation method

MODULE IV : [9 L]

Introduction to Microwave Instrumentation:

Spectrum Analyzer ; Block diagram of a spectrum analyzer – operational features of functional units and applications of Spectrum Analyzers.

Vector Network Analyzer (VNA) : Block diagram of VNA operational aspects of different functional units comprising VNA. Measurement of Scattering parameters and other applications.

Time Domain Reflectometer (TDR) : Block diagram of TDR and its working principle

Reflection coefficient measurement and interpretation of Time domain Reflected waveform.

Industrial applications of TDR.

References:

1. G.H.Bryant- Principles of Microwave Measurements- Peter Peregrinus

Ltd.

2. T.S.Laverghetta- Hand book on Microwave Testing

3. S.F.Adam- Microwave Theory & Application- Prentice Hall, Inc

4. A.E. Bailey, Ed. Microwave Measurements- Peter Peregrinus Ltd

5. Annapurna Das and S K Das Microwave Engineering TMH Publications

6. HP Application Notes

Course Title :DESIGN OF COMMUNICATION EQUIPMENTS AND SYSTEMS					
Course Code : ECEN5243					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

The following outcomes (COs) are expected from the students after completion of the course –

1. An ability to apply knowledge in designing electronics for communication engineering.
2. An ability to analyze and interpret data.
3. An ability to learn and apply modelling based approach through the extensive use of simulator tools.
4. An ability to pursue research work in new areas of communication equipments and systems.
5. Design of complex PCBs.
6. Clear perception about testing of parameters.

Module I: [10 L]

Design Considerations of Communication equipments and systems:
Implementing Radio Link, Path profile, RF path loss calculations, Transmitter / Receiver parameters and their significance – SNR, SINAD, sensitivity, Hum and Noise, Quieting, Distortion, Rated RF power, RF power, Fade Margin.

Study and evaluation of Performance parameters for data communication like Bit and symbol error rates, Spectral Bandwidth calculations.

Module II: [10 L]

Design of various blocks of communication equipments such as PLL, Equalizer, Interleaver, Interference consideration in processor / controller enabled radios- desensitization problem, means to mitigate the problem – detailed study of clock speed & shape, PCB design.

Module III: [10 L]

PCB Design and EMI/EMC

PCB design practices for Analog and Mixed signal circuits- Ground loops, Precision circuits, supply isolation, shielding and guarding – different techniques. PCB design practices for High Speed Digital circuits, signal integrity and EMC. EMI/EMC testing standards and compliance.

Module IV: [8 L]

Types of antenna – selection procedure for correct antenna, measurement of the network performance – different techniques.

Emulation of testing procedure in laboratory, test procedures for Receiver / Transmitter parameters with different standards like CEPT, EIA.

Reading:

1. "High-speed Digital Design- A Handbook of Black Magic" – Howard Johnson, Martin Graham- Prentice Hall.

2. "EMC for Product Designers" – Tim Williams – Elsevier 2007.

3. "Digital Communication" – B. Sklar – Pearson Ed.

4. "Circuit Design for RF Transceiver" – D. Leenaerts, Johan van dar Tang, Cicero S. Vaucher – kluwer Academic Publishers, 2003

5. "Practical Radio Engineering & Telemetry for Industry" – David Bailey – Elsevier, ISBN 0750658037.

Course Title: Advanced Digital Signal Processing(DSP) and Applications Laboratory					
Course Code : ECEN5252					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	4	4	2

Course outcomes:

The students will acquire understanding of the following:

1. Basics of sampling, convolution etc, Z-transform

2. DFT and FFT and their applications

3. Filters – IIR and FIR

4. Digital filters, multirate signal procesing.

Simulation Laboratory using standard Simulator:

1. Convolution of two sequences using graphical methods and using commands- verification of the properties of convolution.

2. Z-transform of various sequences – verification of the properties of Z-transform.
3. Twiddle factors – verification of the properties.

4. DFTs / IDFTs using matrix multiplication and also using commands.

5. Circular convolution of two sequences using graphical methods and using commands, differentiation between linear and circular convolutions.

6. Verifications of the different algorithms associated with filtering of long data sequences and Overlap –add and Overlap-save methods.

7. Butterworth filter design with different set of parameters.
8. Chebyshev filter design with different set of parameters.

9. FIR filter design using rectangular, Hamming and Blackman windows.

Hardware Laboratory using Xilinx FPGA:

1. Writing of small programs in VHDL and downloading onto Xilinx FPGA.
2. Mapping of some DSP algorithms onto FPGA.

Course Title: DESIGN AND SIMULATION LABORATORY					
Course Code : ECEN5253					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**4**	**4**	**2**

Course Outcome: Designing graphical user interfaced models of various communication systems/ subsystems with the help of suitable advanced software e.g. MATLAB/ OCTAVE/LABVIEW/ NS/ PUFF/ IE3D/ ANSOFT/ HFSS/ CST/ QUALNET/ MICROWAVE OFFICE etc. for detailed study of their operating principle and their performance vis-a-vis practical limitations like, channel bandwidth, noise, attenuation etc.

Suggested topics are

1. ADPCM – granular noise & quantization noise.
2. MPSK – signal bandwidth, PSD, distinguishability, scatter plot etc.
3. Digital filters – ripples in pass band & stop band, slope in transition band, poles & zeros etc.
4. Optimum filters for receiving base band random binary data – Pe vs. S/N.
5. Signal bandwidth and Pe vs. S/N in different modes of line coding.
6. Signal bandwidth and Pe vs. S/N in different modes of modulation.
7. Error rates in error control for different types of error control coding.
8. Throughput vs. input density in different MAC protocols.
9. DSSS – error rate due to different types of chip code.
10. Fading channel/ multipath transmission and Rake receiver.
11. Cellular architecture, WiFi, WiMAX using QUALNET.
12. OFDM using QUALNET.
13. Different routing algorithms & protocols.
14. Characterization of micro strip antenna.
15. Characterization of transmission lines.
16. Study of important parameters and practical considerations in microwave circuits.

Second Year Syllabus

(M.Tech, ECE)

Second Year, First Semester:

Course Title: Remote Sensing and applications					
Course Code: ECEN 6131					
Contact Hours/week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

CO

After going through this course, the students will be able to

1. Apply previously gathered knowledge on Electromagnetic Theory and Microwave Engineering to appreciate this subject.

2. Understand the basics of remote sensing principles and technologies and various remote sensing systems.

3. Acquire knowledge about the various remote sensing techniques for applications in improving social, economic and environmental conditions for agricultural, forestry and water body management

4. List various Remote Sensing missions worldwide

5. Analyze the operation of various remote sensing devices

6. Categorize the role of the Indian remote sensing program to explore possibilities in further studies and research.

Syllabus

Module I: Introduction to Remote Sensing. Development of remote sensing technology and advantages. EM spectrum, thermal emission and solar refection remote sensing. Interaction of EM radiation including atmospheric scattering, emission and absorption Atmospheric windows, spectral signature of various land cover features. (6L)

Variation of earth's reflectivity with angle of incidence, wavelength and geographical location; seasonal variation of reflectivity, solar radiation reflected from Earth. Thermal emission from cloud, raindrops, snow and fog. Radio noise and interference (6L)

Module 2: Basics of Remote sensing using Satellites. Sensors and cameras, Active, passive and ground based remote sensing. Introduction to Indian Remote Sensing Systems. Concepts of Thematic mapping. Microwave and Millimeter wave radiometers, Scanning systems, Scatterometer, Altimeters. (6 L)

Module 3: Satellite based remote sensors, space based remote sensors. Application of Remote Sensing in India, IRS Satellites, NOAA series, UARS (Upper atmosphere Research Satellites), TRMM (Tropical Rainfall Measuring Mission) (4L)

Module 4: Remote Sensing Technologies: spectral , spatial and temporal resolution. microwave sensing of sea surface, FOV(field of view),Radiation Principles (Plank's and Stephen Boltzman Law) (6 L)

Remote Sensing systems: LIDAR, SODAR, AURA MLS, Megha Tropiques. wind speed, water vapor and trace gas measurement. Recent and future trends . Research areas and insight into scopes and facilities in India (4 L)

Total : 32 Lectures.

Books:

1. Remote Sensing : Basudeb Bhatta (Oxford University Press)
2. Remote Sensing of Environment : Jenson (Pearson)

Course Title: Internet of Things (IoT) and applications					
Course Code: ECEN6132					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

At the end of the course, the students will acquire the following.

1. Understand different protocols.
2. Analyze IoT architecture.
3. Design applications based on IoT.
4. Create sensor based applications.
5. Develop new applications.
6. Compare different IoT uses.

Pre-requisite: Wireless Communication, Networking Concepts, Cellular/ WAN System

MODULE I : (10 L)

Introduction to IoT,
M2M to IoT- the vision, perspective, architectural overview, M2M & IoT fundamentals.

MODULE II : (10 L)
IoT architecture, state-of- the-art standards,
IoT reference models- domain model, information model, functional model, communication model.

MODULE III : (8 L)
Safety, privacy, security models, sensors and networks, interfacing for IoT, introduction to Python language

MODULE IV : (8 L)
Engineering applications- V2V, Industrial IoT, uses in healthcare, agriculture sectors

References:

1. Internet Of Things: Converging Technologies For Smart Environment And Integrated Ecosystems - Vermesan, Ovidiu, Fries, Peter - River Publishers, 2013
2. Internet Of Things Applications: From Research And Innovation To Market Deployment - Vermesan, Ovidiu, Fries, Peter- River Publishers, 2014
3. Python Programming For Teens - Lambart, Kenneth A. CENGAGE Learning, 2014
4. Understanding Smart Sensors - Frank, Randy, Artech House,2013
5. Learning Internet Of Things - Peter Wahar- Publisher PACKT - Amazon.In

Course Title: MIMO Systems					
Course Code: ECEN6133					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

At the end of the course, the students will acquire the following.

1. Explain the behavior of wireless communication.
2. Compare different channel models and MIMO channel model.
3. Calculate the capacity of MIMO communication systems.
4. Explain the diversity performance of MIMO channels.
5. Understand different coding schemes.
6. Design systems with multi-user MIMO communications.

MODULE I : (8 L)

Introduction to wireless communication systems and wireless channels.

MODULE II : (10 L)

Wireless channel models.
MIMO channel model.

MODULE III : (10 L)

Information Theory basics for MIMO communication.
Capacity of MIMO Communication systems.
Diversity performance of MIMO channels.

MODULE IV : (8 L)

Space Time Coding schemes.
Multi-user MIMO communications.

References:

1. Principles of Mobile Communications by G. Stuber, Springer, 2nd ed..
2. Wireless Communications by A. Goldsmith, Cambridge
3. Space Time Coding, by Jafarkhani, Cambridge
4. OFDM for Wireless Communications by R. Prasad, Artech House, 2004
5. Adaptive PHY-MAC Design for Broadband Wireless Systems by R. Prasad, S. S. Das and Rahman, River Publishers

Course Title: Design And Technology For Photonic Integrated Circuit					
Course Code: ECEN 6125					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Objectives:

Students will be able to:

1. Recognize materials and solve problems associated with Lorentz and Drude models.

2. Explain wave propagation through isotropic and anisotropic mediums and can apply the concept in solving associated problems.

3.Analyze structures composed of different materials and can solve problems associated with wave propagation through metals, dielectrics, dielectric-dielectric, metal-dielectric and metal-metal interfaces.

4.Design coupled devices for both co-directional and contra-directional propagation.

5. Design interferometers and resonators using periodic dielectric structures.

6. Analyze and synthesis basic photonic components using simple python coding.

Module 1: Introduction (12L)

Importance of photonic integrated circuit. **Components and materials for photonic integrated circuits**. **Review of EM wave propagation;** isotropic medium, wave impedance, Poynting vector, polarisation, reflection. **Electromagnetic properties of materials;** Lorentz oscillator model, Lorentz model for dielectrics, Kramers-Kronig relation, Drude model for metals. **Anisotropic medium;** dispersion, phase and group velocity, index ellipsoids, polarisation, optical axes.

Module 2: Optical waveguide (8L)

Planar waveguides; TE and TM Modes, propagation constants, field distribution, dispersion equation. **Rectangular waveguide;** basic equation, dispersion relation, Kumar's method, effective index method. **Multimode interference (MMI) devices.**

Module 3: Coupled mode theory and applications (8L)

Coupled mode equations. Co directional and contra-directional couplers.
Derivation of coupling coefficients; slab waveguide and rectangular waveguide. **Interferometers;** Febry-perot, Mach-Zehnder. **Ring resonator. Bragg Gratings. Photonic band-gap devices;** periodic dielectric structure in two dimensions, square and honeycomb lattice, dispersion, wave guiding, directional coupler, left-hand propagation, self collimation.

Module 4: Fabrication and characterization (8L)

Materials, technology and process. Device fabrication flow; ion exchange-Glass, diffusion-$LiNbO_3$ (dynamic device), etching -Silicon. **Numerical analysis using Python**; meshgrid, rectangles and the centering algorithm, bars and rectangles via linear meshgrids, lines & fills via linear meshgrids, circles & ellipses via Radial meshgrids, Pie Wedges via azimuthal meshgrids, Boolean operations.

Text books:

1. Fundamentals of Photonics by **Bahaa E. A. Saleh, Malvin Carl Teich**
2. Theory of Optical Processes in Semiconductors: Bulk and Microstructure by **P. K. Basu**
3. Fundamentals of Optical Waveguides by **Katsunari Okamoto**
4. Waves and Fields in Inhomogeneous Media by **Weng Cho Chew**

Reference books:

1. Photonic Crystals: Molding the flow of light by **John D. Joannopoulos**
2. Silicon Photonics Design: From Device to Systems by **Lukas Chrostowski, Michael Hochberg**

List of Open Electives offered by different Departments
M Tech, Second Year, Semester III

A. Theory							
Department	**Course Number**	**Subject**	**Scheme Of Studies Per Week**			**Total**	**Credits**
			L	**T**	**P**		
			3	**0**	**0**	**3**	**3**
AEIE	**AEIE6121** **AEIE6122**	**Biosignal and Biomedical Image Processing** **Intelligent Control**					
BT	**BIOT6121**	**Engineering Mathematics and Biostatistics**					
ChE	**REEN6121** **REEN6122**	**Composite Material for Renewable Energy** **Safety and Hazards in Energy Industry**					
CSE	**CSEN6121** **CSEN6122**	**Business Analytics** **Advanced Artificial Intelligence**					
ECE	**ECEN6121** **ECEN6122** **ECEN6123** **ECEN6124**	**AD HOC Networks and Uses** **Design of Embedded Systems** **Cognitive Radios** **Automation in VLSI Design**					
IT	**INFO6123**	**Information Theory and Coding**					
MATH	**MATH6121**	**Optimization Techniques**					

Subject Name: BIOSIGNAL AND BIOMEDICAL IMAGE PROCESSING					
Paper Code: AEIE6121					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

COURSE OUTCOMES:

On completion of this course you should be able to:

1. Understand acquisition, general properties and clinical applications of biomedical signals such as ECG, EEG, EMG, EP and speech signal.
2. Learn the fundamentals of different modes of 2D and 3D medical imaging, including fluoroscopic, ultrasound imaging, computed tomography and magnetic resonance imaging.
3. Demonstrate advanced knowledge of filtering, transforms and spectral analysis of biomedical signal and images.
4. Apply image processing techniques for enhancement, filtering, segmentation and registration biomedical images.
5. Gain skill set to compress biomedical signals and images using loss less and lossy compression techniques as well as modern compressed sensing technique.
6. Perform signal analysis and classification using PCA, ICA, LDA, Bay's classifier, KNN and k-means clustering algorithm.

MODULE I – [8L]

Acquisition, General Properties and Clinical Applications of Biomedical Signals and their signal processing aspects:

Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Evoked Potential (EP)and Speech Signals.

*Physics, Signal Processing and Clinical Applications of major modalities for medical imaging:*Ultrasound, X-ray, CT, MRI, PET, and SPECT.

MODULE II – [10L]

Fundamentals of Biomedical Signal and Image Processing Techniques:

Signal acquisition- Sampling in time, aliasing, quantization, interpolation and noise; Convolution, Correlation and Covariance of signals.

Signal Transform: Discrete Fourier transform (DFT) and its properties, the fast Fourier transform (FFT), Short Time Fourier Transform (STFT), Time-Frequency analysis- Continuous wavelet transform and discrete wavelet transform, Discrete Cosine Transform (DCT)- Application of these transforms and examples with MATLAB.

Digital Filters: FIR and IIR digital filters design criteria, signal averaging, MATLAB implementation. Spectral Analysis: Nonparametric Estimators of PSD and Parametric Estimators.

MODULE III – [9L]

Medical Image Processing Techniques:

Extension of filtering and Transforms methods to 2-D signals and systems.

Image enhancement, Image Registration, Image Segmentation-pixel based, region based, edge based and morphological methods of segmentation with example in MATLAB.

MODULE IV – [9L]

Emerging topics:

Biomedical Data Compression- Need for data compression, Lossless and lossy compression, Compressive Sensing Algorithms– Sampling, representation and reconstruction for Signal and Image Processing Applications.

Multivariate Analyses: Principal Component Analysis and Independent Component Analysis.

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Classification: Bayes' rule, detection, statistical classification, Linear Discriminant Analysis (LDA), Cluster Analysis- K-means clustering, K-nearest neighbour (KNN) classifier; Evaluation of classifier performance.

REFERENCES:

1. J. L. Semmlow and B. Griffel, Biosignal and Medical Image Processing, 3rd Eds., 2014.
2. J. L. Semmlow, Biosignal and Medical Image Processing: MATLAB based Applications, Marcel Dekker, Inc., Yew York, USA, 2004.
3. Amine Naït-Ali (Ed.), Advanced Biosignal Processing, Springer, 2009.
4. H. Liang, J. D. Bronzino and D. R. Peterson (Eds.), Biosignal Processing- Principle and Practices, CRCPress, 2013.
5. K. J. Blinowska, J. Zygierewicz, Practical Biomedical Signal Analysis Using MATLAB, CRC Press, 2012.

SUBJECT NAME: INTELLIGENT CONTROL					
Paper Code: AEIE6122					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

COURSE OUTCOMES:

After the completion of the course, the students will be able to:

1. Explain the concept of intelligent control and their applications.
2. Learn basics of Neural Network and control systems based on it.
3. Gain knowledge about fuzzy set theory and control scheme based on it.
4. Apply Genetic Algorithm to solve optimization problems in different control systems.
5. Provide detailed theoretical and practical aspects of intelligent modeling, optimization and control ofnon-linear systems.
6. Design Neural Network based predictor of nonlinear system.

MODULE I – [10L]

Introduction to Intelligent Systems and Neural Networks:

Introduction and motivation, Approaches to intelligent control, Architecture for intelligent control, Expert systems. Artificial Neural Networks: Concept of ANN and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feedforward multilayer perceptron. Learning and training of the neural network, Adaptive learning rate, weight update rule, Radial basis function networks.

MODULE II - [10L]

Fuzzy Logic and Model Based Fuzzy Control:

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self organizing fuzzy logic control. Fuzzy logic control for nonlinear time- delay system.

MODULE III - [8L]

Evolutionary Computation Techniques:

Genetic Algorithm: Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters, Evolutionary design of controllers. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and ant-colony search and simulated annealing techniques for solving optimizationproblems.

MODULE IV - [8L]

Hybrid Computing Technique:

Neuro-Fuzzy Hybrid System, Adaptive Neuro-Fuzzy Inference System, Genetic Neuro Hybrid System, Genetic Fuzzy hybrid and Fuzzy Genetic hybrid system, Applications in system identification and control.

Introduction to Quantum Computation: Quantum neural network for fuzzy classifier, Quantum Neuro-Fuzzy classifier.

REFERENCES:

1. Y.C. Shin and C. Xu, Intelligent Systems: Modeling, Optimization and Control, CRC Press, 2008.
2. Kazumi Nakamatsu and Roumen Kountchev Eds., "New Approaches in Intelligent Control- Techniques, Methodologies and Applications", Springer, 2015.
3. Michael Negnevitsky, "Artificial Intelligence : a Guide to Intelligent Systems", Addison Wesley, 2005.
4. Robert E. King, "Computational Intelligence in Control Engineering", Control Engineering Series.
5. Marzuki Khalid, "Artificial Intelligence : Fuzzy Logic Module", University Technology Malaysia.
6. Marzuki Khalid, "Artificial Intelligence : Artificial Neural Networks Module", Universiti Teknologi Malaysia

Subject Name: Engineering Mathematics and Biostatistics					
Paper Code: BIOT6121					
Contact Hours Per Week	L	T	P	Total	Credit Points
	3	0	0	3	3

COURSE OUTCOMES:

After completion of this course, students will be able to:

1. Understand and apply the basic principles of engineering mathematics.
2. Estimate men, median, mode and other parameters of central tendency in biological samples.
3. Evaluate the probability of occurrence by different methods in an experimental set-up.
4. Solve problems regarding differences in parameters between experimental and control groups bytesting hypothesis.
5. Analyze the relationship between experimental groups in biological samples with the help of correlation and regression.
6. Estimate the difference between and within biological parameters in same or different groups by analysis of variance.

MODULE-I [9L] INTRODUCTION TO ENGINEERING MATHEMATICS

Linear Algebra: Matrices and Determinants, Eigen values and Eigen vectors; Definite integration with Applications; Differential equations with applications; Numerical solution of ODEs: different methods.

MODULE-II [9L] CENTRAL TENDENCY AND THEORETICAL DISTRIBUTION

Statistics of dispersion: Variability, Central tendency, Mean deviation, Standard Deviation, Variance; Probability Distribution for discrete random variables and continuous random variables; Skewness, Kurtosis, theoretical probability distributions: binomial, poisson, normal.

MODULE-III [9L] TESTING OF HYPOTHESIS

Testing Hypothesis: Concepts and importance in experimental research, type of errors; testing means, Significance of difference between means using Z score; Large sample tests based on normal distribution – Test based on t and F distributions, Chi square test for goodness of fit, independence of attribute, homogeneity, and variance of a normal population.

MODULE-IV [9L] CORRELATION, REGRESSION & ANOVA

Correlation and Regression analysis; Analysis of Variance: One way and two way classifications of Anova – Applications in Biological Sciences.

TEXT BOOKS:

1. Introduction to Biostatistics. Pranab K Banerjee. (2nd edition). S. Chand & Co.
2. P.N. Arora, P.K. Malhan, Biostatistics, Himalaya Publishing House.
3. B.K. Pal and K. Das. Engineering Mathematics. Vol. 1 and 2. U.N. Dhur & Sons Pvt. Ltd.

REFERENCE BOOKS:

1. Debajyoti Das and Arati Das. Statistics in Biology and Psychology, Academic Publishers.
2. P. Kandasamy, K. Thilakavthy and K. Gunavathy. Numerical Methods. S. Chand and Co., New Delhi, 1999.
3. B.S. Grewal, J.S. Grewal. Numerical Methods in Engineering and Science. Khanna Publishers, New Delhi, 1999.

4. M.K. Jain, S.R.K. Iyengar and R.K. Jain. Numerical Methods for Engineering and Scientific Computation (3rd Edition). New Age International (P) Ltd., New Delhi, 1995.
5. C.F. Gerald, P.O. Wheatley. Applied Numerical Analysis (5th Edition), Addison – Wesley, Singapore, 1998.
6. S. Narayanan, K. Manickavachakam Pillai and G. Ramanaiah. Advanced Mathematics for Engineering Students-Vol.-III. S. Viswanathan Pvt. Ltd., Chennai, 1993.

Subject Name: Composite Materials					
Paper Code: REEN 6121					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

COURSE OUTCOME:

By the end of the course the students will be able to

1. Impart updated knowledge and provide strong foundation to the M. Tech. students on thepreparation, structure, fabrication, properties and applications of different advanced composite materials.
2. Acquire vast ideas and strong confidence in applications of high tech materials in modern devices used in both renewable and non-renewable energy sector.
3. Carry out R & D activities for developing newer advanced materials for use in renewable energy sector.
4. Solve stringent industrial problems and needs wherever applicable more economically.
5. Pursue higher studies & carry out research works effectively in the field of materials science & engineering.
6. Acquire sound employability in different eminent academic, R & D institutes and industries.

MODULE–I: 9 L

Learning objective; Introduction: Definition; Classification and characteristics of Composite materials; Advantages and application of composites for both general engineering & renewable energy engineering purpose; Functional requirements of reinforcement and matrix; Effect of reinforcement (size, shape, distribution, volume fraction, and orientation of particles and fibres/whiskers) on overall composite performance;

MODULE II: 9 L

Applications of composites/nano-composites in renewable energy engineering: Wind turbine, Gas turbine; hydro- turbine; electrical double layer capacitors used in storage devices (conducting polymer carbon nano-tube composites), tandem & hot carrier solar cells: transition metal- chalcogenides; perovskite-based solar cells, nano- diamond based solar energy converter, graphene-silicon batteries; black phosphorous-based solar photo voltaic; Nickel sulphide anchored graphene composites for high performance super capacitors electrode materials for fuel cell applications; Chromium-doped poly-aniline –CNT nano-composites as super capacitors electrode materials.

MODULE III: 9 L

Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers, Silicon carbide fibres & Alumina whiskers. Properties and applications of whiskers, particle reinforcements. Mechanical behaviour of composites: Rule of mixtures, Inverse rule of mixtures. Iso-strain and Iso- stress conditions. Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

MODULE IV: 9 L

Preparation of Metal Matrix Composites: Casting– Solid State diffusion technique, Cladding – Hot iso-static pressing; Properties and applications; Preparation of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering; Preparation of Carbon–Carbon composites: Knitting, Braiding, Weaving, Properties and applications; Preparation of Polymer Matrix

Composites: Preparation of Moulding compounds and pre-pregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding; Properties and applications.

TEXT BOOKS:

1. Material Science and Technology – Vol 13 – Composites by R.W. Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction; W D Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007

REFERENCES:

1. Hand Book of Composite Materials by Lubin George(Ed)
2. Composite Materials – K. K. Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

Subject Name: Safety and Hazards in Energy Industry					
Paper Code: REEN 6122					
Contact Hours Per Week	L	T	P	Total	Credit Points
	3	0	0	3	3

COURSE OUTCOMES:

By the end of the course the students will be able to

1. Analyze the effect of release of toxic substances
2. Understand the industrial laws, regulations and source models.
3. Apply the methods of prevention of fire and explosions.
4. Understand the advantages of preventive maintenance.
5. Understand the relief and its sizing methods.
6. Understand the methods of hazard identification and preventive measures.

MODULE I: 9L

Definition of safety, Hazard and Risk, Safety program, Inherent safety, Safety regulations, OSHA, Process safety management, mechanical and electrical hazards, types, causes and preventive steps/procedure, Hazards due to fire, Distinction between fire and explosion, Upper Flammability limit and Lower Flammability Limit, Fire Triangle, Fire prevention and firefighting, equipment and methods, Safety color codes..

MODULE II: 9L

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Service life of equipment. Tools for hazards identification: HAZOP, Fault Tree, Event Tree, FMEA, Wear and Corrosion and their prevention, Application of lubrication and different methods of lubrication, Types of corrosion, corrosion prevention methods.

MODULE III: 9L

Risk analysis concept and methodology: Risk concept and measure of risk, Risk acceptance criteria, Quantitative risk analysis, decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

MODULE IV: 9L

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

REFERENCE:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.
5. Chemical Process Safety: Fundamentals with Applications: D. A. Crowl and J.F.Louvar, Prentice Hall, 1990

Course Name :Business Analytics					
Course Code : CSEN6121					
Contact hours per week	L	T	P	Total	Credit Points
	3	0	0	3	

COURSE OUTCOMES:

1. Students will demonstrate knowledge of data analytics.
2. Understand and critically apply the concepts and methods of business analytics
3. Students will demonstrate the ability to use various techniques to support data driven business decision-making.
4. Student will demonstrate how to recognize trends, detect outliers, summarize data sets and analyze relationships between variables
5. Able to develop and test hypotheses
6. Initiate interest to learn various tools used in this area on his/her own.

MODULE I [8 L]

Introduction: Overview of Business analytics, Business analytics vs Business Analysis vs Data Science, Scope of Business analytics, Business Analytics Process, Organization structure needed for effective Analytics, Competitive advantages of Business Analytics, Data and models for Business analytics

Data Visualization : Summarizing Data (Mean, Mode, Variance, Standard Deviation, Skewness), Tools for Single variable (histogram), Tools for Pairs of variables (box plot, scatter plot, contour plot), Tools for Multiple variables. **Statistical Tools:** Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modeling, sampling and estimation methods overview.

MODULE II [10 L]

Types of Statistical Analysis: Descriptive type of statistical Analysis, Inferential Type of Statistical Analysis, Predictive Analytics, Perspective Analytics and its step in the business analytics Process, Causal Analysis, nonlinear Optimization.

Trendiness and Regression Analysis: Modeling Relationships and Trends in Data, simple Linear Regression.

Data Mining techniques: Classification, clustering, Association rules, Outer detection, Sequential Patterns used in business analytics.

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

MODULE III [10 L]

Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New- Product Development Model, News vendor Model, Overbooking Model, Cash Budget Model.

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

MODULE IV [8 L]

Recent Trends in Business Analytics: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Business Analytics Tool – R: Overview of R, Some basic coding syntax of R, Discuss some Modeling Techniques in Business Analytics with R for simple problems.

REFERENCE:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

	SUBJECT NAME: Advanced Artificial Intelligence				
	Paper Code: CSEN6122				
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

COURSE OUTCOMES:

After the completion of the course, the students will be able to:

1. Understand the building blocks of artificial intelligence, knowledge representation, reasoning, and machine learning techniques to real-world problems.
2. Formulate and solve problems with uncertain information using Bayesian approaches.
3. Learn supervised and unsupervised learning techniques and criteria of their performance assessment.
4. Employ fuzzy logic for development of artificial intelligent systems.
5. Familiar with AI search algorithms like genetic algorithms.
6. Develop artificial neural network model for different classification problems as well as understand basic of some of the more advanced topics of AI such as deep learning and convolutional neural network.

MODULE I – [9L]

Introduction to AI: Logic foundations of Artificial Intelligence, Constraint reasoning, Qualitative reasoning, Probabilistic reasoning- Bayesian probability, Steps of Bayesian problem solving, Naïve Bayesian Learning Model, Boosting of naïve Bayesian model- AdaBoost Algorithm.

MODULE II - [9L]

*Learning:*Supervised, Unsupervised and Reinforcement learning; Learning decision trees; Generalization and over fitting, Cross validation, Loss function, Regularization, Complexity versus goodness of fit.

Regression and classification with linear Models- Univariate linear regression, Multivariate linear regression, Linear classification with logistic regression; Perceptron Learning Algorithm (linear model), Adaline and Madaline; K-nearest neighbor model.

MODULE III - [9L]

*Emergent Intelligence:*Fuzzy expert systems- Fundamentals of Fuzzy sets, membership functions, Linguistic variables and hedges, operations on fuzzy sets, fuzzy rules, fuzzy inference, examples of building fuzzy expert system, fundamental issues with Fuzzy systems;

Evolutionary computation- Formal model of evolution system theory, Darwin's evolutionary algorithm, Classifier system; Genetic algorithm - basic principles of genetic algorithm, genetic operators, simple illustration of genetic algorithm with examples.

MODULE IV - [9L]

Neural Networks & Deep Learning: Introduction- Basic models of artificial neurons, activation functions, Simple perceptron, multilayer perceptron, Backpropagation learning algorithm, Applications of neural networks in classification and estimation.

Deep learning – Concepts of deep learning, deep networks, training of deep networks, applications of deep learning;

Convolutional neural network, recurrent neural network

REFERENCES:

1. Stuart J. Russell and Peter Norvig, *Artificial Intelligence A Modern Approach*, 3rd Edition, Pearson, 2016.
2. Toshinory Munakata, *Fundamentals of the New Artificial Intelligence- Neural, Evolutionary, Fuzzy and More*, Second Edition, Springer, 2008.
3. Richard E. Neapolitan, Xia Jiang, *Artificial Intelligence- With an Introduction to Machine Learning*, Second Edition, CRC Press, 2018.
4. Michael Negnevitsky, *Artificial Intelligence- A Guide to IntelligentSystems*, Addison-Wesley.
5. Neural Networks and Learning Machines, Simon Haykin, Third Edition, PHI Learning, 2009.
6. Y. S. Abu-Mostafa, M. Magdon-Ismail, H. T. Lin, Learning from Data A short Course, AMLbook.com.
7. J. Han and M. Kamber, Data Mining Concepts and Techniques, 3rd, Edition, Morgan Kaufmann Publishers, July 2011.

Course Title : AD HOC Networks and Uses					
Course Code : ECEN6121					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

COURSE OUTCOMES:

1. Students will develop the ability to apply knowledge of mathematics, science and engineering in the areas of communication engineering.
2. They will be able to analyze a situation and interpret a data in ad hoc networks.
3. Students will acquire knowledge to learn and apply modeling based approach through the extensive use of simulator tools.
4. Students will be able to compare and decide about different routes.
5. They will analyse the performance of routes.
6. Students will be able to understand and develop ability to participate in research work.

MODULE I: [10 L]

Ad hoc Network: Introduction, Basic concept on ad hoc network, static and mobile ad hoc network, transmitter- receiver constraints, Applications.

MAC protocol: Hidden terminal, Exposed terminal, IEEE802.11 in ad hoc mode.

Routing protocols: Proactive, Reactive and hybrid routing protocol, DSDV algorithm, Dynamic source routing, Ad hoc on-demand routing, Location aided routing, Link reversal routing.

MODULE II: [10L]

Analysis of TCP performance in wireless ad hoc network: TCP window management and problems, different solution schemes, QoS in wireless ad hoc network – analysis of degradation of receiver SNR, practical solutions.

Achieving energy efficiency in wireless ad hoc network: Different schemes to increase the lifetime of the node in ad hoc network – MAC layer protocol, Routing protocol.

MODULE III: [8 L]

Localization Management: Location acquisition technique, location sensing technique, location aware routing protocol. Primary and secondary source , Different principles like weighted centriod algorithm to locate sources. Security for wireless ad hoc network: Security goals, threats and challenges, Different schemes of security in ad hoc network, routing security. Spectrum utilization – Generic Access Network (GAN) and other methods, Hotspots and uses.

MODULE IV: [6 L]

Sensors- sensor networking, WSN, hardware and software platforms, OS for WSN, distributed sensor network, healthcare monitoring, environmental sensing, industrial monitoring, smart city concept.

REFERENCES

1. ”Ad Hoc Wireless Networks – Architectures and Protocols” - C.Siva Ram Murthy and B.S. Manoj – Pearson Education
2. Mobile Ad Hoc Networking – Stefano Basagni, Marco Conti, Silvia Giardano, Ivan Stojmenovic – Wiley India
3. Security and Quality of Service in Ad Hoc Wireless Networks – Amitabh Misra – Cambridge University Press

Course Title: **Design of Embedded Systems**					
Course Code: **ECEN 6122**					
Contact Hrs	L	T	P	Total	Credit Points
per week	**3**	0	0	**3**	**3**

COURSE OUTCOMES:

1. Students will learn Embedded System Design Methodology
2. Students will learn Embedded Processor Design
3. Students will learn 8051 Micro-Controller
4. Students will learn Embedded Memory and I/O Device interface
5. Students will learn Real time OS
6. Students will learn ARM Micro-Controller and PIC Micro-Controller

MODULE I: INTRODUCTION TO EMBEDDED SYSTEMS: [8L]

Embedded systems overview with various type of examples in different domains such as in communication systems, robotics application and in control application, Design challenge – optimizing design metrics, embedded processor technology, Difference between embedded computer systems and general purpose computer Systems, Design methodology.

MODULE II: EMBEDDED SYSTEM PROCESSOR DESIGN: [10L]

Custom single-purpose processors design: using finite state machine model and RTL model. Standard single- purpose processors design: Timers, and watchdog timers, LCD controller. Interfacing of Embedded Processors: Hardware protocol basics, interfacing with a generalpurpose processor, RS232, I2C, CAN protocol.

MODULE III: INTRODUCTION TO 8051 MICROCONTROLLER: [10L]

8051 architecture, pin configuration, I/O ports and Memory organization. Instruction set and basic assembly language programming. Interrupts, Timer/Counter and Serial Communication in 8051, Introduction to PIC and ARM micro-controllers.

MODULE IV: INTERFACING WITH MEMORY AND I/O DEVICES: [8L]

Different types of embedded memory devices and interfacing: SRAM, DRAM, EEPROM, FLASH, CACHE memory. Different types of I/O devices and interfacing: Keypad, LCD, VGA. Square wave and pulse wave generation, LED, A/D converter and D/A Converter interfacing to 8051.

TEXT BOOKS:

1. Embedded System Design: A Unified Hardware/Software Approach – 2nd Ed. by Ed Frank Vahid and Tony Givargis
2. Embedded Systems: A Contemporary Design Tool by James K. Peckol
3. Embedded / Real-Time Systems: Concepts, Design and Programming by K.V.K. Prasad
4. Embedded Systems by Raj Kamal

REFERENCE BOOK:

1. Computers as Components: Principles of Embedded Computing System Design – 2nd Ed. by Wayne Wolf.

Course Title : COGNITIVE RADIOS					
Course Code : ECEN6123					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

COURSE OUTCOMES:

The following outcomes are expected from the students after completion of the course –

1. An ability to apply knowledge of mathematics, science and engineering in the emerging areas of RF communication.
2. An ability to analyze a situation.
3. An ability to learn and apply modular approach.
4. An ability to understand research work in new areas of cognitive radios and spectrum hole sensing.
5. Development of a passion to pursue next generation wireless communication.
6. An ability to design intelligent radios for future.

MODULE I: [9 L] INTRODUCTION TO SOFTWARE DEFINED RADIO

Definitions and potential benefits, software radio architecture evolution, technology tradeoffs and architecture implications. Differences between software enable radio and software defined radio. Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules.

MODULE II: [9 L] COGNITIVE RADIO TECHNOLOGY

Introduction – Radio flexibility and capability – Aware – Adaptive – Comparison of Radio capabilities and Properties – Available Technologies – IEEE 802 Cognitive Radio related activities – Application, position awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques.

MODULE III: [10 L] COGNITIVE RADIO DESIGN AND CHALLENGES

Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture. Design Challenges associated with CR – Hardware requirements – Hidden primary user problem – detecting spread spectrum primary users – sensing duration and frequency – security

MODULE IV: [8 L] SPECTRUM SENSING

Spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design, applications of cognitive radios to optimize spectrum utilization, to reduce transmit power reduction and to improve data rate even in noisy conditions. Matched filter – waveform based sensing – cyclostationary based sensing – Energy detector based sensing – Radio Identifier – Cooperative sensing-other sensing methods.

REFERENCES:

1. Joseph Mitola III, "Software Radio Architecture: Object-Oriented Approaches to wireless system Engineering", John Wiley & Sons Ltd. 2000
2. Thomas W. Rondeau, Charles W. Bostain, "Artificial Intelligence in Wireless communication", ARTECH HOUSE. 2009.
3. Bruce A. Fette, "Cognitive Radio Technology", Elsevier, 2009.
4. Ian F. Akyildiz, Won- Yeol Lee, Mehmet C. Vuran, Shantidev Mohanty, "Next generation / dynamic spectrum access / cognitive radio wireless networks: A Survey" Elsevier Computer Networks, May 2006
5. Simon Haykin, "Cognitive Radio: Brain-Empowered Wireless Communication", IEEE Journal on selected areas in communications, Feb 2005.

Course Name: Automation in VLSI Design					
Course Code : ECEN6124					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

COURSE OUTCOME:

1. Students will understand MOS Transistor Based Digital VLSI Circuits
2. Students will understand Physical Layout Design of Digital VLSI Design
3. Students will understand VLSI Design Cycle
4. Students will learn Verilog HDL (Hardware Description Language)
5. Students will learn High level and Logic level Synthesis Algorithm
6. Students will learn Floorplan, Placement and Routing Algorithm

MODULE I: VLSI CIRCUITS AND PHYSICAL LAYOUT: [10L]

Unit 1: MOS Transistor Characteristics, MOS as Digital Switch, NMOS Logic Family, CMOS Logic Family, CMOS Inverter Characteristics (VTC), Inverter Delay, CMOS Gates like NAND and NOR gates, Pass Transistor Logic and Transmission Gate, CMOS Sequential Circuits, CMOS D-Latch and D-Flip-Flop

Unit 2: CMOS Cross Section, Layout and Mask layers, Inverter Layout, Lambda Rule vs Micron Rule, Std Cell Layout Topology, Stick Diagram, Euler Path Algorithm, Layout Legging.

MODULE II: VLSI DESIGN METHODOLOGY: [6L]

Unit1: Moore's Law, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI, GSI), Technology growth and process Node,

Unit2: Full Custom Design, Std Cell based Semi Custom Design, VLSI Design Cycle, Y-Chart.

MODULE III: EDA TOOLS: HIGH LEVEL SYNTHESIS AND HDL: [8L]

Unit 1: High level Synthesis EDA Flow, Control and Data Flow Graph, Scheduling, Allocation, Binding, RTL

Unit 2: Why HDL ? Frontend Design Flow using HDL (Behavioral, RTL and Gate Level), Verilog Modeling: Behavioral, Data-Flow, Structural and Mixed, Test Bench, FSM Example: Mealy Machine and Moore Machine. Pipeline Example.

MODULE IV: EDA TOOLS: LOGICAL SYNTHESIS AND PHYSICAL DESIGN AUTOMATION: [12L]

Unit 1: Combinational Logic Optimization: BDD: Binary Decision Diagram, OBDD, ROBDD, Technology Mapping: Pattern DAG, Subject DAG, Sequential Logic Optimization

Unit 2: Physical Layout Automation EDA Flow, Partitioning: KL Algorithm, Floor-planning cost function, Placement, Detailed Routing: Channel Routing, Horizontal Constraint Graph, Vertical Constraint Graph, Cyclic Constraint, Left-edge Algorithm, Global Routing: Steiner Tree, Maze Routing.

TEXT BOOK:

1. Principles of CMOS VLSI Design, A Systems Perspective, Author: Neil Weste, Kamran Eshraghian, Addison Wesley, 2nd Edition, 2000

2. Algorithms for VLSI Physical Design Automation, Author: N. Sherwani, KLUWER ACADEMIC PUBLISHERS (3rd edition)

REFERENCE BOOK:

1. CMOS Digital Integrated Circuits, Analysis and Design, Author: Sung-Mo Kang, Yusuf Leblebici, Tata McGraw Hill (3rd Edition), 2006
2. CMOS VLSI Design, A Circuits and Systems Perspective (3rd Edition) Author: Neil Weste, David Harris, Ayan Banerjee. Pearson, 2011
3. Digital Integrated Circuit, Design Perspective, Author: .M. Rabaey, Prentice-Hall
4. VLSI Design and EDA TOOLS, Author: Angsuman Sarkar, Swapnadip De, Chandan Kumar Sarkar, SCITECH PUBLICATIONS (India) Pvt. Ltd., 2011
5. Algorithms for VLSI Design Automation, Author: Gerez, Wiley, 2011

Subject Name: Information Theory and Coding					
Paper Code: INFO6123					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

COURSE OUTCOMES:

Students who complete the course will demonstrate the ability to do the followings.

1. Derive equations for entropy, mutual information and channel capacity for all types of channels.
2. Compare among different types of error correcting codes.
3. Evaluate the channel performance using Information theory.
4. Formulate the basic equations of linear block codes.
5. Apply convolution codes for performance analysis.
6. Design BCH code for Channel performance improvement.

Detailed Syllabus:

Module I: (9 L)

Entropy and Mutual Information: Entropy, Joint and Conditional Entropy, Relative Entropy and Mutual Information, Chain Rules, Fano's Inequality, Information measures for continuous random variables, Markov chains.

Source coding: Huffman coding, Kraft Inequality, Shannon-Fano Coding, Shannon-Fano-Elias Coding, Arithmetic Coding and Run length coding.

Channel Capacity: Channel models, Discrete memoryless channels, Shannon's noisy coding theorem, The Shannon limit.

MODULE II: (11 L)

Linear Block Codes: Design of linear block codes, introduction of linear block codes, Matrix description of linear block codes, parity check matrix, syndrome and error detection, minimum distance of a block code, error detecting and error correcting capability of a block code, design of encoder and syndrome decoder for linear block codes. Hamming codes.

Cyclic Codes: Polynomials, division algorithm for polynomials, a method for generating cyclic codes, matrix description of cyclic codes, generator and parity check polynomials, syndrome and error detection.

MODULE III : (8 L)

BCH Codes: Primitive elements, minimal polynomials, generator polynomials in terms of minimal polynomials, Error Syndrome,Error location polynomial,examples of BCH codes, Reed-Solomon Codes, Interleaved and Concatenated Codes.

MODULE IV : (8 L)

Convolutional Codes: Tree codes, trellis codes, polynomial description of convolutional codes, distance notions for convolutional codes, the generating function,

matrix representation of convolutional codes, decoding of convolutional codes – Viterbi Algorithm, distance and performance bounds for convolutional codes, Turbo codes, Turbo decoding.

REFERENCES:

1. Information theory, coding and cryptography - Ranjan Bose; TMH.
2. Information and Coding - N Abramson; McGraw Hill.
3. Elements of Information Theory - T. M. Cover and J. A. Thomas, John Wiley, New York.
4. Information Theory - R B Ash; Prentice Hall.

Subject Name: Optimization Techniques					
Paper Code: MATH6121					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

COURSE OUTCOMES:

Students who complete the course will demonstrate the ability to do the followings.

1. Describe the way of writing mathematical model for real-world optimization problems.
2. Identify Linear Programming Problems and their solution techniques
3. Categorize Transportation and Assignment problems
4. Apply the way in which Game Theoretic Models can be useful to a variety of real-world scenarios in economics and in other areas.
5. Convert practical situations into non-linear programming problems.
6. Solve unconstrained and constrained programming problems using analytical techniques.

MODULE I: LINEAR PROGRAMMING PROBLEM (LPP)-I (9L)

Formulation of an LPP; Graphical Method of solution of an LPP; Convex Combination and Convex Set; Convex Hull and Convex Polyhedron; Canonical and Standard form of an LPP; Basic Solution of a system of linear equations; Simplex Method; Big-M Method; Concept of Duality; Mathematical formulation of duals.

MODULE II: LINEAR PROGRAMMING PROBLEM (LPP)-II (9L)

Transportation Problems (TP) ; Representation of Transportation Problems as LPP; Methods of finding initial basic feasible solution of TP: North-West Corner Rule, Matrix Minima Method, Vogel's Approximation Method; Optimality test of the basic feasible solution; Assignment Problems; Hungarian Method.

MODULE III: GAME THEORY (9L)

Introduction; Strategies; The Minimax and Maximin Criterion; Existence of Saddle Point; Two person zero some Games; Games with saddle Point – Pure Strategies; Games without a Saddle Point – Mixed Strategies; Symmetric Games; Dominance Principle; Graphical Method of Solution; Algebraic Method of Solution.

MODULE IV: NON-LINEAR PROGRAMMING PROBLEM (NLPP) (9L)

Single-variable Optimization; Multivariate Optimization with no constraints: Semidefinite Case, Saddle Point; Multivariate Optimization with Equality Constraints: Method of Lagrange Multipliers; Multivariable Optimization with inequality constraints: Kuhn-Tucker Conditions.

SUGGESTED READINGS:

1. *Linear Programming and Game Theory* by J. G. Chakraborty and P. R. Ghosh, Moulik Library.
2. *Operations Research* by Kanti Swarup, P. K. Gupta and Man Mohan, S. Chand and Sons.
3. *Engineering Optimization* by S. S. Rao, New Age Techno Press.
4. *Operations Research by J K Sharma, Macmillan India Ltd*