SLIET LONGOWAL

2.2.4 - ELECTRONICS AND COMMUNICATION ENGINEERING (Ph.D. - ECE)

Course work Subject codes and subject names

SUB CODE	SUBJECT NAME
EC-10000	FUZZY LOGIC
EC-10001	DATA COMMUNICATION & NETWORK SECURITY
EC-10002	FUNDAMENTALS OF OFDM SYSTEMS
EC-10003	OPTICAL FIBER COMMUNICATION SYSTEMS
EC-10004	DIGITAL IMAGE PROCESSING
EC-10005	ELECTROMAGNETICS & ANTENNA SYSTEM ENGINEERING
EC-10006	VLSI TECHNOLOGY & DESIGN
EC-10007	FUNDAMENTALS OF WIRELESS COMMUNICATIONS
EC-10008	BIOELECTROMAGNETICS
EC-10009	FIBER AMPLIFIERS FOR OPTICAL COMMUNICATION
EC-10010	ADVANCED OPTICAL COMMUNICATION SYSTEMS & NETWORKS
EC-10011	WIRELESS SENSOR NETWORKS

2.2.4 - ELECTRONICS AND COMMUNICATION ENGINEERING (Ph.D. - ECE)

EC-10000 FUZZY LOGIC

L	T	P	CREDITS
3	1	4	4

Sessional Marks: 50 **End Semester Examination Marks: 50**

Unit-I **12 hrs**

Introduction to Fuzzy Systems:
Merits of Fuzzy systems. Introduction to Architecture of a Fuzzy systems, fuzzification, Rule Base ,Inference engine, defuzzification

Fuzzy Mathematics
Fuzzy sets and operations of fuzzy sets, properties of fuzzy sets, fuzzy relations, fuzzy graphs & Fuzzy arithmetic.

Unit-II **12 hrs**

Architecture and Design Issues
Fuzzification, Fuzzy Rule-base and Fuzzy Rule Based models – implication process, defuzzification Techniques.

Analog Design of Fuzzy Processors
Modular design, design of fuzzifier, knowedge base and inference engine, defuzzifier design.

Unit-III **12 hrs**

Fuzzy Model Identification
Structure Specifications, Parameter estimation, model validation.

Unit-IV **12 hrs**

Introduction to Soft Computing
Introduction to Neural Networks, Swarm Intelligence, Ant Colony Optimization and its algorithms, Applications to Fuzzy System Design.

Introduction to Type-2 Fuzzy Systems
Sources of Uncertainty, Type-2 membership functions, Operations and properties of Type-2 Fuzzy sets, Type Reduction Techniques, Type-2 Fuzzy Logic Systems and applications.

RECOMMENDED BOOKS

Title	Author	Publisher
Fuzzy Sets and Fuzzy Logic: Theory and Applications	George J. Klir and Bo Yuan	Prentice-Hall of India, New Delhi,1997
Fuzzy Logic: Intelligence, Control and Information	John Yen and Reza Langari	Prentice-Hall, New Jersey,1999
Uncertain Rule-Based Fuzzy Logic Systems	J.M.Mendel	Prentice-Hall, Upper-Saddle River, NJ, 2001
Neural Fuzzy Systems: Introduction and New Directions	Chin-Teng Lin & C.S. George Lee	Prentice-Hall International,1996

2.2.4 - ELECTRONICS AND COMMUNICATION ENGINEERING (Ph.D. - ECE)

EC-10001 DATA COMMUNICATION & NETWORK SECURITY

L	T	P	CREDITS
3	1	0	4

Sessional Marks: 50 **End Semester Examination Marks: 50**

Unit-I **12 hrs**

INTRODUCTION: Introduction to Data Communication & Network Security, Data representation, Components, Protocols & Standards, Network Models,OSI model, TCP/IP model, Data & Signals, Transmission Performance Parameters, Multiplexing, FDM, TDM, WDM, Transmission Media, Guided and Unguided, Circuit Switching, Packet Switching, Message Switching, Error Detection & Corection, Hamming Code.

Unit-II **12 hrs**

NETWORK SECURITY: Network Security Issues such as Impersonation, Security Services, Message Confidentiality, Message Integrity, Message Authentication, Message Non-repudiation, Digital Signature, IPSecurity, SSI/TLS, Virtual Private Networks and Firewalls.

WEB SECURITY: Web Servers, Secure Electronic Mail, Enhanced Email, Pretty Good Prvacy.

Unit-III **12 hrs**

CRYPTOGRAPHY: Security Goals, Attacks, Tupes of Cryptography, Linear Congruence, Chines Remainder Theoem, Symmetric Key Cryptography, Monoalphabetic Substitution Ciphers such as the Caesar Cipher, Cryptanalysis of Monoalphabetic ciphers, Polyalphabetic Ciphers such as Vigenere, Vernam Cipher, Transposition Ciphers, Asymmetric Key Cryptography, Encyption system, Introduction to Merkle-Hellman and Knapsacks, Rivets- Shamir-Adlman(RSA) Encryption, DES Standards.

Unit-IV **12 hrs**

STEGANOGRAPHY & WATERMARKING: Types of Steganography, Attacks on Steganography, Characteristics of Steganography, Blind and Non Blind Steganography, Reversible Steganography, LSB Substitution Techniques, Moderate Bit Substitution Method, Modern Application of Steganography, introduction to watermarking.

RECOMMENDED BOOKS

Title	Author	Publisher
Data Communication and Networking	Behrouz A Forouzan	TMH
Cryptography & Security	Behrouz A Forouzan	TMH
Principles of Cryptography	William Stallings	Pearson Education
Security in Computing	Charles P. Pfleeger	Prentice Hall
Cryptography & Network Security	Atul Kahate	TMH

2.2.4 - ELECTRONICS AND COMMUNICATION ENGINEERING (Ph.D. - ECE)

EC-10002 FUNDAMENTALS OF OFDM SYSTEMS

L	T	P	CREDITS
3	1	0	4

Sessional Marks: 50 **End Semester Examination Marks: 50**

Unit-I **12Hrs**

Introduction: OFDM, Broadband radio channel characteristics, Envelope fading, Time dispersive channel, frequency dispersive channel, statistical characteristics of broadband channels, canonical form of broadband transmission, OFDM realization.

Unit-II **12 hrs**

PHY layer issues: frequency synchronization, OFDM carrier offset data model, pilot based and non pilot based estimation, channel estimation, pilots for 2D OFDM channel estimation, 2D MMSE channel estimation, reduced complexity channel estimation, beamfoming, MIMO channels and capacity.

Unit-III **12 hrs**

Multiple Access Protocols: Basic MAC protocols, contention based and non-contention based MAC protocols, OFDM advantages, multiuser diversity.

Unit-IV **12 hrs**

OFDMA Design Considerations: OFDMA traffic channel, system model, channel configuration for fixed and mobile applications.

OFDM based Wireless systems: Digital broadcasting and DVB-T, Wireless LAN and IEEE 802.11, Wimax and IEEE 802.16.

RECOMMENDED BOOKS

Title	Author	Publisher
Wireless Communication and Networking	William Stallings	Pearson Education
Wireless Communication	Theodore S. Rappaport	Pearson Education
Computer networks	Andrew S. Tanenbaum	PHI
Computer networks and Network protocols	Darix	PHI

2.2.4 - ELECTRONICS AND COMMUNICATION ENGINEERING (Ph.D. - ECE)

EC-10003 OPTICAL FIBER COMMUNICATION SYSTEMS

L	T	P	CREDITS
3	1	0	4

Sessional Marks: 50 **End Semester Examination Marks: 50**

Unit-I **12 hrs**

Optical Communication Systems

Need for Fiber optic communications. Evoltion of Light wave systems. Optical Fibers as a communication channel (Block Diagram approach). The role of fiber optic communication technology.

Basic concepts of Optical Fibers

Concept of total internal reflection, Numerical aperture. Basic structure of optical fiber. Single and multimode fibers. Step index and graded index fibers.

Unit-II **12 hrs**

Fiber Losses

Attenuation in Opticalfibers. Bending losses. Absorption losses. Scattering and its types(Stimulated Brillioun Scattering, Stimulated Raman Scattering). Dispersion effects. Types of dispersion. Intermodal and chromatic dispersion. Four wave mixing.

Optical Transmitters

Basic concepts of light sources. L.E.D., its types. Surface emitter and edge emitter L.E.Ds. L.E.D characteristics. Semiconductor laser. Laser structure and its characteristics. Basic optical Transmitter.

Unit-III **12 hrs**

Optical Receivers

Basic concepts. Responsivity, rise time and band width, photodetector and its basic principle. Basic optical receiver.

Optical Amplifiers

Basic concepts. Need of optical amplifiers. Concept of population inversion. Spontaneous and stimulated emission. Erbium Doped fiber amplifiers. Gain spectrum of E.D.F.A. Raman amplifiers. Raman gain and bandwidth. Characteristics of Raman amplifiers.

Unit-IV **12 hrs**

WDM Systems

WDM light wave systems. Need of WDM components.(Multiplexers and de- multiplexers, star couplers, wavelength converter, WDM transmitters and receivers). Cross talk in WDM systems. Cross phase modulation and four wave mixing.

RECOMMENDED BOOKS

Title	Author	Publisher
Optical Fiber Communication	Gred Keiser	McGraw-Hill International Editions
Optical Fiber Communication	J.M.Senior	Pearson Education

2.2.4 - ELECTRONICS AND COMMUNICATION ENGINEERING (Ph.D. - ECE)

EC-10004 DIGITAL IMAGE PROCESSING

L	T	P	CREDITS
3	1	4	4

Sessional Marks: 50 **End Semester Examination Marks: 50**

Unit-I **12 hrs**

Introduction

Image formation in cameras and human eye, image formation in other (X-ray, tomography, MRI etc.), Continuous images are sampled and qunatized to get digital images, Digital images are two-dimentional signal data, Examples of digital image processing operations, Areas of applications (industrial, medical, defence, photo-editting), Related areas (computer version, graphics, image analysis, pattern recognition)

Digital image Fundamentals

Human visual system (HVS), Digital Image Sensors, Image Formation, Image Sampling and Quantization, Representation of Digital images as 2D arrays.

Unit-II **12 hrs**

Image Enhancement: Spatial domain techniques

Gray level transformation, Histogram transformation, Equalization, Mean, std, and median computation using histograms, Arithmatic/logic operations, Filtering through convolution, smoothing, noise reduction, derivatives, sharpening, de-blurring.

Image Enhancement: Fourier domain techniques

One-dimensional Fourier Transform, continous domain, discrete domain, Two-dimensional Fourier Transform, continous domain, discrete domain, Filtering, Properties of Fourier Transform.

Unit-III **12 hrs**

Image Restoration

Model of image degradation/restoration, Noise models (uniform and Gaussian), Linear shift- invariant degradations, OFT, MTF, PTF, PSF, LSF, ESF, Estimation of degradation OTF/PSF, Motion deblurring, Inverse filtering, Weiner Filtering, Geometric, transformations.

Colour Image Processing

Light spectrum, visible wavelengths, Colour models, Color image processing(Histogram specification and filtering)

Unit-IV **12 hrs**

Image Compression

Fundamentals ,Coding redundancy, Interpixel redundancy, Psycho-visual redundancy, Fidelity criteria, Image compression models, Source encoder and decoder, Channel encoder and decoder, Measuring information, Error-free compression, Huffman coding, Arithmatic, and LZW coding, Lossy

compression, Transform coding model, Discrete Cosine Transform, Bit allocation based on zonal and threshold coding, An Example: Sequential baseline JPEG, JPEG2000 and MPEG basics.

Image Reconstruction

Radon transform, Examples of projection data,(x-ray,emission, ultra sound tomography), Fourier slice theoem, Filtered back-projection, Algebraic reconstruction techniques.

RECOMMENDED BOOKS

Title	Author	Publisher
Digital Image Precessing,	R.C. Gonzalez & R.E. Woods,	Prentice-Hall,2002
Digital Image Precessing, Vol.1,	A.Rosenfeld and A.C.Kak,	Academic Press, 1982.
Digital Image Precessing,	Anil Jain	PHI

2.2.4 - ELECTRONICS AND COMMUNICATION ENGINEERING (Ph.D. - ECE)

EC-10005 ELECTROMAGNETICS & ANTENNA SYSTEM ENGINEERING

L	T	P	CREDITS
3	1	4	4

Sessional Marks: 50 **End Semester Examination Marks: 50**

Unit-I **12 hrs**

Introduction to Electromagnetics: Maxwells equations in various forms, Boundary conditions, Plane Wave propagation, Wave equation for free space, Polarization, Plane waves at interfaces, Reflection of waves at dielectrics and conductors, Poynting Theorem.

Unit-II **12 hrs**

Antenna Radiation: Introduction to antenna, retarded vector potential, radiation from small current element, near and far fiels approximations, Power radiated by current element and its radiation resistance, Radiation from half wave dipole, power radiation and its radiation resistance.

Antenna parmeters: Radiation pattern, Poynting theorem Power density, Radiation intensity, Antenna Gain, Directive Gain, Directivety, Antenna efficiency, Effective aperture, Effective length, radiation resistance, Antenna beam-width, Antenna band- width Noise temperature of antenna, Friis transmission formuls.

Unit-III **12 hrs**

Microstrip-antennas: Basic characteristics, Feeding methods, Rectangular patch antenna, Design of rectangular patch antenna, calculation of its resonant frequency, Circular patch antenna, its design and resonant frequency, Quality factor Bandwidth and efficiency. Introduction to various types of fractal antenna, advantages and applications of fractal antennas.

Unit-IV **12 hrs**

Antenna Arrays: Broad side array, End fire array, parasitic array, array of two point sources, Multiplication of pattern, Linear array of N isotropic point sources, Calculation of beamwidth of major lobe, dipole and folded dipole antenna, Yagi Uda antenna and its design.

Microwave Antennas: Antennas with parabolic reflectors and their feed systems, Slot antenna, various types of Horn antennas and its design.

RECOMMENDED BOOKS

Title	Author	Publisher
Antenna Theoy	Constantine A. Balanies	Johan Wiley &Sons(ASIA).
Antenna and wave Propagation	K.D. Parsad	Satya Parkashan, New Delhi
Antennas for all applications	Johan D Kraus	Tata McGraw- Hill.
Antenna theory and Practice	Chatterjee R	New Age International

2.2.4 - ELECTRONICS AND COMMUNICATION ENGINEERING (Ph.D. - ECE)

EC-10006 VLSI TECHNOLOGY & DESIGN

L	T	P	CREDITS
3	1	0	4

Sessional Marks: 50 **End Semester Examination Marks: 50**

Unit-I **12 hrs**

Introduction: Monolithic Integrated Circuit technology, Bipolar & MOS IC, Film IC, Silicon Wafer Preparation & characterization, thermal oxidation, oxide thickness measurement, oxidation system, diffusion of dopants, diffusion equations, dopant profiles, sheet resistance, diffusion furnace, liquid and gaseous dopants, ion implantation techniques, apparatus used, epitaxial growth of silicon, apparatus for epitaxy, photolithography techniques for pattern transfer, mask masking, photo resist & etching techniques, film deposition, vacuum deposition & sputtering apparatus, CVD processes and its applications in IC lab, metallization.

Unit-II **12 hrs**

MOS transistor : MOS structure, MOS/IGFET devices, MOS system under external bias, structure & operation of MOSFET, enhancement mode and depletion mode devices, I-V characteristics, MOSFET scaling & small geometry effects, CMOS bias circuits, MOS inverters, static & dynamic characteristics, NAND, NOR, AOI circuits, design considerations, layout design, micron & submicron technologies, parasitic effects, physical limitations, concepts of SPICE for circuit simulation.

Unit-III **12 hrs**

Standard Digital ICs: Combinational & Sequential MOS logic circuits, design of standard cells for LSI, VLSI circuits, computer – aided design technology, semiconductor memories, DRAM, SRAM, Flash.

Unit-III **12 hrs**

Programmable logic devices: PLA, PAL, PLD/CPLD, PGA/CPGA, ASIC, VLSI testing.

RECOMMENDED BOOKS

Title	Author	Publisher
VLSI Technology	S.M.Sze (Ed.)	McGraw Hill
Basic VLSI Design	D.A.Pucknell & Eshraghian	PHI
Modern VLSI Design Systems on Silicon	Wayne Wolf	Pearson
Publication VLSI fabrication principles, 2nd	S Gandhi	John Wiley
The Science & Engineering of Microelectronics Fabrication	S.A. Campbell	Oxford
Introduction to Digital Microelectronics Circuits	K.Gopalan	TMH
Microelectronic circuits, *international Student Edition*	Sedra/Smith	Oxford
Microelectronics	Millman & Grabel	McGraw Hill

2.2.4 - ELECTRONICS AND COMMUNICATION ENGINEERING (Ph.D. - ECE)

EC-10007 FUNDAMENTALS OF WIRELESS COMMUNICATIONS

L	T	P	CREDITS
3	1	0	4

Sessional Marks: 50 **End Semester Examination Marks: 50**

Unit-I **12hrs**

Radio Channel Characteristics: transmission bands and their characteristics, radio channels, channel modeling, channel fade statistics, Inter -Symbol (ISI) and inter- channel interference (ICI).

Unit-II **12hrs**

Modulation Techniques for Wireless Systems: Analog Modulation, Digital Modulation, ASK, FSK, PSK, DPSK, QAM.

Multiple Access for Wireless Systems: FDMA, TDMA, CDMA

Unit-III **12hrs**

Performance Increasing Techniques for Wireless Networks: Diversity Techniques, Coding, Equalization, Power Control, Multi- sub carrier modulation.

Unit-IV **12hrs**

Cellular Concept: Different generations of cellular systems, IMT-2000, WCDMA and CDMA 2000.
Wireless Systems: WLL, WLAN and WiMax.

RECOMMENDED BOOKS

Title	Author	Publisher
Wireless networks	P. Nicopolitidis M. S. Obaldat G. I. Papadimitriou A.S.Pomportsis	John Wiley & Sons
Wireless communications : Principles & practice	T. S. Rappaport	Prentice – Hall

2.2.4 - ELECTRONICS AND COMMUNICATION ENGINEERING (Ph.D. - ECE)

EC-10008 BIOELECTROMAGNETICS

L	T	P	CREDITS
3	1	0	4

Sessional Marks: 50 **End Semester Examination Marks: 50**

Unit-I **12hrs**

Introduction to biomedical systems:

Introduction to cardiovascular system, nervous system, respiratory system, digestive system & urinary system.

Unit-II **12hrs**

Biomedical instruments:

Bioelectric signals and electrodes, electrocardiograph (ECG), electroencephalograph (EEG), electromyography (EMG), phonocardiograph (PCG), pacemaker, defibrillator and patient monitoring system.

Unit-III **12hrs**

Basics of electromagnetics:

Static electric field, electric field intensity, electric solar potential, charge density, coulombs law, gauss law, static magnetic field, magnetic flux density, amperes law, time varying fields, faraday's laws, Maxwell equations from faraday's laws, displacement current, Maxwell's equations from amperes law, free space, Maxwell equations for free space, boundary equations, plane wave propagation, wave equations for free space.

Unit-IV **12hrs**

Antennas:

Basic antenna parameters- radiation parameters, antenna beam area, antenna beam width, radiation intensity, gain, directive gain, power gain, directivity(D), antenna bandwidth, radiation resistance, front to back ratio, hatz dipole antenna, monopole radiators, loop antenna, folded dipole antenna, parabolic reflector, helical antenna, horn antenna, slot antenna.

RECOMMENDED BOOKS

Title	Author	Publisher
Antenna theory	Constantine A. Balanies	John Wiley & Sons Antennas
for all applications	John D Kraus	Tata McGraw Hill Anatomy &
physiology	Ross & Wilson	Churchil Livingstone
Biomedical instrumentation & measurement	Cromwell	Prentice Hall

2.2.4 - ELECTRONICS AND COMMUNICATION ENGINEERING (Ph.D. - ECE)

EC-10009 FIBER AMPLIFIERS FOR OPTICAL COMMUNICATION

L	T	P	CREDITS
3	1	0	4

Sessional Marks: 50 **End Semester Examination Marks: 50**

Unit-I **12hrs**

Non linear effects in optical fibers:

Concepts of scattering, elastic and inelastic scattering, simulated brillioun scattering and stimulated Raman scattering, basics of Raman amplification, comparison of Raman amplifiers with EDFA amplifiers.

Basic concepts of Raman amplifiers:

Advantages of Raman amplification (noise figure & improved gain flatness), concerns in Raman amplification (multi path interference, pump noise transfer to the signal), advance concepts of pumping in Raman amplifiers, pimp sources.

Unit-II **12hrs**

Theory of Raman amplifiers:

Pump and signal equations, Raman gain spectrum, co propagating & counter propagating pump arrangements, single pump and multi pump Raman amplification, effects of polarization mode dispersion in Raman amplifiers.

Unit-III **12hrs**

Distributed Raman amplifiers

Benefits of Distributed Raman amplification (upgradability, noise improvements and band width flatness), characteristics of Distributed Raman amplifiers, noise properties of Distributed Raman amplifiers, wavelength multiplexing of pumps in Distributed amplifiers.

Unit-IV **12hrs**

System Impairments:

Introduction, pump noise transfer to the signal, concept of relative intensity noise (RIN), measurements of RIN transfer, Multipath interference penalties, basic concepts, measurement of DRS noise, MPI suppression.

RECOMMENDED BOOKS

Title	Author	Publisher
Raman Amplification in Fiber Optical Communication Systems	C. Hddley & G.P.Aggarwal	Academic Press, USA

2.2.4 - ELECTRONICS AND COMMUNICATION ENGINEERING (Ph.D. - ECE)

EC-10010 ADVANCED OPTICAL COMMUNICATION SYSTEMS & NETWORKS

L	T	P	CREDITS
3	1	0	4

Sessional Marks: 50 **End Semester Examination Marks: 50**

Unit-I **12 hrs**

OPTICAL AMPLIFIERS:

Basic concepts, need of optical amplifiers, concept of population inversion, spontaneous & stimulated emission, erbium doped fiber amplifiers, gain spectrum of EDFA, Raman amplifiers, Raman gain & bandwidth, characteristics of Raman amplifiers, advantages of Raman amplification (noise figure & improved gain flatness), concerns in Raman amplification (multi path interference, pump noise transfer to the signal), advance concepts of pumping in Raman amplifiers, pump sources.

Unit-II **12 hrs**

ULTRA FAST COMMUNICATIONS :

WDM light wave systems, need of WDM, WDM components, (multiplexers & demultiplexers, star couplers, wavelength converter, WDM transmitters & receivers), cross talk in WDM systems. Cross phase modulation & four wave mixing, optical signal processing, optical computing, security in fast communications.

Unit-III **12 hrs**

SYSTEM IMPAIRMENTS:

Attenuation in optical fibers, bending losses, absorption losses, elastic & inelastic scattering, stimulated brillioun scattering and stimulated Raman scattering, non linearities in raman amplification, non linear distortion comparison in raman amplifiers & EDFA amplifiers, dispersion effects, types of dispersion, intermodal & chromatic dispersion, four wave mixing in fiber and optical devices.

Unit-IV **12 hrs**

OPTICAL GENERATION & RECEPTION:

Basic concepts of light sources, LED & its types, surface emitter and edge emitter LEDs, LED characteristics, semiconductor lasers, laser structure & its characteristics, basic optical transmitter, basic concepts, Responsivity, rise time & band width, photo detectors (PIN, APD) & its basic principles, basic optical receiver, analog optical generation & reception, digital optical generation & reception.

RECOMMENDED BOOKS

Title	Author	Publisher
Raman Amplification in Fiber Optical Communication Systems	C.Headley & G.P.Aggarwal	Academic Press, USA.
Optical Fiber Communication	Gerd Keiser	McGraw-Hill
Fiber Optical Communication	G.P.Aggarwal	John Wiley

2.2.4 - ELECTRONICS AND COMMUNICATION ENGINEERING (Ph.D. - ECE)

E10011 WIRELESS SENSOR NETWORKS

L	T	P	CREDITS
3	1	0	4

Sessional Marks: 50 **End Semester Examination Marks: 50**

Unit-I **12 hrs**

ADHOC WIRELESS

Introduction, mobile Ad hoc networks, technologies for Ad hoc networks, issues in Ad hoc wireless networks, IEEE802.11 architecture and protocols, protocol for Ad hoc wireless networks.

Issues & classification of MAC protocol, other MAC protocols, dynamic source routing (DBR), Ad hoc distance vector (AoDV) routing, routing protocols, multicasting routing issues.

Unit-II **12 hrs**

TRANSPORT LAYER & SECURITY PROTOCOLS

Issues in designing transport layer protocols, TCP over Ad hoc wireless networks, network security attacks & key management.

Unit-III **12 hrs**

WIRE SENSOR NETWORKS

Basic sensor network architectural elements, applications of sensor networks, comparison with Ad hoc wireless networks, challenges & hurdles, architecture of WSNs , hardware components, operating systems & execution environments, some examples of sensor nodes, network architecture, sensor networks scenarios, optimization goals & figures of merit, design principles for WSNs.

Unit-IV **12 hrs**

COMMUNICATION PROTOCOLS

Physical layer & trans receiver design considerations in WSNs, fundamentals of (wireless) MAC protocol, address & name management in wireless sensor networks, localization & positioning.

Routing protocols data dissemination & gathering, routing challenges & design issues in wireless, routing strategies in wireless sensor networks, QoS in wireless sensor networks, coverage & deployment

RECOMMENDED BOOKS

Title	Author	Publisher
Ad hoc wireless networks: Architectures & protocols&	B.S.Manoj C.Siva Ram Murty	2nd Ed Pearson education
Fundamentals of mobile & pervasive computing	Adleshein & Gupta	TMH,2005
Wireless sensor networks Technology protocols & applications	Kazem Sohraby, Daniel Minoli,Taieb Znati,	John Wiley & Sons