MEDC – 101 Advanced Mathematics

UNIT I

Solution of Partial Differential Equation (PDE) by separation of variable method, numerical solution of PDE (Laplace, Poisson's, Parabola) using finite difference methods, Elementary properties of FT, DFT, WFT, Wavelet transform, Haar transform.

UNIT II

Probability, compound probability and discrete random variable. Binomial, Normal, Poisson's distribution. Sampling distribution, elementary concept of estimation and theory of hypothesis,recurred relations.

UNIT III

Stochastic process, Markov process transition probability transition probability matrix, just and higher order Markov process, Markov chain. Queuing system, transient and steady state, traffic intensity, distribution queuing system, concepts of queuing models (M/M/1: Infinity/ Infinity/ FC FS), (M/M/1: N/ Infinity/ FC FS), (M/M/S: Infinity/ Infinity/ FC FS).

UNIT IV

Operations of fuzzy sets, fuzzy arithmetic & relations, fuzzy relation equations, fuzzy logics.MATLAB introduction, programming in MATLAB scripts, functions and their application.

UNIT V

Introduction and definition of reliability, derivation of reliability functions, Failure rate, Hazard rate, mean time t future & their relations, concepts of fault tolerant analysis, Elementary idea about decision theory and goal programming.

Reference Books:

1. Higher Engineering Mathematics by B.V. Ramana, Tata Mc Hill.
2. Advance Engineering Mathematics by Ervin Kreszig, Wiley Easten Edd.
3. Applied Numerical Methods with MATLAB by Steven C chapra, Tata Mc Graw Hill.
4. Introductory Methods of Numerical Analysis by S.S. Shastry,
5. Introduction of Numerical Analysis by Forberg
6. Numerical Solution of Differential Equation by M. K. Jain
7. Numerical Mathematical Analysis By James B. Scarborogh
8. Fourier Transforms by J. N. Sheddon
9. Fuzzy Logic in Engineering by T. J. Ross
10. Fuzzy Sets Theory & its Applications by H. J. Zimmersoms

MEDC – 102 MICRO CONTROLLER SYSTEM DESIGN

Unit 1
Review of 8-Bit and 16-bit microprocessor, support chips and interfacing techniques, single chip micro-computers, architecture, program and data memory, ports, input Output interfacing and programming,

Unit2
Single chip micro controllers- INTEL 8051/ 8751, MOTOROLA 68HC0/68HC11 architecture,instruction set and programming, Memory mapping, addressing modes, Registers, expanded modes. Interrupt handling timing and serial I / O.

Unit3
Software development Modular approach, integrated software development environment, Object oriented interfacing and programming, Recursion and debugging.

Unit 4
ATMEL 89C51 / 52 and PIC micro-Controllers- Case studies.Design and application of Micro-Controller in Data acquisition, Embedded controllers, Process control etc.

Unit 5
DSP Processor architecture and sample design using TI – DSP.

Reference Books:
1. Embedded Systems 8051 By Majidi & Majidi
2. Design With Micro-Controllers By John P. Peatman Tmh
3. Embedded Micro-Computers System By Jonathan W. Valvano
4. Data Manuals – Intel Motorola

MEDC – 103 DSP APPLICATION

Unit 1

Review of Discrete time signals: sequences, representation. Discrete time systems: linear, time in variant, LTI systems, properties, and constant coefficients difference equations. Frequency Domain representation of discrete time signals and systems

Unit 2

Review of Z Transform – Properties, ROC, Stability, Causality, Criterion. Inverse Z Transform, Recursive and Non Recursive systems, Realization of discrete time system

Unit 3

DFT: Properties, Linear and Circular convolution, Discrete Cosine Transform, Relationship between DFT and DCT. Computation of DFT: FFT/Decimation in Time and Decimation in Frequency

Unit 4

FIR and IIR systems: Basic structure of FIR and IIR, Bilinear Transformation, Design of Discrete time IIR filter-Butterworth , Chebychev , Inverse Chebychev , Elliptic etc. Design of FIR filters by windowing – Rectangular, Bartlett, Hann, Hamming, Kaiser, Window filter,Design method relationship of Kaiser to other window. Application of MATLAB for Design of Digital filter. Effect of Finite register length in filter Design

Unit5

Discrete time Random signals: Discrete time random process, Averages, Spectrum Representation of finite energy signals, response of linear systems to random signals. Power spectrum estimation: Basic principals of spectrum estimation, estimate of auto con variance, power spectrum ,cross con variance and cross spectrum.

Advance signal processing technique and transforms: multi rate signal processing- down sampling/up sampling, introduction to discrete Hilberts Transform, Wavelet Transform, Haar Transform etc.

Reference Books:

1. Discreate time signal Processing by Opperenheim & Schaffer PHI 2nd Edition
2. Digital Signal Processing using MATLAB by S.Mitra
3 Digital Signal Processing By Proakis Pearson Education
4. Theory & application of Digital Signal Processing by L.R.Rabiner & B. Gold PHI

MEDC – 104 VLSI DESIGN

Unit1
Introduction: Basic concept of integrated circuits and manufacturing, Design fundamental for digital CMOS circuits, Design Abstraction and circuit Validation.

Unit2
CMOS circuit and Logic Design: CMOS Logic gate design, Basic Physical design, CMOS Logic structure, I /O Structure, Power and Delay consideration.

Unit 3
System Design: CMOS Chip Design, standard cells, Programmable gate array, Design Capture, Simulation and Verification.

Unit 4
Subsystem Design: Data Operation, CMOS Sub System Design, Memory and Control Strategies, PLA and ROM Implementation

Unit 5
CAD system and Algorithms: CAD systems, Layout Analysis, Placement and Routing Algorithms, Timing Analysis, Optimization, Logic Synthesis and Simulation, Testability Issues.

Reference Books:
1. Principal Of Cmos Design: A System Prospective By Waste
And Eshraghin
2. Vlsi Design: System On Silicon, Pearson Education
3 Vlsi Technology By Sze S.M. Tmh
4 Basic Vlsi Design, System And Circuits By Pucknil D.A. Phi
5 Vhdl Primer By Bhaskar Star Galax Pub.

MEDC-105 WIRELESS ADHOC NETWORK

Module – 1:

Wireless Communication Systems & Standards:
Evolution of Mobile Radio Communications, Different generations (1G to 4G) of Cellular Networks, GSM, UMTS, GPRS, EDGE, Cellular telephone systems, WLAN, WLL, Bluetooth, PAN. (5)

Text Books:

1. "Wireless Communications: Principles and Practice" by T. S. Rappaport, Prentice Hall.
2. "Wireless Communication Technology" by Roy Blake, Thomson – Delmar.

Module – 2:

Propagation & Fading:
Propagation path loss, Free-space propagation model, Outdoor propagation models (Okumura model & Hata model), Indoor propagation models (Partition Losses in the same floor and between floors), Multipath fading, time dispersive and frequency dispersive channels, delay spread and coherence bandwidth, LCR and ADF. (8)
Text Books:

1. "Wireless Communication: Principles & Practice" by T.S. Rappaport, Prenctice Hall.
2. "Mobile Cellular Telecommunications Systems" by W. C. Y. Lee.

Module – 3:

Diversity & Combining Techniques:
Diversity Schemes (Space, frequency, field and polarization diversities) and combining techniques. (4)

Text Book:

"Wireless Communications: Principles and Practice" by T.S. Rappaport, Prentice Hall.

Module – 4:

Mobile Radio Interferences & System Capacity:
Co-channel Interference and System Capacity, Channel planning for Wireless Systems, Adjacent channel interferences, Power control for reducing interference, Near-end-to-far-end interference, Inter-symbol and Simulcast interference, False alarm rate and word error rate. (6)

Module-5:

The Cellular Concept-System Design Fundamentals: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies- Prioritizing Handoffs, Practical Handoff Considerations,Interference and system capacity – Co channel Interference and system capacity, Channel planning for Wireless Systems, Adjacent Channel interference , Power Control for Reducing interference,Trunking and Grade of Service, Improving Coverage & Capacity in Cellular Systems- Cell Splitting,Sectoring .

MEDC – 201 System Programming

Unit 1

Fundamental of programming, steps in problem solving with digital computer algorithm, flow chart and textual representation, primitive actions, control construct like conditional, iteration,conditional repetition, recursion, programming with Pascal of C

UNIT2

Data & Data types, data representation, data structure array-various operations with array,concept of pointers and pointers manipulations, pointers for data structures and functions, static and dynamic allocations, implementations with arrays and pointers, various operations like searching, appending,insertion & deletion in lists, doubly linked list and their implementations, stack,PUSH/POP &TOP of stack operation, applications of stacks, queues & various operations on queues, tree, binary and K-ary trees, tree traversal, insertion and deletion in tree, B-tree and AVL tree, operations on those tree applications

Unit 3

Searching and sorting, linear, binary and Hash search, minimum and maximum selection, divide and conquer, sorting, insertion sort, bubble sort, quick sort & heap sort, matrix operations,dynamic programming

Unit 4

Overview of system programs, Assembler, interpreter, compiler, Editor and operating system.

Reference books: -

1.Data structure & Program design by Kruze, PHI
2.Algorithms,Data structure & programs by Wirth N., PHI
3.The programming language by Kernighan & Ritchi, PHI
4.Introductory problem solving by pascal by Schieder,John Wiley

MEDC – 202 Modelling and Simulation of Computer

Unit 1

Induction to Discrete event system simulation, its applications, advantages and advantages, system and system, environments and component of system, Discreate and Homogeneous system,modeling of system and type of models, Various steps in simulation, General concept in discrete event simulation.

Unit 2

Practical models in simulation: review of terminology and concepts, useful statistical models,discrete distributions, continuous distributions, Possion process and empirical distribution.

Unit 3

Queuing model: Characteristics of queuing system transient and steady state behavior of queue, measures of performance using queuing systems property.

Unit 4

Random number and its generation: Properties of random numbers, distribution of pseudo random no, test for random no., Random variant Distribution, inverse transform technique, Direct transformation for normal distribution, Acceptance and rejection technique.Modeling: Data Collection, identifying the distribution with data, parameter variation, goodness of fit tests, selection of input model without data, multivariate and input models.

Unit 5

Introduction and validation of simulation models: output analysis for single model, nature of output data, types of simulation with respect to output analysis, types of performance and their estimation, output analysis for terminating simulations, analysis for terminating simulation.

Reference Books:

1. Simulation Modeling and Analysis by
2. Modeling and simulation by Bank and Carson PHI
3. Network Modeling, simulation and analysis by Garcia and Garcia
4. Telecommunication Network: Protocols, Modeling and Analysis By M. Schwartz

MEDC – 203 Network Design Technology

Unit 1
Review of concepts of Layering and Layered models- OSI & TCP/IP LAN Technology, transmission Medium, Topology, Medium Access Control (MAC) Techniques including MAC& LLC sub layers,

Unit 2
LAN system, Ethernet system, Fast Ethernet& Gigabit Ethernet, Token Ring, FDDI Internet working with TCP/IP, Internet Protocol (IP) Suite including IP V4, IP V6 Transport Protocols, TCP and UDP

Unit 3
Introduction to IP routing, various interior gateways protocols like RIP, OSPF and exterior gateway protocols like BGP

Unit 4
Introduction to label Switching and MPLS WAN technology: WAN Vs LAN, Circuit switching mechanism and network design, packet switched networking including routing and traffic control, X.25 ISDN and Broadband ISDN: Overview, ISDN, interface and functions, layers and ISDN services- ISDN standards and services
High Speed network frame relay, frame relay protocols, services and congestion control,

Unit 5
ATM: ATM adaptation layer (AAL), ATM traffic and congestion control ATM LAN, ATM LAN emulation and multi protocols over ATM (MPOA)

Reference Books.
1. Redia Pearlman, Interconnections, bridges, routers, switches and Int protocols Pearson Edu
2. Comer, Internetworking with TCP/IP Vol. I PHI
3. Tenenbaum, Computer Networks, PHI
4. Forouzan B, Data communication and networking, TMH.
5. Stalling W, Data and computer communications, PHI
6. Hardy, Inside networks, PHI
7. Glover and Grant, Digital Communication, PHI

MEDC – 204 Optical Network

Unit 1
Introduction to optical network: Telecommunication, first generation optical network,multiplexing technique, second generation optical network,virtual circuit services and data gram,transparencies of regenerator

Unit 2
Network components: couplers, Isolators, Circulators, Multiplexer , filter, fiber bragg gratings as ADD/Drop multiplexers, frabry perot filters, acoustics optical tunable filters, characterization of switches, mechanical, electro-optic, thermo-optic, and SOA switches, switching architecture.

Unit 3
First generation of optical network: SONET, SDH, goals of SONET design , Multiplexing in SONET,elements of SONET/SDH infrastructure, SONET physical layer,comuter interconnections,ESCON, fiber channel, FDDI,ATM,IP layered architecture , physical layer, data link layer, network layer, transport layer

Unit 4
Broad cast and select network: topologies for broadcast networks, bus topology, star topology,media access control(MAC) protocols, throughput calculation, synchronization, aloha and slotted ALOHA, test beds,LAMBDANET,rainbow,starnet

Unit 5
Wavelength routing network: optical layer, wavelength cross connect, wavelength reuse reliability, virtual topology and circuit switching and node design, degree of wavelength conversion, network design and operation traffic models, and performance criteria, static and reconfigurable network, classification of light paths

Unit 6
Photonic packet switching ,optical time domain multiplexing(OTDM),Method of multiplexing and demultiplexing, Broadcast ,OTDM network ,bit interleaving and packet interleaving, optical and gates non linear optical loop mirror, tera hertz optical asymmetric demultiplexer, switch based network, deflection routing

Referance Books:
1. Optical Networks: Apractical Prospective By R.Ramaswamy and K.N.Shivrajan
2. Optical Networks By C.S.R.Murthy and M.Guruswamy, PHI
3. Computer Networks By Tanenbaum

MEDC – 205 Mobile & Satellite Communication

Unit 1

Review of wireless and cellular radio communication: The cellular concept, system design fundamentals, frequency reuse, reused distance, cluster size, channel assignment strategies,handoff strategies, co-channel interference and system capacity, trunking and grade of service.

Unit 2

Speech coding for wireless system applications and broadcast systems, coding techniques for audio and voice and popular speech codes. Brief introduction to radio channel characterization,multi-path propagation, co channel interference, exponential power delay profile, propagation effects, scattering, ground reflection, fading, long normal shadowing, coherence bandwidth

Unit 3

Modulation techniques for mobile and satellite communication, their generation and detection, performance of spectral and power efficiency. Physical layer technique, diversity,spread, spectrum, frequency hopping, direct sequence, adaptive equalization, Orthogonal Frequency Division Multiplexing (OFDM)

Unit 4

MAC Protocols; 802.11 and its variants, ETSI-HILARAN type 1 MAC protocol, multiple access with collision avoidance.

Unit 5

Introduction to GEO, MEO and LEO satellite systems, Antena positioning in GEO and Link calculations, wideband CDMA concepts principles.

Reference Books.

1. Wilkies and Garg, Principles of GSM technology, PHI
2. Schiller J., Mobile Communications, Addison Wesley
3. Viterbi A, CDMA, Addison Wesley
4. Gokhle, Introduction to Telecommunications, Delmer Thomson

MEDC – 301(A) Information Theory & Coding

Unit 1

Introduction to uncertainty, information, entropy and its properties, entropy of binary memory less source and its extension to discrete memory less source, coding theorem, data compression, prefix coding, HUFFMAN coding, Lempel-Ziv Coding.

Unit 2

Discrete memory less channels, Binary symmetric channel, mutual information & its properties,channel capacity, channel coding theorem, and its application to BSC, Shannon's theorem on channel capacity, capacity of channel of infinite bandwidth, Bandwidth signal to noise Trade off, Practical communication system in light of shannon's theorem, Fading Channel.

Unit 3

Group and field of Binary system Galois field and its construction in GF (2 m) and its basic properties,vector spaces and matrices in GF(2), Linear Block Codes, Systematic codes, and its encoding circuits, syndrome and error detection ,minimum distance, error detecting and correcting capabilities of block code, Decoding circuits, Probability of undetected error for linear block code in BSC ,Hamming code and their applications.

Unit 4

Cyclic codes and its basic properties, Generator & parity check matrix of cyclic codes, encoding & decoding circuits, syndrome computation & error detection, cyclic Hamming codes.

Unit 5

Introduction to BCH codes, its encoding & decoding, error location & correction.Introduction to convolution codes, its construction & viterbi algorithm for maximum likelihood decoding.

Reference Books:

1. Digital Communication by Haykins Simon Wiley Publ.
2. Error control Coding: Theory and Application, by Shu Lin and Cosstlello,PHI
3. Modern analog and Digital Communication system, by B.P. Lathi
4. Digital Communication by Sklar, Pearson Education
5. Principal of Communication system by Taub & Schilling, TMH
6. Error Correcting Codes by Peterson W., MIT Press
7. Digital Communication by Carson,MGH
8. Digital Communication by Proakis,TMH

MEDC – 302(A) Advanced Digital Communication

Unit 1

Introduction to digital modulation technique and their spectral characteristics, optimum receivers for signals corrupted by AWGN and their performance for memory less channel, optimum receivers for PCM, regenerative repeaters and link budget analysis.

Unit 2

Estimation of signal parameters, carrier phase and symbol timings.Signal design band limited channels and their characterization, probability of error in detection PAM with zero ISI, modulation codes for spectrum spacing.

Unit 3

Optimum receivers for channels with ISI and AWGN, linear equalization and decision feed back equalization, adaptive linear and adaptive decision feed back equalizer.

Unit 4

Multi channel and multi carrier systems, spread spectrum signals for digital communication, direct sequence spread spectrum signals and frequency hopped spread spectrum signals and their performances, OFDM.

Unit5

Characterization of fading multi path channels, frequency non-selective slowly padding channels,diversity techniques for padding multi path channels, coded waveform for padding channels and their application.

REFERENCE BOOKS:

Digital Communication by Proakis TMH
Digital Communication by Glover and Grantt PHI
Digital Communication by Simon Haykins

MEDC – 302(B) Optical Instrumentation & Measurement

Unit 1

Optical Instrument: Optical Time Domain Reflector, Optical low Coherence Reflect meter, Optical Spectrum Analyzer Optical power and energy meter, Monochrometer, CCD, Ellipsometer,transducer, Lock in Amplifier, Box car Average.

Unit 2

Fiber Optics Component and Devices: Direction Couplers, beam splitters, switches, modulations,connectors, couplers, polarizer, polarization controllers, amplifiers, fiber laser, reflector, wavelength filters, polarizing beam splitter, wavelength division multiplexes, fiber optic isolator etc.

Unit 3

Fiber optic sensors: Pressure, temperature, strain, Magnetic & Electric field sensors based on characteristics like intensity, phase, polarization, frequency and wavelength of light wave

Unit 4

Fiber optic Measurement: Introduction to measurement techniques i) Multimode Fiber: Refractive Index Profile, Geometric Measurement, Numerical Aperture, Total Attenuation, Scattering Loss and differential mode loss, Non destructive loss Measurement (OTDR), Transmission Bandwidth and dispersion, Bandwidth of Jointed fiber, Differential Mode Delay (DMD)

ii) Single Mode Fiber: Attenuation, Refractive Index Profile (RIP), Mode Field Diameter, Equivalent step Index (EXI) Profile, Mode Cut off Wave length and the Single Mode operating regime,Dispersion, Birefringenence Measurement, Measurement of the Propagation constant of fiber mode.

Reference Books:

1. Optical Fiber Communication By S. Senior
2. Fiber Optics Measurement By A. Ghatak, M.R. Shenoy
3. Fundamental Of Fiber Optics in Telecommunication & Sensors Systems
4. Introduction to Fiber Optics By A. Ghatak and Tyagrajan
5. Optical Fiber Sensors system And Application By B. Culshaw

MECM 101 - SEPARATION PROCESSES

UNIT- I

Mechanisms of Mass Transport, steady and molecular diffusion, Equimolar counter diffusion, Diffusion asa Mass flux, Thermal Diffusion, Multicomponent gas phase system: Molar Flux in terms of effective diffusivity,Maxwells law of Diffusion, Diffusivities in solids liquids, gases. Steady state molecular diffusion in fluids at rest and in laminar flow, Unsteady State Diffusion.

UNIT - II

Mass transfer in turbulent flow- eddy diffusion and prandtl mizing length,Mass Trasfer through a phase boundry Two film theory, Penetration Theory The Film Penetration theory,Surface Renewal theory,Diffusion in Liquids. Velocity in Mass Transfer. Mass Transfer in Turbulent Flow:Renolds Analogy,Chilton Colburn Analogy

UNIT - III

Boundry Layer: Introduction, Momentum Equation , The Turbulent Boundary Layer: The turbulent portion, The laminar sub layer,Boundary Layer Theory applied applied to a pipe flow: Entry Conditions,Application of the Boundary layer theory.

UNIT – IV

Principle of membranes separation process, classification characterization & preparation of membrane,membranes modulus &application ,liquid membranes and industrial application.

UNIT - V

Ternary and multicomponent system fractionation theories: Multicomponent Mixture: Equilibrium Data,Feed and Product Composition, Light and Heavy key components,Calaulation of a number of plates required for a given separation, Minimum Reflux Ratio,No of Plates at total reflux, Relation bet Reflux ratio and no of plates. Brief Description about Azeotropic and Extractive distillation.

REFERENCE BOOK

1. Coulson &Richardson Volume 1, Edition 6(Chemical Engineering)
2. Coulson &Richardson Volume 2, Edition 6(Chemical Engineering)
3. B.K. Datta. “Separation process Technology“
4. J.D. Seader “Separation process principles” Second Edition
5. Nath K. Membrance separation Technology PHI

MECM 102 - ADVANCED TRANSPORT PHENOMENON

UNIT-I

Velocity distribution in laminar flow The equations of change for isothermal flow: creeping flow around a solid sphere Equations of continuity, equation of motion, the equation of mechanical energy, application of Navier-Stokes equation to solve problems like falling film,flow in a tube, shape and surface of a rotating fluid.

Unit-II

Velocity distribution in turbulent flow, microscopic balance for isothermal system macroscopic balance for non isothermal system.

UNIT-III

Temperature distribution in solids and in laminar flow , The equations of change for nonisothermal flow:Equations of energy, ,use of equations of change to set up steady state heat transferproblems,

UNIT – IV

Temperature distribution in turbulent flow energy transport by radiation. Temperature fluctuations and the time smoothed temperature . time smoothing energy equation semi empirical expression for the turbulent energy flux.

UNIT-V

Concentration distribution in solid and in laminar flow The equations of change for multi component systems: Concentration distribution in turbulent flow macroscopic balance for multicomponent system.

REFERENCE BOOKS:

1. Transport Phenomena R.B.Bird, W.E.Stewart and E.N.Lightfoot, Wiley international Edition, NewYork 2002.
2. Advanced transport Phenomena, J.C. Slattery Cambridge series in Chemical Engg., 1999.
3. Transport Processes And Unit Operations-Geankoplis

MECM 103- REACTOR DESIGN

UNIT-I
Models for Non-Ideal flow Reactors: Two- parameter models- Real CSTR modeled using bypass and dead space, real CSTR modeled as two CSTR interchange, testing a model and determining its parameters.

UNIT-II
Catalysis and catalytic reactors: Design of reactors for gas solid reactions. Heterogeneous data analysis for reactor design; catalyst deactivation – Types of Deactivation, Moving bed Reactors,Packed Bed Catalytic Reactor, Reactors with Suspended Solid Catalyst.

UNIT-III
External diffusion effects on heterogeneous reactions- External resistance to mass Transfer: Mass transfer coefficient, mass transfer to a single particle, mass transfer limited reactions in packed beds, The Shrinking Core Model.

UNIT-IV
Introduction of Heterogeneous Reactions, Diffusion and reaction in porous catalysts- Diffusion andreaction in spherical Catalyst pellets, internal effectiveness factor, Falsified Kinetics, Overall effectiveness factor.G/L Reactions on Solid Catalyst: Trickle Beds, SlurryReactors, Fluidized Bed Reactors.

UNIT-V
Non- isothermal reactor design- energy balance, nonisothermal adiabatic , CSTR, PFR, low,reactors at steady state, equilibrium conversion; multiple steady states- ignition- extinction curve.

UNIT-VI
Distribution of residence times for chemical reactors- ResidenceTime Distribution (RTD) Function, Measurement of the RTD, and Characteristics of the RTD, RTD in Ideal Reactors,Zero-Parameter Models, RTD and Multiple Reactions.

REFERENCE BOOKS:
1. Octave Levenspiel, “Chemical Reaction Engineering”, Wiley Eastern University, 3rd Edition New Delhi (2001).
2. Fogler, H.S., “Elements of chemical reaction engineering”, Prentice Hall, 4th Ed. New Jersey (1986).
3. Lannyd. Schmidt, “The Engineering of Chemical Reaction”, University of Minnesota.
4. Stanley M. Walas, “ Chemical Reaction Engineering Handbook Of solved Problems”, University of Kansas, Lawrence.

MECM 104- ADVANCED HEAT TRANSFER

UNIT-I

General equation of change for energy. heat conduction equation in cylindrical coordinate,spherical coordinates. Heat conduction through a hollow cylinder. Critical thickness of insulation.

UNIT-II

Steady and unsteady state conduction is one, two and three dimensional cases. Finite difference method in steady and unsteady conduction. Two dimension steady state heat conduction in rectangular plates and semi infinite plates. Transient heat conduction in solid with finite conduction and convective resistance.

UNIT-III

Forced Convection: Laminar flow over flat plate Momentum equations of hydrodynamic boundary layer over a flat plate. Blasius solution of laminar boundary layer flows. Laminar and turbulent flow over a flat plate, turbulent flow in tube, cylinder and sphere. Analytical and semi analytical solutions.

Free convectionMomentum and energy equations for laminar free convection heat transfer on a flat plate. Equations for velocity and temperature in vertical and horizontal planes for cylinders and spheres.

UNIT-IV

Radiation heat transfer concepts. Angle factor calculation. Network method of analysis of radiation exchange. Radiation calculation through gas and vapors.

UNIT - V

Design of compact heat exchanges, Heat transfer due to boiling liquefied metal heat transfer. Heat exchanger effectiveness and number of transfer unit.

REFERENCES BOOKS:

1. Process Heat Transfer, D.Q. Kern
2. Heat Transfer J.P. Holman
3. Heat and mass transfer R.K. Rajput
4. Fundamental of engineering heat and mass transfer. R.C.Sachdeva

MECM105 - PROCESS MODELLING AND SIMULATION

UNIT-I

Introduction to modeling, a systematic approach to model building, classification of models.Conservation principles, thermodynamic principles of process systems.

UNIT-II

Development of steady state and dynamic lumped and distributed parameter models based onfirst principles.

UNIT-III

Development of grey box models. Empirical model building. Statistical model calibration and validation. Population balance models. Examples.Solution strategies for lumped parameter models. Stiff differential equations.

UNIT-IV

Solutionmethods for initial value and boundary value problems. Euler's method. R-K methodshooting method, finite difference methods. Solving the problems using matlab library package.

UNIT-V

Solution strategies for distributed parameter models. Solving parabolic, elliptic andhyperbolic partial differential equations. Finite element and finite volume methods.

REFERENCES:

1. K. M. Hangos and I. T. Cameron, "Process Modelling and Model Analysis",Academic Press.
2. W.L. Luyben, "Process Modelling, Simulation and Control for Chemical Engineers",2nd Edn., McGraw Hill Book Co., New York.
3. W. F. Ramirez, "Computational Methods for Process Simulation", 2nd ed.,Butterworths.
4. Mark E. Davis, "Numerical Methods and Modelling for Chemical Engineers", John Wiley & Sons.
5. Singiresu S. Rao, "Applied Numerical Methods for Engineers and Scientists" Prentice Hall, Upper Saddle River, NJ.

MECM201-PROCESS PLANT OPTIMIZATION TECHNIQUES

UNIT- I

Introduction to optimization and its scope in chemical process design, Developing Models for Optimization, Formulation of objective function, Optimization Theory and Methods:Basicconcept of optimization of Unconstrained Function,One dimensionalsearch, Unconstrained Multivariable optimization.

UNIT- II

Linear programming and Applications, Simplex Method,Nonlinear programming with constraints, quadratic programming, successive quadratic programming.

UNIT- III

Mixed integer programming, Optimization in large scale plant design and operation, integrated planning, scheduling and control in the process industries.

UNIT- IV

Application of optimization:Heat transfer and Energy conservation, SeparationProcess, Fluid flow system, chemical reaction design and operation.

UNIT- V

Optimization and Functions of a Complex Variable and Numerical Analysis:Gauss siedal method, Gauss elimination method, Eulers Method, Modified Euler Method and Runga-Kutta Method for Ordinary Differential Equations, Tranzoidal Rule and Simpson's 1/3 and 3/8 Rules.

REFERENCE BOOKS

1. Optimization of the Chemical Process Edgar, Himmelblau, Lasden.
2.Numerical Methods in Engineering and Science Dr B.S Garewal
3. Optimization theory and practice, G.S. Beveridge and R.S.Schechter, McGraw Hill, Newyork.
4. Engineering Optimization-Methods and Applications, Reklaitis,G.V., Ravindran, A., and Ragsdell,K.M., John Wiley, New York

MECM 202 -COMPUTER AIDED DESIGN FOR PROCESS EQUIPMENTS

UNIT- I

General design consideration, Optimum design, Property estimation, Material and Energy balance, introduction to special software for steady and dynamic simulation of chemical engineering systems

UNIT- II

Computer aided design of heat transfer equipment. Design of double heat exchangers, shell and tube heat exchangers, condensers and evaporators.

UNIT- III

Computer aided design of mass transfer equipment. Design of mass transfer equipments: Design of distillation column, Absorption tower bothplate as well as packed type

UNIT- IV

Computer aided design of chemical reactors, Batch reactor, continuous stirred tank reactor and Plug flow reactor.

UNIT- V

Interactive computer graphics and drafting Simulation software, spread sheeting,Flowsheeting software, Integrated software system, development of software programs.

REFERENCES

1. Bruce A Finlayson “Introduction to Chemical Engineering Computing”, Wiley Student Edition.
2. James M. Douglas “Conceptual Design of Chemical Processes”, McGraw Hill, New York.
3. M.S Peter and K.D. Timmerhaus, R.E West, “Plant design and economics for chemical engineers”, McGraw Hill
4. B.C. Bhattacharyya and C.M. Narayanan, “Computer Aided Design of Chemical Process Equipment", New Central Book Agency (P) Ltd., New Delhi.
5. Robert G. Squires,“Computer Applications in chemical Engineering: Process Design & simulation”
6. Alexandre C. Dimian, “Integrated Design and Simulation of Chemical Processes”, Elsevier.
7. B. Wayne Bequette, “Process Dynamics: Modeling, Analysis and Simulation”, Prentice Hall International Series.

MECM 203 - ADVANCED PROCESS DYNAMICS & CONTROL

UNIT-I

Review of first and higher order systems, closed and open loop response. Dynamic behavior,stability analysis and design of feedback controllers and Cohen-Coon controller tuning. Control valve types linear, equal percentage and quick opening valve. Design of valves.

UNIT-II

Frequency response analysis, design of control system, Controller tuning and process identification. Zigler-Nichols tuning methods, Bode-Nyquist Plots, Bode stability Criterion,Nyquist stability Criterion. Feedback Control of systems with large dead time or inverse response.

UNIT-III

Control systems with multiple loops, Advance control techniques cascade, selective and split – Range control, feed forward and ratio control, adaptive and inferential control systems.

UNIT- IV

Synthesis of alternative control configurations for MIMIO processes. Interaction and Decoupling of control loops, RGA and the selection of loops .Design of non-interacting control loops.Design of control systems for complete plants.Tuning of multivariable controllers.

UNIT-V

Sample Data Controllers: Basic review of Z transforms, Response of discrete systems to various inputs. Open and closed loop response to step, impulse and sinusoidal inputs, closed loop response of discrete systems. Design of digital feed back controllers. Introduction to control of non-linear systems

REFERENCE BOOKS

1. 'Process Systems analysis and Control', D.R. Coughanour, Mc.Graw Hill, II Edition, 1991.
2. 'Process Dynamics and Control', D.E.Seborg, T.F.Edger, and D.A.Millichamp, John Wiley and Sons, II Edition, 2004.
3. 'Principle and Practice of Automatic Process Control', C.A.Smith and A.B.Corripio, John Wiley and Sons, 1985.
4. 'Process Modelling Simulation and Control for Chemical Engineers', W.L.Luyben, McGraw Hill, II Edition, 1990.
5. Chemical Process Control – Theory and Practice', Stephanopoulous, Prentice Hall of India Ltd.1984.
6. Process control: Modeling, Design and simulation, B.Wayne Bequette PHI, 2003.
7. Chemical Process Control " An Introduction to theory & Practices, Stephanopoulos, PHI.
8. Process Dynamics, Modeling and Control, Babatunde O, W. Harmon Ray, Oxford University Press.
9. Process Dynamics and control. D.E. Seborg, T.F. Edgar, D.A. Mellichamp Wiley.

MECM 204 - PRODUCTIVITY AND MANAGEMENT'

UNIT- I

Introduction to operations research – Development of operational research, definition,characteristics, scopes, opportunity and operation research in problem solving. Limitations of operational research and applications. Differences between manufacturing and serviceoperations.

UNIT- II

Model, types of model, constructing model and deriving solution from model, operations research model in practices, computer software for operational research. Approach of the assignment model, models with price Breaks, with Restrictions.

UNIT- III

Duality theory, Primal Dual relationships in formulation and their solutions, Sensitivity Analysis,Dual Simplex Method. Transportation problem – Formulation, Optimal solution, unbalanced transportation problem.

UNIT- IV

Optimization- Techniques, planning and control models (Network techniques), deterministic case. Maximization and Minimization problem – Development and construction. PERT and CPM analysis Difference between CPM and PERT.

UNIT- V

Analysis for operations management, cost data for operations management – Break even analysis, investment analysis

REFERENCE BOOKS

J.K.Sharma Operations Research Theory & Applications
Pream Kumar Gupta, D.S. Hira, Operations Research
J.K Sharma Operations Research Theory and Application

MECM205- INDUSTRIAL POLLUTION CONTROL

UNIT-I

Major problems and pollution in environment, Environmental gradients, Tolerance and adaptation, Environmental laws and Provisions, Guidelines for pollution and health aspects for different industries, environmental impact assessment, environmental auditing

UNIT- II

Problems concerned to air pollution and its effects, meteorological aspects of air pollution,chemical and photochemical reactions in atmosphere, Principles and designing of air pollution controlling and abating instruments, Mitigating measures

UNIT-III

Sources of water pollution and standards for waterfor different purposes, water treatment, effect of waste water on ecology Noise pollution, its measurement and mitigating measures

UNIT-IV

Sources and classification of solid waste, properties of solid waste, transportation and treatment of MSW and ISW (Industrial Solid Waste), Hazardous waste, its storage and treatment

UNIT-V

Basic concepts of LCA, Waste minimization by reuse and recycling, Case study for different industries for waste minimization and environmental perspectives.

REFERENCES:

1. Environmental Engineering, Gerard Keily; Tata McGraw Hill Pub.
2. C. S. Rao, Environmental Pollution Control Engineering; New Age International Publishers
3. H.S.Peavy, D.R.Rowe and George Tchobanoglous, Environmental Engineering; McGraw Hill International

MECM-301(A) DATA BASE FOR PROCESS PLANT DESIGN

UNIT-I

Shell and Tube Heat Exchanger Design: 1-2 parallel –counter flow: Shell and Tube Exchanger, Flow arrangements for increased heat recovery, Calculations for Process conditions.

UNIT-II

Multiple Effect Chemical Evaporation: Calculations of Chemical Evaporators, Solution of industrial problems: concentration of cane sugar liquors – forward feed, Evaporation of paper pulp waste liquors – backward feed, caustic soda concentration – forced circulation evaporators.

UNIT-III

Vaporizers and Reboilers: Vaporizing processes, Reboiler arrangements, Classification of vaporizing exchangers, Heat flux and temperature difference Limitations, Relation between maximum flux and maximum film coefficient,

UNIT-IV

Towers: Introduction, Contacting Devices, Choice between Packed Columns and Plate columns,Tower Packings, Choice of plate types, Transfer unit calculations, Column diameter. Packed Towers: Introduction, Type and Size of Packings, Flooding, Pressure Drop, Foam, Holdup,Degree of Wetting, Column Diameter, Height of Packing,

UNIT-V

Introduction, Sieve Trays: Tower Diameter, Plate Spacing, Entrainment, Weepage, Tray Layout,Valve trays: Flooding and Entrainment, Tray Spacing, Foaming Tray type, Tray diameter and Lay out, Hydraulic Parameters.

REFERENCE BOOK:

1. Process Heat Transfer by D.Q.Kern, Mc Graw Hill Co., 1997.
2. Process Plant Design by Backhurst and Harker Amercian ElservierPub.Co., Heinmann Chemical Engineering Series, 1973.
3. Process Equipment Design by M.V.Joshi, McMillan India,1996.
4. Coulson and Richardson Chemical Engineering Volume 6 Pergamon Press.

MECM -301(B) BIOCHEMICAL ENGINEERING

UNIT-I
Introduction to microbiology: Biophysics and the cell doctrine, the structure of cells, important cell types,from nucleotides to RNA and DNA, amino acids into proteins.

UNIT-II
Kinetics of enzyme catalyzed reaction: the enzyme substrate complex and enzyme action, simple enzyme kinetics with one and two substrates, other patterns of substrate concentration dependence, modulation and regulation of enzyme activity, other influences on enzyme activity.

UNIT-III
Immobilized enzyme technology: enzyme immobilization, industrial processes, utilization and regeneration of cofactors. Immobilized enzyme kinetics: effect of external mass transfer resistance, analysis of intra particlediffusion and reaction.

UNIT-IV
Kinetics of cellular growth in batch and continuous culture, models for cellular growth – unstructured,structured and cybernetic models. Thermal death kinetics of cells and spores

UNIT-V
Introduction to metabolic pathways, biosynthesis, transport across cell membranes, end products ofmetabolism, stoichiometry of cell growth and product formation.

UNIT- VI
Transport phenomena in bioprocess systems: Gas-liquid mass transfer in cellular systems,determination ofoxygen transfer rates, overall kLa' estimates and power requirements for sparged and agitated vessels, scaling of mass transfer equipment, heat transfer.

REFERENCE
1. Biochemical engineering fundamentals by J.E.Bailey and D.F.Ollis, 2nd Ed,1986,McGraw Hill.
2. Bioprocess Engineering by Michael L. Shuler and Fikret Kargi, 2nd edition, Pearson education education
3. Biochemical engineering by James M.Lee – Prentice-Hall-1992.
4. Biochemical engineering by Aiba, Humphrey and Mells, academic press.
5. Bioprocess engineering principles, Pauline M. Doran, Academic Press.
6. Biochemical Engineering, H.W. Blanch and D.S. Clark, Marcel Dekker, 1997

MECM -301(C) NANOTECHNOLOGY IN CHEMICAL ENGINEERING

UNIT- I

Nano materials and nano composites: Introduction, surface of nanoparticles, thermal phenomena, surface energy-general considerations, phase transitions, thermodynamics, heat capacity of nano particles, Phase transformations of nanoparticles, nanoparticle Structure fluctuations.

UNIT- II

Gas Phase Synthesis of Nanoparticle: Fundamental considerations, inert gas condensation,physical and chemical vaporsynthesis, laser ablation, Microwave plasma process, flame aerosolprocess, coated particle synthesis of nano particles, sol-gel and Hydrothermal processes,freeze drying attrition, Chemical vapor deposition methods for producing nano particles.

UNIT- III

Properties of nano particles:

a) Magnetic properties: super paramagnetic properties, applications, exchange coupled magnetic nano materials.

b) Optical properties: quantum confinement, quantum dots and other lumophores, metallic and semiconducting nano particles, special luminescent nano particles, electroluminescence,electrochromic and photochromic materials, magneto-optic applications.

UNIT- IV

Electrical properties: electrical conductivity in nano-rods andnanotubes, Photoconductivity of nano-rods, electrical conductivity of nano composites.Mechanical Properties: General considerations, influence ofgrain size, sintering temperature,super plasticity, filled polymer composites, nano fluids and applications of nano fluids.

UNIT- V

Carbon Nanotubes: nano rods and nano plates, Layeredstructures, compounds with layers structures, nano tubes and nanorods from materials other than carbon.Thin films: Kinetic theory of gasses, concepts vacuum, Thermal evaporation, sputtering, ion implantation concepts in nanomaterial science.

REFERENCE BOOKS

1. Nano Materials & Introduction to Synthesis, Properties &Application. Dieter Vollath, Wiley VCH 2006.
2. Handbook of nanophase and nanostructured materials Vol1,2,3,4 Zhong Lin Wang, Yi Liu and Ze Zhang, Academic-Plenum Pblisher, 2002.
3. Nano technology, Richard booker, Earl Baysen Wiley Cheamtech, 2005.
4. Nano Materials, A.K. Bandyopadhyay New Age International Publishers, 2008 .

MECM -302 (A) DESIGN OF PIPING SYSTEMS FOR CHEMICAL PLANTS

UNIT-I

Fundaments of fluid flow through pipes-Calculation of pressure drop for Newtonian & non-Newtonian fluids, incompressible & compressible fluids and two-phase flow, Calculation of economic pipe diameter, insulation thickness, equivalent length, Slurry transport and pipelines

UNIT-II

Engineering flow diagram, nomenclature and equipment elevation Piping layout, line pressure drop, piping analysis, stress analysis of curved pipelines, yard piping

UNIT-III

Piping codes, standards and specifications-ASME, ASTM, API Piping components-pipes, pipe ends, pipe fittings, end fittings, flanged joints, valves, valve codes and standards, valve classification, valve components, bolts, gaskets (fasteners and sealing elements)

UNIT-IV

Piping materials-selection, cost and installation Design of heat exchanger piping, Thermosyphon reboiler piping, Pressure relief piping Steam tracing design, Thermowell design, Expansion loops and expansion joints

UNIT-V

Design of pipeline network-Pinch analysis Pipeline operation and maintenance-friction reduction, cleaning, coating, wear, leak detection, water hammer

REFERENCES

1. Peter Smith, Fundamentals of piping design, Gulf Publishing HouseKellog, Design of pipeline systems
2. Sahu, Handbook of Piping Design

Grading IIIrd Semester w.e.f.2011-12

MECM 302-(B) ENERGY MANAGEMENT

UNIT-I

Introduction to sources of Energy : Solar Energy, WindEnergy , Bio Mass , Chemical Energy,Magneto hydro dynamics, Geothermal, Ocean Energy, Nuclear Energy. Present usage levels.

UNIT-II

Solar Energy: Solar Radiation and its measurements, solar energy collectors: Flat plate collectors, concentrating collectors, Storage of Solar energy techniques: Thermal storage, Latent heat storage, Electrical, Chemical Storage, Mechanical Energy storage, solar pond.

UNIT-III

Energy from Biomass: Solid, liquid and gaseous biofuels conversion Techniques: Anaerobic digestion, Fermentation, Chemical reduction, Liquefaction, gasification, Hydrogenation and oil extraction. Bio gas generation: Factors affecting biodigestion for Biomass, energy audit,energy conservation & reuse.

UNIT-IV

Chemical Energy Sources : Fuel Cell : Operation of afuel cell, Classification of fuel cells ,Advantages and disadvantages of a fuel cell, conversion efficiency of a fuel cell, Polarization in fuel cells Hydrogen Energy: Hydrogen production methods: Electrolysis, Thermo-Chemical methods, Fossil Fuel methods.

UNIT- V

Electrochemical Energy Conversion & Storage:EMF, reversible cells and irreversible cells,reversible electrodes, free energy changes and emf in cells, effect of cell temperature on batteries, derivation of number of electrons involved in a cell reactions, constant power, effect of battery design. Primary batteries, secondary batteries – lead acid, nickel cadmium, nickel metal hydride, silver oxide zinc system, energy management in chemical process plants

REFERENCE BOOKS

1. Culp, A, " Principles of Energy Conversion" MCGraw Hill,1979.
2. G.D. Rai, " Energy Sourses" , Khanna Publishers, 2008.
3. Mr. Barak, "Electrochemical Power sources", I.E.E. series Peter Peregrinus Ltd. Steverage,U.K 1980, reprint 1997.
4. Linden D and Thomas B.Reddy, "Hand Book on Batteries and Fuel Cell", McGraw Hill Book Co.,New York, 3rd Edition, 2002.
5. J.P. Gabano, "Lithium Batteries", Academic Press, London, 1983.

MECM-302(C) FLUIDIZATION ENGINEERING

UNIT-I
INTRODUCTION
The fluidized state, Nature of hydro dynamic suspension particle-particle forces, species of fluidization, Regimization of the fluidized state, operating models for fluidizations systems,Application of fluidization systems.

UNIT-II
HYDRODYNAMICS OF FLUIDIZATION SYSTEMS
General bed behavior pressure drop, Flow regimes, Incipient fluidization, pressure fluctuations,phase hold ups, Measurement techniques, Empircial correlations for soilds holdup, iquid holdup and gas holdup, Flow models - generalized wake model, structural wake model and other important models.

UNIT -III
SOLIDS MIXING AND SEGREGATION
Phase juxtaposition operation shifts, Reversal points, Degree of segregation, Mixing segregation equilibrium, Generalized fluidization of poly disperse systems, liquid phase mixing and gas phase mixing.

UNIT-IV
HEAT AND MASS TRANSFER FLUIDIZATION SYSTEMS
Mass transfer - gas-liquid mass transfer, Liquid soild mass transfer and wall to bed mass transfer,Heat transfer - column wall - to - bed heat transfer, Immersed vertical cylinder-to-bed heat transfer, Immersed horizontal cylinder to-bed heat transfer.

UNIT-V
MISCELLANEOUS SYSTEMS
Conical fluidized bed, Moving bed, Slurry bubble columns, Turbulent bed contactor, Two phase and three phase inverse fluidized bed, Draft tube systems, Semi fluidized bed systems, Annular systems, typical applications, Geldart's classification for power assessment, Powder characterization and modeling by bed collapsing.

REFERENCES:
1. Gas-Liquid-Solid Fluidization Engineering, Liang-Shih Fan, Butterworths, 1989.
2. Fluidization Idealized and Bubbleless, with Applications, Mosoon Kwauk, Science Press, 1992.
3. Fluidization Engineering, O. Levenspiel and D. Kunii, John Wiley, 1972.

MEDC-105 ADHOC WIRELESS NETWORK

UNIT-I:

Wireless LANS and PANS: Introduction, Fundamentals of WLANS, IEEE 802.11 Standard, HIPERLAN Standard, Bluetooth, Home RF.

Wireless Internet:

Wireless Internet, Mobile IP, TCP in Wireless Domain, WAP, Optimizing Web Over Wireless.

UNIT-II:

AD HOC Wireless Networks: Introduction, Issues in Ad Hoc Wireless Networks, AD Hoc Wireless Internet.

MAC Protocols for Ad Hoc Wireless Networks: Introduction, Issues in Designing a MAC protocol for Ad Hoc Wireless Networks, Design goals of a MAC Protocol for Ad Hoc Wireless Networks, Classifications of MAC Protocols, Contention - Based Protocols, Contention - Based Protocols with reservation Mechanisms, Contention – Based MAC Protocols with Scheduling Mechanisms, MAC Protocols that use Directional Antennas, Other MAC Protocols.

UNIT -III:

Routing Protocols: Introduction, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classification of Routing Protocols, Table –Driven Routing Protocols, On – Demand Routing Protocols, Hybrid Routing Protocols, Routing Protocols with Efficient Flooding Mechanisms, Hierarchical Routing Protocols, Power – Aware Routing Protocols.

Transport Layer and Security Protocols: Introduction, Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks, Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks, Classification of Transport Layer Solutions, TCP Over Ad Hoc Wireless Networks, Other Transport Layer Protocol for Ad Hoc Wireless Networks, Security in Ad Hoc Wireless Networks, Network Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, Key Management, Secure Routing in Ad Hoc Wireless Networks.

UNIT –IV:

Quality of Service: Introduction, Issues and Challenges in Providing QoS in Ad Hoc Wireless Networks, Classification of QoS Solutions, MAC Layer Solutions, Network Layer Solutions, QoS Frameworks for Ad Hoc Wireless Networks.

Energy Management: Introduction, Need for Energy Management in Ad Hoc Wireless Networks, Classification of Ad Hoc Wireless Networks, Battery Management Schemes, Transmission Power Management Schemes, System Power Management Schemes.

UNIT –V:

Wireless Sensor Networks: Introduction, Sensor Network Architecture, Data Dissemination, Data Gathering, MAC Protocols for Sensor Networks, Location Discovery, Quality of a Sensor Network, Evolving Standards, Other Issues.

TEXT BOOKS:

1. Ad Hoc Wireless Networks: Architectures and Protocols - C. Siva Ram Murthy and B.S.Manoj, 2004, PHI.
2. Wireless Ad- hoc and Sensor Networks: Protocols, Performance and Control - Jagannathan Sarangapani, CRC Press

REFERENCE BOOKS:

1. Ad- Hoc Mobile Wireless Networks: Protocols & Systems, C.K. Toh ,1 ed. Pearson Education.
2. Wireless Sensor Networks - C. S. Raghavendra, Krishna M. Sivalingam, 2004, Springer