Dr.M.G.R.
EDUCATIONAL AND RESEARCH INSTITUTE
UNIVERSITY
(Decl. U/S 3 of the UGC Act 19Hrs56)

DEPARTMENT OF CHEMICAL ENGINEERING

M.Tech- Chemical Engineering – Full Time
2013 Regulation

I SEMESTER						
S.NO	**Sub.Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1.	MCT13C001	Applied Thermodynamics	**4**	**0**	**0**	**4**
2.	MCT13C002	Applied Transport Phenomena	**3**	**0**	**0**	**3**
3.	MCT13C003	Membrane Technology	**3**	**0**	**0**	**3**
4.	MCT13C004	Advanced process control	**4**	**0**	**0**	**4**
5.	MCT13CEXX	Elective-1	**3**	**0**	**0**	**3**
6.	MCT13CEXX	Elective-2	**3**	**0**	**0**	**3**
7.	MCT13CL01	Computer Applications	**0**	**0**	**3**	**2**
Total			**20**	**0**	**3**	**22**

II SEMESTER						
S.NO	**Sub.Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1.	MCT13C005	Modern Separation process	**3**	**0**	**0**	**3**
2.	MCT13C006	Applied Reaction Engineering	**3**	**0**	**0**	**3**
3.	MCT13C007	Chemical process Design	**3**	**1**	**0**	**4**
4.	MCT13C008	Fluidization Engineering	**4**	**0**	**0**	**4**
5.	MCT13CEXX	Elective 3	**3**	**0**	**0**	**3**
6.	MCT13CEXX	Elective 4	**3**	**0**	**0**	**3**
7.	MCT13CL02	Term Paper	**0**	**0**	**3**	**2**
Total			**19**	**1**	**3**	**22**

III SEMESTER						
S.NO	**Sub.Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1.	MCT13C009	Process Modeling and Simulation	**3**	**1**	**0**	**4**
2.	MCT13CEXX	Elective-5	**3**	**0**	**0**	**3**
3.	MCT13CEXX	Elective-6	**3**	**0**	**0**	**3**
4.	MCT13CL03	Project Work Phase - I	**0**	**0**	**12**	**6**
		Total	**9**	**1**	**12**	**16**

IV SEMESTER						
S.NO	**Sub.Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1.	MCT13CL04	Project Work Phase–II	**0**	**0**	**30**	**15**
		Total	**0**	**0**	**30**	**15**

I+II+III+IV= 22 + 22 + 16 + 15 = 75
Total credits earned for the award of the degree : 75

List of Electives						
S.No	**Sub.Code**	**Course Title**	**L**	**T**	**P**	**C**
1	MCT13CE01	Environmental Technology	3	0	0	3
2	MCT13CE02	Drugs and Pharmaceutical Technology	3	0	0	3
3	MCT13CE03	Multiphase flow	3	0	0	3
4	MCT13CE04	Polymer Technology	3	0	0	3
5	MCT13CE05	Bio Process Engineering	3	0	0	3
6	MCT13CE06	Risk Analysis and Management	3	0	0	3
7	MCT13CE07	Fundamentals of Nano Science	3	0	0	3
8	MCT13CE08	Frontiers of Chemical Engineering	3	0	0	3
9	MCT13CE09	Professional Ethics in Engineering	3	0	0	3
10.	MCT13CE10	Industrial Instrumentation	3	0	0	3
11.	MCT13CE11	Fertilizer Technology	3	0	0	3
12.	MCT13CE12	Petroleum Technology	3	0	0	3
13.	MMA3019	Operations Research for Chemical Engineers	3	0	0	3

MCT13C001 **APPLIED THERMODYNAMICS** **4 0 0 4**

OBJECTIVE:

- To recap the three laws of thermodynamics, learn the details of multicomponent mixture thermodynamics
- To learn the fundamental principles of postulational and statistical thermodynamics.

UNIT 1 FUNDAMENTALS OF THERMODYNAMICS **15Hrs**

First law and second law of thermodynamics-Applications-Postulational concepts

UNIT 2 THERMODYNAMIC PROPERTY **10 Hrs**

P-v-T relations of fluid-Thermodynamic property relations-Themodynamic property relations of real gases.

UNIT 3 SOLUTION PROPETY **10 Hrs**

Multi component mixtures – Stability and phase transitions-Property of Solutions.

UNIT 4 VAPOUR-LIQUID EQUILIBRIA **10 Hrs**

Vapour – liquid Equilibria- LIQ-LIQ Equilibrium Solid-fluid equilibrium dilute solutions.

UNIT 5 THERMODYNAMIC PROPERTIES **15 Hrs**

Chemical reaction equilibrium, Statistical Thermo dynamics-concepts- Thermodynamic properties.

Total. No of Hrs:60

REFERENCES

1. Chemical ,Biochemical &Engineering Thermodynamics-Stanley , Sandler, Wiley Indian, IVEdn 2001
2. Chemical engineering Thermodynamics-Y.V.C. Rao University press, Hyderabad 2005
3. Postulational and Statistical Themodynamics- Y.V.C.Rao , Allied Pub, New Delhi

MCT13C002 APPLIED TRANSPORT PHENOMENA 3 0 0 3

OBJECTIVE:

- To learn the laws of conservation of mass, energy and momentum from a control volume view point and arrive at integral expressions in the respective fields.
- To learn in greater depth the convective heat transfer as also the radiation heat transfer. To revisit the different analogies among the transport phenomena from integral equations
- To learn the details of inviscid flow, rotational flow as also the stream function and velocity potential of a flow regime.

UNIT 1 INTEGRAL METHOD OF ANALYSIS USING CONTROL VOLUMES 9Hrs

Description of fluid in motion-Conservation of mass-Newton's second law of motion-conservation of energy-Control volume approach-Shear stress in laminar flow-laminar flow analysis.

UNIT 2 INVISCID FLOW 9Hrs

Differential equations of flow-inviscid flow-dimensional analysis- viscous flow Turbulence-flow in closed conduits-Flow in packed bed.

UNIT 3 STEADY AND UNSTEADY HEAT TRANSFER 9Hrs

Heat transfer phenomena-differential equations of heat transfer-steady &unsteady state conduction

UNIT 4 CONVECTION AND RADIATION HEAT TRANSFER 9Hrs

Convective heat transfer-convective heat transfer correlations-radiation heat transfer

UNIT 5 STEADY AND UNSTEADY MASS TANSFER 9Hrs

Mass transfer-differential equations of mass transfer-steady &unsteady state mass transfer-convective mass transfer-correlations.

Total no. of Hrs: 45

REFERENCES

1 "Transport Phenomena", R,B,Birdetal ,John Wiley & Sons Inc 2002
2 "Transport Phenomena –A Unified Approach" ,R.S. Brodkeyetal Brodkey Publishing 2003
3."Fundamentals of momentum, heat and mass transfer",J.R.Weltyetal John Wiley &Sons, Inc 2001

MCT13C003 **MEMBRANE TECHNOLOGY** **3 0 0 3**

OBJECTIVE:

- To learn about the meaning, nature and types of natural and synthetic membranes, and how they are characterized and manufactured commercially.
- Individual types of membrane processes such as reverse osmosis, ultrafiltration, microfiltration, nano filtration, electro-dialysis etc are to be learnt in depth.
- Besides, sufficient knowledge in ion-exchange membrane separation and some specialized membrane-separation related processes are also to be studied.

UNIT 1 OVERVIEW OF MEMBRANE SEPARATION 9Hrs

Over view of membrane separation processes-membrane types-Materials preparation and Characterisation-Classification of membrane processes-Advantages, Disadvantages-Areas of application-Types of synthetic membranes. Membrane modules-Characterisation.

UNIT 2 REVERSE OSMOSIS AND NANOFILTERATION 9Hrs

R.O &nano filtration-Osmosis-Reverse Osmosis-Models for R.O Transport-design and operating parameters CocentrationPolarisation-Nano filtration-Membranes for-Mass Transport.

UNIT 3 ULTRA FILTERATION MEMBRANES 9Hrs

Principles of Ultra filtration-UF Membranes _Devices in UF- Flux Equations-Fouling Affinity Filtration- Principles of microfiltration-Mebranes for-Fouling-Dialysis principles- Mebranes for-Mass transfer –Applications.

UNIT 4 MEMBRANES FOR GAS SEPERATION 9Hrs

Gas separation principles-Mebranes for-Transport mechanism-Models for Transport-Application-Pervopration-Membranes for-Mass transfer-Factors affecting-Application

UNIT 5 MISCELLANEOUS MEMBRANE SEPERATION PROCESS 9Hrs

Principles of Ion –exchange membrane separation-Membranes for-Factors affecting-Application-Liquid membranes-Mass transport-Application-Other membrane processes-Membrane distillation,Membrane reactors,Charge mosaic membranes,etc

Total no. of Hrs: 45

REFERENCES

1. Membrane Technology and Application- Baker ,R.W., John Wiley & Sons-2004.
2. Membrane Separation Processes-Kaushik Nath-Prentice Hall India -2008

MCT13C004 **ADVANCED PROCESS CONTROL** **4 0 0 4**

OBJECTIVE:

- To learn details of some of the advanced control techniques such as feed forward control systems, dead-time compensation system, internal model systems, multivariable control systems of the analogue type control scheme.
- In addition discrete control system principles leading to digital control systems are to be covered in sufficient detail.
- Learning the various types of digital controllers is also included to have a better insight in the area of control systems.

UNIT I ADVANCED CONTROL STRATEGIES **10 Hrs**

Feed forward control system; Cascade control; Dead-time compensation; Selective control systems- overriding systems, auctioneering control systems etc.; Programmed adaptive controlling—gain scheduling, self-tuning regulator.

UNIT II INTERNAL MODEL CONTROL **10Hrs**

Model-based control systems—Internal Model Control (IMC); IMC structure; Design of IMC controller; IMC-based PID controller.

UNIT III MULTI-VARIABLE CONTROL SYSTEM **15Hrs**

Multivariable system representation; Interacting system; Response of multi-loop control systems; Relative gain array; Decoupling control – concepts, decoupling networks.

UNIT IV DISCRETE SYSTEMS **15Hrs**

Sampling- impulse modulation, clamping, zero-order old; z-Transform; Inverse z-Transform; Properties; Discrete-time response of dynamic systems; Transfer function of discrete systems; Pulse transfer function; Closed-loop system; Stability analysis.

UNIT V DIGITAL FEEDBACK CONTROLLERS **10 Hrs**

Design of digital feedback controllers; Digital approximation of classical controllers; Effect of sampling; Dahlin's algorithm; Dead-beat algorithm; Ringing; IMC algorithm; Simplified model predictive algorithm.

Total no. of Hrs: 60

REFERENCES:

1. Stephanopoulos, G., 'Chemical Process Control…' Prentice Hall of India 2004
2. Bequette, B.W., 'Process Control: Modeling, Design, and Simulation', Prentice Hall 2008
3. Coughanowr, D.R., 'Process System Analysis and control', McGraw-Hill 1991.

MCT13CL01	**COMPUTER APPLICATIONS**	**0**	**0**	**3**	**2**

LIST OF EXPERIMENTS

1. Absorption
2. Distillation.
3. Extraction
4. Filtration
5. Heat Exchangers
6. Size separation
7. Leaching
8. Reactors
9. Process Economics

SEMESTER II

MCT13C005 MODERN SEPARATION PROCESSES 3 0 0 3

OBJECTIVE:

- To study the modern day separation technique as applied in the chemical process industry; for example, membrane separation, adsorption separation, ionic separation are some of the more important techniques which are to be learnt.
- In addition some unconventional types of separation that are in various stages of development are also sought to be taught.

UNIT I SEPARATION PROCESS IN GENERAL 9Hrs

Review of conventional processes; Advances in separation techniques based on size, surface properties, ionic properties & other special characteristics of substances; Process concept, theory & equipment used in cross-flow filtration and cross-flow electro filtration.

UNIT II MEMBRANE SEPARATIONS 9Hrs

Types and choice of membranes—plate & frame, tubular, spiral wound, and hollow fiber; Membrane reactors and their relative merits; Principles, Concepts and Membrane equations for microfiltration, ultrafiltration, Nanofiltration, reverse osmosis, electrodialysis, dialysis and Donnon dialysis; Economics of membrane operations.

UNIT III SEPARATION BYADSORPTION TECHNIQUES 9Hrs

Mechanisms; Types and choice of adsorbents; Normal adsorption techniques; Affinity chromatography; Types of equipment and commercial processes; Recent advances; Process economics.

UNIT IV IONIC SEPARATIONS 9Hrs

Controlling factors; Applications; Types of equipment used for electrophoresis, dielectrophoresis; Ion exchange chromatography; Electrodialysis; Commercial processes.

UNIT V OTHER TECHNIQUES 9Hrs

Separations involving lyophilization, pervaporation and permeation techniques – for solids, liquids, and gases; Industrial viability; Examples; Zone melting; Adductive crystallization; Supercritical fluid extraction; Industrial effluent treatment by modern techniques.

Total no of Hrs: 45

REFERENCES:

1. Rousseau, R.W., ‘ Handbook of Separation Process Technology’ John Wiley, NY 1987
2. Nakagawal, O.V., ‘Membrane Science & Technology’, Marcel Dekker, 1992
3. Humphrey,J. and Keller,G., ‘ Separation Process Technology’ McGaw-Hill 1997

MCT13C006 **APPLIED REACTION ENGINEERING** **3 0 0 3**

OBJECTIVE:

- To learn the basic intricacies of heterogeneous chemical reactions with as well as without catalysts.
- To learn some details regarding catalysis, catalysts and their characteristics and methods of their manufacturing. Some specific types of catalyst-based reactors like fixed-bed, mixed tank, fluidized-bed and moving-bed reactors are also to be studied.
- To study the accent is on the design procedures of these reactors.

UNIT 1 HETEROGENEOUS REACTION – NON-CATALYST **9**Hrs

Solid –fluid non catalysed reactions-Kinetics-Reactor design. Fluid –fluid reactions –Reactor Design.

UNIT 2 HETEROGENEOUS REACTION - CATALYST 9Hrs

Catalytic Reactions-Rate equations –Models –Langmuir- Hinshelwood Rideal- Eiley Mechanism-Catalyst-Properties-Preparation.

UNIT 3 EFFECTIVENESS FACTORS IN CATALYTIC REACTION 9Hrs

External mass transport-Internal diffusion in Catalytic Reactions- Effectiveness Factor-Heat Tranport in Catalytic Reactions.

UNIT4 TYPES OF CATALYTIC REACTION 9Hrs

Fixed bed catalytic Reactor- Fluidised bed Catalytic Reactor-Design Principles.

UNIT 5 DESIGN EQUATIONS FOR CATALYTIC REACTIONS 9Hrs

Experimental determination of kinetics of catalytic reactions Slurry Reactors-Kinetics and Design- Trickle Bed Reactors –Design Micro Reactors.

Total no of Hrs: 45

REFERENCES

1. Introduction TO Chemical Reation Engineering & Kinetics-Ronald W.Missenetal,John Wiley & Sons-2000.
2. Chemical and catalytic Reaction Engineering- Carberry,J.J., Dover Publication,2001.

MCT13C007 **CHEMICAL PROCESS DESIGN** **3 1 0 4**

OBJECTIVE:

- To learn the design basics of important process equipment such as reactors, separators, columns, heat exchangers and other similar units.

UNIT I INTRODUCTION 10Hrs

The Hierarchy of Chemical process Design- Overall process Design, approaches to design.

UNIT II CHOICE OF REACTORS AND SEPARATOR 15Hrs

Reaction path, reactor performance, practical reactors, Separation of Heterogeneous mixtures, homogeneous fluid mixtures.

UNIT III SYNTHESIS OF REACTION – SEPARATION SYSTEMS 10Hrs

Process recycle, Batch processes, process yield

UNIT IV DISTILLATION SEQUENCING 10Hrs

Using simple columns, using columns with more than two products, Distillation Sequencing Using thermal coupling.

UNIT V HEAT EXCHANGER NETWORK & UTILITIES – ENERGY TARGETS 15Hrs

Heat recovery pinch, The Problem table Algorithm, Utilities Selection, Energy targets capital & total Cost targets.

Total no of Hrs: 60

REFERENCES

1. Douglas, J.M., "Conceptual Design of Chemical Process", McGraw Hill, New York, 1988.
2. Smith, R., "Chemical Process Design", McGraw Hill, New York, 1995.

MCT13C008 **FLUIDIZATION ENGINEERING** **4 0 0 4**

OBJECTIVE:

- To learn in depth of the fluidization principle, and to make use of it in designing fluidized bed reactors, bubbling fluidized beds, liquid-solid fluidized beds.
- To understand the basic principles of fluidization-engineering are to be learnt.

UNIT 1 INTRODUCTION TO FLUIDISATION 9Hrs

Particle Characterisation-Application of fluidisation –Flow through fixed beds- Fluidisation phenomena-Regimes of fluidisation-Minimum fluidisation velocity.

UNIT 2 CHARACTERISTICS OF FLUIDISED BEDS 9Hrs

Bubbling fluidised beds-solids –gas hold up-Wake-effect of temperature, pressure-gas distributors-Internal tubes and baffles.

UNIT 3 HEAT & MASS TRANSFER IN FLUIDISED BEDS 9Hrs

Heat transfer in fluidised beds-Mass transfer in fluidised beds-Fluidised bed scale up.

UNIT 4 FLUIDISED BED TYPES 9Hrs

Ciculatingfluidised beds-Liquid-solid fluidised beds, Gas-liquid –solid fluidized beds, Non conventional fluidised beds.

UNIT 5 APPLICATIONS OF FLUIDISATION 9Hrs

Fluid catalytic cracking-Gasifiers and combustors,-Chemical production and processing- Coating and Granulation – Fluidised bed Drying.

Total no of Hrs: 45

REFERENCE

1. Fluidisation Engineering –Kunii ,D and Levenspiel,D ,Butterworth Heinemann –London.
2. Hand Book of fluidisation and Fluid Particle systems-Edited by Wen-Ching-Yang, Marcel Dekker Inc-New York-2003
3. Fluidised Particles –J.F. Davidson , Cambridge press,1963.

MCT13CL02	**Term paper**	**0**	**0**	**3**	**2**

Students should submit two reports at the end of the II semester on any recent/modern Chemical Engineering topics.

SEMESTER III

MCT13C009 **PROCESS MODELING AND SIMULATION** **4 1 0 4**

OBJECTIVE

- A Knowledge of this course will be useful for students to take up chemical process equipment design assignments in the organization**.**

UNIT 1 9Hrs

Introduction to modeling-Problem definition-Steps in modeling Process simulation-Macroscopic Balance Equations-Other equations.

UNIT 2 9Hrs

Staged operations modeling-Lumped capacity systems –Steady and Unsteady state-Linear equations and solutions.

UNIT 3 9Hrs

Microscopic balances –Differential equations-solutions of ordinary Differential equations-applied problems in models.

UNIT 4 9Hrs

Models involving partial differential equations-solutions –Steady state and unsteady state.

UNIT 5 9Hrs

Numerical methods applied in solutions of process models.

Total no. of Hrs: 45

REFERENCE

1. Process Plant Simulation –B,V.Babu –Oxford Press -2004
2. Modeling and Analysis of Chemical Processes-K.Padmanabhan, K.BaluI K International .Pub-2007
3. Process Modeling Simulation and Control –Luyben W.L. –McGraw Hill -1993

MCT13CL03	**PROJECT WORK –I**	**0**	**0**	**12**	**6**

Report to be submitted on project done at either industry or department.

MCT13CL04	**PROJECT WORK-II**	**0**	**0**	**3**	**0**	**15**

Project Work-II may be a continuation of Project work-I, (or) a new project work. Students should submit a consolidated report at the end of semester-IV.

ELECTIVES

MCT13CE01 ENVIRONMENTAL TECHNOLOGY 3 0 0 3

OBJECTIVE:

- To learn about the various environment-polluting hazardous factors/substances some important scenario are explained.
- To learn the BOD, COD analysis techniques as also the water sterilization methods. Importance is also given to soil pollution abatement and noise pollution prevention as well as control.

UNIT 1: AIR POLLUTION 9Hrs

Introduction to factors influencing environment-Environmental degradation and consequential hazards- Types of air pollution-Ozone layer depletion-Acid rain-acid jolt-Green house effect and climatic changes- Carcinogenic pollutants.

UNIT 2: WATER POLLUTION 9Hrs

Introduction of BOD and COD – importance and experimental determination- Waste water treatment and recycling-Methods of sterilization of drinking water- Correlation between dissolved oxygen and quality of water.

UNIT 3: SOIL POLLUTION 9Hrs

Soil pollution-Saline intrusion- Long range pollution-Consequence of indiscriminate solid waste dumping- Effect of fertilizers and Pesticide residue on the soil-blue jaundice (Cyanosis)-Preparation of bio pesticides.

UNIT4: NOISE POLLUTION 9Hrs

Noise pollution-allowed decibel levels-Health hazards of exposure to noise-Abatement technologies.

UNIT 5: ABATEMENT TECHNOLOGY 9Hrs

Abatement technologies to suit the pollutant-alternate non conventional energy sources-Morbidity and mortality.

Total Number of Hrs-: 45

REFERENCES

1. Introduction to Environmental Engineering and Science by Gilbert M.Masters, Prentice Hall, 2004.
2. Industrial chemistry by Dr.B.K.Sharma 7th edition.

MCT13CE02 DRUGS AND PHARMACEUTICAL TECHNOLOG Y 3 0 0 3

OBJECTIVE:

- To learn the latest development in the drugs and pharmaceutical industry, important unit processes in the drug manufacturing are also to be learnt.
- Some of the important manufacturing principles which are techno-legal in nature are to be learnt.
- To gain knowledge microbiological and animal health-care drugs, analytical principles

UNIT I INTRODUCTION, DRUG METABOLISM AND PHARMACO KINETICS 9Hrs

Development of drugs and Pharmaceutical Industry: organic therapeutic agent's uses and economics. Drug metabolism; Physico chemical principles: radio activity; pharma Kinetics-action of drugs on human bodies.

UNIT II IMPORTANT UNIT PROCESSES AND THEIR APPLICATIONS 9Hrs

Chemical conversion processes: Alkylation: carboxylation: condensation and cyclisation: dehydration: esterification, halogenations, oxidation, sulfonation, complex chemical conversions fermentation

UNIT III MANUFACTURING PRINCIPLES 9Hrs

Compressed tablets: Wet granulation: dry granulation or slugging: direct compression: tablet presses formulation: coating pills: capsules sustained action dosage forms: parential solution, oral liquids: injections: Ointments: Standard of hygiene and manufacturing practice.

UNIT IV PHARMACEUTICAL PRODUCTS, MICROBIOLOGICAL AND ANIMAL PRODUCTS 9Hrs

Vitamins; cold remedies; laxatives:analgesics;nonsterodial contraceptives: external antiseptics; antacids and others. Antibiotics; biological; hormones; vitamins; preservation.

UNIT V PHARMACEUTICAL ANALYSIS, PACKING AND QUALITY CONTROL 9Hrs

Analytical methods and tests for various drugs and pharmaceuticals.Packing; Packing techniques; quality control.

Total Number of Hrs:45

REFERENCES

1. Yalkonsky, S.H.;Swarbick.J.;"Drug and Pharmaceutical Sciences",Vol.I,II,III,IV,V,VI and VII,Marcel DekkarInc New York,1975.
2. Remingtons Pharmaceutical Sciences",Mack Publishing Co,1975.
3. Rawlines, E.A.,Bentleys Text book of Pharrmaceutics",Edition, BaillereTindall, London,1977.

MCT13CE03 **MULTIPHASE FLOW** **3 0 0 3**

OBJECTIVE:

- To know in essence what is multiphase systems all about.
- To understand basic concepts and definitions like volumetric flux, mass flux, drift flux etc.
- Modeling multi-phase systems, particle-fluid interaction and applying equation of state application on those systems to be learnt.
- Some of the practical multiphase systems in application are also studied.

UNIT 1 CHARACTERISTICS OF MULTIPHASE FLOW 9Hrs

Important non-dimensional (dimensionless) numbers; prominent variables for describing multiphase flows; Calculation and measurement of particle size; Size distribution and moments; Size distribution models.

UNIT II PARTICLE FLUID INTERACTION 9Hrs

Equation of motion for a single particle; Calculation of drag; Motion of particle in two- dimensions; Effects of unsteady and non-uniform flow fields; Effects of acceleration; Effects of coupling; Interaction between particles-mechanism of interaction; Inter-particle forces; Hard sphere model, Soft sphere model; Discrete element modeling; Semi-empirical methods; Kinetic theory; Force chains.

UNIT III MODELING OF MULTIPHASE FLOW 9Hrs

Flow patterns—identification and classification; Flow pattern maps; Transition momentum and energy balance; Homogenous and separated flow models; Correlations for use with homogenous and separated flow models; Void fraction and slip-ratio correlations; Influence of pressure drop; Empirical treatment of two-phase flow; Drift flux model; Correlations for bubble, slug and annular flows.

UNIT IV CONSERVATION EQUATIONS 9Hrs

Averaging procedures—time, volume and ensemble averaging; Quasi-one-dimensional flow; Two-fluid volume-averaged equations of motion; Turbulence and two-way coupling.

UNIT V MULTIPHASE SYSTEMS 9Hrs

Flow regime and hydrodynamic characteristics of packed bed, fluidized bed; Pneumatic conveying; Bubble columns; Trickle beds; Conventional and novel measurement techniques for multiphase systems including Laser-doppler, anemometry, particle image velocimetry.

Total no. of Hrs: 45

REFERENCES

1.Brennen, C.E., 'Fundamentals of multiphase flow' .pdf.
2.Clift,R., Weber,M.E., and Grace,J.R., 'Bubble drops & Particles', Academic Press NY 1978.
3.Crowe,C.T., Sommerfield,M. and Tsuji,Y., 'Multiphase flow with droplets & particles', CRC Press, 1998.

MCT13CE04 **POLYMER TECHNOLOGY** **3 0 0 3**

OBJECTIVE:

- Knowledge of macromolecules their classification.
- To understand how polymers are manufactured their characteristics and how they are applied in industry.
- Students can gain knowledge about the engineering qualities of the polymers which are of great commercial application in modern times.

UNIT – I INTRODUCTION, DEFINITION AND CONCEPTS **9Hrs**

Introduction; definitions: polymer& macro molecule , monomer, functionality, average functionality, copolymer, polymer blend., plastic and resin. Classification of polymers: based on source, structure, applications, thermal behavior, and mode of polymerization. Concept of average molecular weight of polymers, molecular weight distribution, poly dispersity index. Practical significance of polymer molecular weight.

UNIT-II POLYMER DEGRADATION AND SYNTHESIS **9Hrs**

Degradation of polymers, types of degradation, thermal, mechanical, photo, oxidative, hydrolytic degradation. Polymer synthesis, Isolation and purification of polymers, polymer fractionation, molecular weight determination using distribution curve, determination of glass transition temperature

UNIT-III TYPES OF POLYMERISATION **9Hrs**

Methods of polymerization: mass or Bulk polymerization process, solution polymerization process, suspension polymerization process and emulsion polymerization method comparison of merits and demerits of these methods. Effect of polymer structure on properties of polymers

UNIT-IV POLYMER PROCESSING **9Hrs**

Polymer processing: Plastics, elastomers, fibers, compounding of polymer resins, brief description of: i) Compression and transfer molding ii) Injection molding iii) Extrusion iv) Blow molding v) Calendaring vi) Laminating and pultrusion.

UNIT-V SPECIALITY POLYMERS **9Hrs**

Specialty Polymers: High temperature resistant polymers, conducting polymers, composites, nano polymers, properties and applications

Total no. of Hrs: 45

REFERENCES

1. Introduction to physical polymer science, Leslie Howard Sperling 2006.
2. Industrial Plastics: Theory and application, Erik Lokensgard 2008.
3. Polymer Science by Gowarikar, N.V.Viswanathan, Jayadevsreedar 2003
4. Plastic materials, J.A. Brydson, Newnes-Butterwarths (7^{th} edition) 1999.
5. Text book of polymer science, Bill meyer, F.W.Jr. (3^{rd} edition.) John Wiely&sons 2007.

MCT13CE05 **BIO PROCESS ENGINEERING** **3 0 0 3**

OBJECTIVE:

- To learn about the fundamental principle of bio reactions
- To know how basic chemical engineering principles like material/ energy balance, process stoichiometry and rheological principles help in the design of bio reaction equipment such as bio-reactors etc.

UNIT 1 9Hrs

Bioprocess development-Application of Engineering concepts-Material and Energy balances.

UNIT 2 9Hrs

Momentum Transport-Rheology-Fluid Dynamics-Application in Bioprocesses.

UNIT 3 9Hrs

Heat transport principles in Bioprocesses-Mass Transport principles in Bioprocesses.

UNIT 4 9Hrs

Unit operations in Bioprocesses-Chemical reactions – Kinetics- Enzyme kinetics-Cell Growth Kinetics.

UNIT 5 9Hrs

Homogeneous and Heterogeneous reactions –Reactor Engineering

Total no. of Hrs: 45

REFERENCE

1. Biological Process Engineering-Arthur T. Johnson ,John Wiley -1999
2. Bioprocess Engineering Principles –Paulin M. Doran , Elsevier,2008
3. Bioprocess Engineering –Basic Concepts-Michael L.Shuler and FikretKargi- Prentice
4. hall India-2002.

MCT13CE06 **RISK ANALYSIS AND MANAGEMENT** **3 0 0 3**

OBJECTIVE

- A knowledge of this course will help students to implement safety policy and to deal with undue eventualities in the organization.

UNIT I **9Hrs**

General: Risk types, Completion, Permitting, Resource, Operating, Environmental, Manageable, Insurable, Risk Causes, Risk Analysis types and causes.

UNIT II **9Hrs**

Techniques: General, Risk adjusted discounted rate method, Certainty Equivalent Coefficient method, Quantitative Sensitivity analysis, Probability distribution, Coefficient of variation method, Simulation method, Crude Procedures, Payback period, Expected monetary value method, Refined procedures,Shackle approach, Hiller's model, Hertz model, Goal programming.

UNIT III **9Hrs**

Risk Management: Emergency relief Systems, Diers program, Bench scale experiments, Design of emergency relief systems, Internal emergency planning, Risk management plan, mandatory technology option analysis, Risk management alternatives, risk management tools, risk management plans, Risk index method, Dowfire and explosion method, Mond index Method

UNIT IV **9Hrs**

Risk Assurance and Assessment: Property Insurance, Transport insurance, Liability insurance, Pecunious insurance, Risk Assessment, Scope Canvey study, Rijimond pilot study, Low Probability high consequence events. Fault tree analysis, Event tree analysis, Zero Infinity dilemma

UNIT V **9Hrs**

Analysis in Chemical Industries : Handling and storage of Chemicals, Process plants, Personnel protection equipments. Environmental risk analysis, International environmental management system, Corporate management system, Environmental risk assessment, Total quality management, Paradigms and its convergence.

Total no. of Hrs:45

REFERENCES

1. Sincero, A. P. and Sincero, G. A., "Environmental Engineering – A Design Approach", Prentice Hall of India, 1996.
2. Pandya, C. G., "Risks in Chemical Units", Oxford and IBH Publishers, 1992.
3. Fawcett, H. H., "Safety and Accident Prevention in Chemical Operations by John Wiley & Sons, 1982.
4. Kind, R. W., "Industrial Hazard and Safety Handbook" Butterworth, 1982.
5. Srivastav, S., "Industrial Maintenance Management", Sultan Chand & Co., 1998.
6. Rao, P. C. K., "Project Management and Control", Sultan Chand & Co., Ltd., 1996
7. Steiner, H. M., "Engineering Economic Principles", McGraw Hill Book Co., New York, 1996.

MCT13CE07 FUNDAMENTALS OF NANOSCIENCE 3 0 0 3

OBJECTIVE:

- To enable the students to learn about basis of nanomaterial science, preparation method, types and application

UNIT I INTRODUCTION 8Hrs

Nanoscale Science and Technology- Implications for Physics, Chemistry,Biology and Engineering-Classifications of nanostructured materials- nanoparticles- quantum dots, nanowires-ultra-thinfilms-multilayered materials.Length Scales involved and effect on properties: Mechanical, Electronic,
Optical, Magnetic and Thermal properties.Introduction to properties andmotivation for study (qualitative only).

UNIT II GENERAL METHODS OF PREPARATION 9Hrs

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition,MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic LayerEpitaxy, MOMBE.

UNIT III NANOMATERIALS 12Hrs

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube,Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes(MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes,Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays9Hrs0functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications

UNIT IV CHARACTERIZATION TECHNIQUES 9Hrs

X-ray diffraction technique, Scanning Electron Microscopy – environmental echniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS Nanoindentation

UNIT V APPLICATIONS 9Hrs

NanoInfoTech: Information storage- nanocomputer, molecular switch, superchip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics andbiotechnology, Nano medicines, Targetted drug delivery, Bioimaging–MicroElectro Mechanical Systems (MEMS), Nano Electro Mechanical Systems
(NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition,Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery

TOTAL No. of Hrs: 45

REFERENCES

1. G Timp (Editor), "Nanotechnology", AIP press/Springer, 1999.
2. AkhleshLakhtakia (Editor),"The Hand Book of Nano Technology,Nanometer Structure, Theory, Modeling and Simulations".Prentice-Hall of India (P) Ltd, New Delhi, 2007.
3. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
4. N John Dinardo, "Nanoscale charecterisation of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000

MCT13CE08 FRONTIERS OF CHEMICAL ENGINEERING 3 00 3

OBJECTIVE:

- To enable the students to understand the chemical product design and available renewable energy resources

UNIT I PROCESS INTENSIFICATION 9Hrs

Novel reactor configurations; combination of reaction and separation; use of different energy fields, lab on a chip.

UNIT II CHEMICAL PRODUCT DESIGN 9Hrs

Scope and importance; identification of needs and specifications; sources of ideas and screening ideas; selection of product idea; process development for product manufacture; specialty chemical manufacture; economic aspects.

UNIT III RENEWABLE ENERGY 9Hrs

Hydrogen production, Hydrogen economy, Fuel Cell Technology, biofuel cells and bio-hydrogen, solar energy

UNIT IV MATERIALS ENGINEERING 9Hrs

Polymers and composites, ceramics and glasses, colloidal dispersions and nanoparticles, thin films and electronic materials

UNIT V BIOENGINEERING 9Hrs

Biomechanics, biotransport and biomaterials, biomolecular and cellular engineering, drug discovery and development.

TOTAL No. of Hrs: 45

REFERENCE:

1. Mitchell, B.S., An introduction to materials engineering and science for chemical and materials engineers, John Wiley and Sons Inc., New Jersey, 2004
2. Keil, F. J., Modeling of Process Intensification Wiley-VCH Verlag GmbH &Co. KGaA2007
3. Cussler, E.l. and Moggridge, G.D., "Chemical product design" Cambridge University Press, Cambridge, 2001
4. Hoffmann,P, Tomorrow's energy: hydrogen, fuel cells, and the prospects for cleaner planet, MIT Press, Sabon, 2002

MCT13CE09 PROFESSIONAL ETHICS IN ENGINEERING 3 0 0 3

OBJECTIVE:

- To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES 10Hrs

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty –Courage – Valuing time – Cooperation – Commitment – Empathy – Selfconfidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS 9Hrs

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry –Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory –Consensus and Controversy – Models of professional roles - Theories aboutright action – Self-interest – Customs and Religion – Uses of Ethical Theories

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9Hrs

Engineering as Experimentation – Engineers as responsible Experimenters –Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9Hrs

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality– Conflicts of Interest – Occupational Crime – Professional Rights – EmployeeRights – Intellectual Property Rights (IPR) – Discrimination

UNIT V GLOBAL ISSUES 8Hrs

Multinational Corporations – Environmental Ethics – Computer Ethics –Weapons Development – Engineers as Managers – Consulting Engineers –Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility

TOTAL No. of Hrs: 45

REFERENCES

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, NewJersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "EngineeringEthics – Concepts and Cases", Cengage Learning, 2009
3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education,New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, "Fundametals of Ethics forScientists and Engineers", Oxford University Press, Oxford, 2001
5. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making forPersonal Integrity and Social Responsibility" Mc Graw Hill education, IndiaPvt. Ltd.,New Delhi 2013.\
6. World CommUNITy Service Centre, ' Value Education', Vethathiri publications,Erode, 2011
7. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGrawHill, New Delhi, 2003.
8. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

MCT13CE10 INDUSTRIAL INSTRUMENTATION 3 0 0 3

OBJECTIVE:

- To impart knowledge on measuring of process variables, analytical instrumentation, automatic process controls.

UNIT I **5Hrs**

Introduction – Variables, UNITs & standards of measurement, Measurement terms – characteristic. Data Analysis.

UNIT II **12Hrs**

Process Variables Measurement–Temperature systems– Thermocouples, Thermo resistive system, Filled-system thermometers, Radiation thermometry, Location of temperature measuring devices in equipments, Pressure system – Mechanical pressure elements Pressure Transducers and Transmitters,Vacuum measurement, Resonant wire pressure Transducer, Flow system –Differential producers, Variable area flow meters, Velocity, vortex, mass, ultrasonic & other flow meters, positive displacement flow meters, Open –channel flow measurements, Force systems, Strain gauges Humidity Moisture system, Humidity Measurement, Moisture measurement system, Rheological system, Viscosity measurement, Radiation system, Nuclear radiation instrumentation.

UNIT III **12Hrs**

Analytical instrumentation – Analysis instruments, Sample conditioning forprocess analyzers, X-ray Analytical methods, Quadrupole mass spectrometry,Ultra violet Absorption Analysis, Infra red process analyzers, Photometricreaction product analysers Oxygen analyzers, Oxidation – reduction potential measurements, pH measuring systems, Electrical conductivity and Resistivity measurements, Thermal conductivity, gas analysis, Combustible, Total hydrocarbon, and CO analyzer, Chromatography.

UNIT IV **9Hrs**

Fundamentals of Automatic process control – Control algorithms-Automatic controllers – Electronic controllers - Electric controllers (Traditional) – Hydraulic controllers – Fluidics - Programmable controllers.

UNIT V **7Hrs**

Sensors, Transmitters and control valves - Pressure, Flow, Level, Temperature and Composition sensors, Transmitters, Pneumatic and electronic control valves, Types, Actuator, accessories, Instrumentation symbols and Labels.

TOTAL No. of Hrs: 45

REFERENCES

1. Ernest Doebelin, Measurement systems, McGraw – Hill Book, Co., NY, 1975.
2. Astrom K.J., Bjonwittenmark, Computer controlled systems, Prentice- Hallof India, New Delhi 1994.
3. Cartis Johnson, Process Control Instrumentation Technology, Prentice-Hallof India, New Delhi 1993.
4. Fribance, “Industrial Instrumentation Fundamentals” ,Mc Graw Hill Co. Inc.New York 1985
5. Eckman D.P. “Industrial Instrumentation”, Wiley Eastern Ltd., 1989.
6. Considine D M and Considine G D “Process Instruments Controls” Handbook 3rd Edition, McGraw – Hill Book Co., NY, 1990.
7. Scborg D E,.Edgar T.F and Mellichamp D.A, “Process Dynamics and Control” John Wiley 1989.

MCT13CE11 FERTILIZER TECHNOLOGY 3 0 0 3

OBJECTIVE:

- To enable the students to learn the fertilizer manufacturing including new or modified fertilizer products and new techniques

UNIT I NITROGENOUS FERTILISERS 9Hrs

Methods of production of nitrogenous fertilizer-ammonium sulphate, nitrate,urea and calcium ammonium nitrate; ammonium chloride and their methods of production, characteristics and specifications, storage and handling.

UNIT II PHOSPHATIC FERTILISERS 9Hrs

Raw materials; phosphate rock, sulphur; pyrites etc., processes for the production of sulphuric and phosphoric acids; phosphates fertilizers – ground rock phosphate; bone meal-single superphosphate, triple superphosphate, triplesuperphosphate, thermal phosphates and their methods of production, characteristics and specifications.

UNIT III POTASSIC FERTILISERS 9Hrs

Methods of production of potassium chloride, potassium sulphate their characteristics and specifications.

UNIT IV COMPLEX AND NPK FERTILISERS 9Hrs

Methods of production of ammonium phosphate, sulphate diammonium phosphate, nitrophosphates, urea, ammonium phosphate, mono-ammonium phosphate and various grades of NPK fertilizers produced in the country.

UNIT V MISCELLANEOUS FERTILISERS 9Hrs

Mixed fertilizers and granulated mixtures; biofertilisers, nutrients, secondary nutrients and micro nutrients; fluid fertilizers, controlled release fertilizers,controlled release fertilizers.

TOTAL No. of Hrs: 45

REFERENCES

1. Sauchelli, V.; "The Chemistry and Technology of Fertilizers", ACS MONOGRAPH No. 148, Reinhold Publishing Cor. New York, 1980.
2. Fertiliser Manual, "UNITed Nations Industrial Development Organisation", UNITed Nations, New York, 1967.
3. Slack, A.V.; Chemistry and Technology of Fertilisers, Interscience, New York, 1966.
4. "Handbook of fertilizer technology", Association of India, New Delhi, 1977.
5. Menno, M.G.; "Fertilizer Industry - An Introductory Survey", HigginbothamsPvt. Ltd., 1973.

MCT13CE12 **PETROLEUM TECHNOLOGY** **3 0 0 3**

OBJECTIVE:

- To make the students understand petroleum engineering principles, their application to petroleum and natural gas manufacturing problems.

UNIT I INTRODUCTION **9Hrs**

Refinery products – Refinery Feeds – Crude distillation – Coking and thermal process.

UNIT II CATALYTIC CRACKING **9Hrs**

Catalytic Cracking - Catalytical hydro cracking – Hydro processing and Reused processing hydro treating.

UNIT III CATALYTICAL **9Hrs**

Reforming and isomerization alkylation and polymerization – Product blending –Supporting processes.

UNIT IV LUBRICIATING **9Hrs**

Lubriciating oil blending stocks petrochemical feedstocks.

UNIT V COST EVALUATION **9Hrs**

Cost Evaluation – Economic evaluation of petroleum reused and refineries.

TOTAL No. of Hrs: 45

REFERENCES

1. Modern Petroleum Technology Upstream Vol I A.G. Lucas Hurley Edition, 2002
2. Petroleum Refining : Technology and economics CRC Press V Edition 2007 J.CH Garry ,Hardward G.E and M.J.Kaiser.

MMA3019 OPERATIONS RESEARCH FOR CHEMICAL ENGINEERS 3 0 0 3

OBJECTIVE:

- To study linear programming and duality programming required for chemical engineers in simulation work.
- To understand dynamic programming and formulations.
- Students can gain knowledge about the networking and queuing models..

UNIT I LINEAR PROGRAMMING 12Hrs

Formulation of LPP – Standard form of LPP – Graphical method – Simplex method – Big M method – Two phase method.

UNIT II DUALITY IN LINEAR PROGRAMMING 12Hrs

Duality – Primal-Dual relation – Dual simplex method – Sensitivity analysis.

UNIT III INTEGER AND DYNAMIC PROGRAMMING 12Hrs

Linear Integer programming – Cutting plane method – Branch and Bound method – Dynamic programming – Formulation.

UNIT IV CPM AND PERT 12Hrs

Network representation – Fulkerson's rule – Critical path method – Scheduling of activities – Earliest and Latest times – Float and Slack times – PERT – Probability for project duration – Cost consideration: Crashing.

UNIT V QUEUING 12Hrs

Elementary concepts – Pure Birth and Death process – Single server Markovian models with infinite and finite capacity – Multi server Markovian models with infinite and finite capacity.

Total no. of hrs: 60

REFERENCES

1. Hamdy A. Taha, *Operations Research: An Introduction (9th ed.)*, Pearson, (2010).
2. Hillier, Lieberman, *Introduction to Operations Research (8th ed.) (IAE)*, Tata McGraw Hill Publishing Co., (2005).
3. Panneerselvam R., *Operations Research (2nd ed.)*, Prentice Hall of India, (2011).
4. Sundaresan V. et al., *Resource Management Techniques*, A.R. Publications, (2009).
5. Ravindran, Phillips, Solberg, *Operations Research: Principles and Practice (2nd ed.)*, John Wiley & Sons, (2007).
6. Hira D.S., Gupta P.K., *Operations Research*, S.Chand & Co., (2007).