Advanced Transport Phenomena

Teaching scheme (Hr/week)			Examination scheme				
Lecture	**Tutorial**	**Term work**	**Theory**	**Sessional**	**Term work**	**Viva-voce**	**Total**
3	**1**	**2**	**60 Marks 3 Hr**	**40 Marks 1 Hr**	**50 Marks**	**-**	**150**

1. **Transport in Turbulent Flow**
    a. **M**omentum Transport: time smoothing of equation of change for incompressible fluid & review of logarithmic law of viscosity
    b. Energy Transport: temperature fluctuations & time smoothing of temperature & energy equation, semi-empirical equations for turbulent energy flux
    c. Mass Transport: time smoothing of equation of change, turbulent concentration profiles
2. **Transport between Two Phases**
    a. Momentum transport: friction factors for flow in tubes, flow rate & pressure drop relations, friction factor for packed beds
    b. Energy Transport: non-isothermal system, heat transfer coefficients, dimensionless correlations for forced & free convection in tubes & around submerged objects, heat transfer coefficient for forced convection through packed bed.
    c. Mass Transport: mass transport coefficient, correlations for binary systems in one phase & at low mass transfer rates, definition & correlation for binary mass transfer coefficients in two phases at low mass transfer rates, transfer coefficients for high mass transfer rates, boundary layer theory
3. **Transport in Layer Flow System**
    a. microscopic mass balance & mechanical energy balances, estimation of friction losses, macroscopic energy balance in non-isothermal systems, use of balances to solve steady state & unsteady state problems.

4. **Transport by other mechanisms:**
    a. Momentum transport in polymeric liquids
    b. Energy transport by radiation
    c. Mass transport in multi component systems and cross effects

Note:

While teaching the above topics more stress is to be given on the following unit operations;

1. Transport Phenomena in liquid extraction
2. Transport Phenomena in gas absorption
3. Transport Phenomena in distillation

Text Book

1. Transport Phenomena by R. B. Bird, W. E. Stewart & F. W. Lightfoot
   John Wiley & Sons
2. Momentum Transfer Operations by S. K. Gupta
   Tata McGraw Hill Corp,

Reference Book

1. Transport Phenomenon in Liquid Extraction by G. S. Laddha & T. E. Degaleesan
   McGraw Hill Publishing
2. Absorption & Extraction by T. K. Sherwood & R. L. Pigford
   McGraw Hill Publishing
3. Multi-component Distillation by D. D. Holland
   Prentice Hall, India

MC122: PARTICULATE TECHNOLOGY

Teaching scheme(Hr/week)			Examination scheme				
Lecture	**Tutorial**	**Term work**	**Theory**	**Sessional**	**Term work**	**Viva - voce**	**Total**
3	**1**	**2**	**60 Marks 3 Hr**	**40 Marks 1 Hr**	**50 Marks**	**-**	**150**

1) Particle Characteristcs like permeability, Angle of friction, Angle of repose,
Despersability apparent density etc.
2) Design of Storage bin, Mohr circle , Mass flow rate of solids from bins etc
3) Pneumatic conveying
4) Slurry transportation
5) Fluidisation and Spouted bed
6) Solid- Solid mixing

REFERENCE BOOKS

1) Encyclopedia of Fluid Mechanics
Chermischnoff, Gulf Publishers Co.
2) Air Pollution Control
Crawford, Tata Mcgraw Hill Publication
3) Fluidization Engineering
Kunii & Levenspiel, McGraw Hill Publication

Introduction to environmental engineering

Teaching scheme (Hr/week)			Examination scheme				
Lecture	**Tutorial**	**Term work**	**Theory**	**Sessional**	**Term work**	**Viva-voce**	**Total**
3	**1**	**2**	**60 Marks 3 Hr**	**40 Marks 1 Hr**	**50 Marks**	**-**	**150**

1. Introduction

Types of pollution & their impacts on the environment

2. Environmental chemistry: Aquatic Chemistry : Chemical equilibria and kinetics fundamentals; Acids and bases; Titrations; Acidity; Alkalinity; Buffers and buffer intensity; Chemical equilibrium calculations; pC-pH diagram. Precipitation and dissolution; Water softening and water conditioning; Langelier index; Solubility diagram; Coexistence of phases in equilibrium; Complexation of metal ions and organic complexes in natural water. Oxidation and reduction reactions stoichiometry; Redox couples; pE-pH diagrams; Redox control in natural systems; Basic concepts of organic and colloid chemistry. Soil Chemistry : Weathering reactions; Structure and surface reactions of clays and oxides; Forces at soil-water interfaces. Atmospheric Chemistry : Chemical equilibria and kinetics; Photo-dissociation and free radical reactions; Chemistry of precipitation; Acid rain.
3. Environmental microbiology: Structure of prokaryotic and eukaryotic cells; Types of microorganisms; Metabolic classification of microorganisms. Microbial metabolism; Respiration and energy generation; Microbial growth. Ecology; Ecosystem structure; Energy flow and material cycling in an ecosystem; Biogeochemical cycling of carbon, nitrogen, phosphorous and sulphur; Biodiversity and conservation of wild genetic resources. Microbiological aspects of drinking water and water distribution systems.

4. Sources & Effects of air and water pollution

Definition, ways of expressing concentration, classification & properties of air pollutants, emission sources – classification according to source types, major emissions from global sources & emission source in India, behaviour & fate of air pollutants, effect of air pollution on – human health, vegetation & materials, air pollution laws & standards Sources of wastewater in process industries, characteristics of waste water, water pollution laws & standards.

5. Meteorological Aspects of Air Pollution and Sampling & Measurement

Pollutant dispersion, temperature lapse rate & stability, wind velocity & turbulence, plume behaviour. Ambient air sampling & stack sampling, analysis of air pollutants

6. Air Pollution Control Methods & Equipment

source correction methods, particulate emission control methods & gaseous emission control methods with special emphasis to Control of sulphur oxides, nitrogen oxides, carbon monoxide & hydrocarbon emissions

7. W. W. Treatment

Objectives & classification of W. W. treatment methods, Use of physical unit operations like screening, communition, grit chambers, flow equalisation, mixing, flocculation, sedimentation, floatation & filtration in waste water treatment. Use of chemical unit processes like chemical precipitation, gas transfer, adsorption, disinfect ion with chlorine & ozone, dechlorination in wastewater treatment

8. Biological Unit Processes

Introduction to treatment processes attached growth and suspended growth processes. Aerobic suspended growth treatment processes: activated sludge process, aerobic aerated lagoons, aerobic digestion, and aerobic stabilisation ponds. Aerobic attached growth treatment processes & their design – trickling filters, rotating biological contactors, anaerobic suspended growth, treatment processes – anaerobic digestion, anaerobic attached growth treatment process & design– anaerobic filter & anaerobic ponds, combined aerobic/anoxic or anaerobic treatment processes – facultative lagoons (ponds), sludge treatment & disposal

9. Solid Waste Management: sources & classification, methods of collection & disposal

10. Noise Pollution: sources of noise pollution & their control methods

Text Book

1. Environmental Pollution Control Engineering by C. S. Rao
   Wiley Eastern Ltd.
2. Waste Water Engineering – Treatment, Disposal & Reuse by Metcalf & Eddy Inc.
   Tata McGraw Hill Publications

Reference Book

1. Introduction to Environmental Engineering by Mackenzie L. Davis & David A. Cornwell
   McGraw Hill International Publications
2. Environmental Engineering by Raw, Peavy & Tchobanoglous
3. Chemistry for Environmental Engineering 3rd Ed. by Sawyer & McCarty
   McGraw Hill Publications

MC225: ADVANCED CHEMICAL REACTION ENGINEERING

Teaching scheme (Hr/week)			Examination scheme				
Lecture	**Tutorial**	**Term work**	**Theory**	**Sessional**	**Term work**	**Viva-voce**	**Total**
3	**1**	**2**	**60 Marks 3 Hr**	**40 Marks 1 Hr**	**50 Marks**	**-**	**150**

1) Non-ideal flow with stress on single parameter and multiparameter models.
2)Fundamentals of heterogeneous reactions, fluid- fluid reactions.
3) Catalytic reaction: effective ness factor of catalyst various types of reactors to determine the reaction rate.
4) Design and analysis of chemical reactors: Design of fluid solid catalytic reactors, packed bed reactors , design of non - catalytic fluid solid reactors . Design of fluid- fluid reactors.

REFERENCE BOOKS

1) Chemical Reaction Engineering(III Edition)
   O.Levenspiel, Wiley Eastern(p) Ltd.
2) Elements of Chemical Reaction Engg(II Edition).
   H.S.Fogler, Prentice Hall(India) Ltd
3) Chemical Engg.Kinetics(III Edition)
   J.M.Smith, McGraw Hill Publication

MC 116 : PROCESS MODEL IDENTIFICATION

Teaching scheme (Hr/week)			**Examination scheme**				
Lecture	**Tutorial**	**Term work**	**Theory**	**Sessional**	**Term work**	**Viva - voce**	**Total**
3	**1**	**-**	**60 Marks 3 Hr**	**40 Marks 1 Hr**	**-**	**-**	**100**

1. Introduction to modeling: Classification of modeling schemes. Introduction to first principle models, gray box models, black box models.
2. Statistical Preliminaries: random process, random variables, time invariance, correlation, correlation coefficient etc.
3. Input signal design: Concept of persistency of excitation, concept of plant friendly ness, design and implementation of input signals like RGS, PRBS, Maximum length signals, Multi level signals, Relay feed back signals, Introduction to Signal design for closed loop systems.
4. Linear models: Introduction to the concept of local linearization. Detailed discussion on time series and state space model development. Introduction to linear regression, analysis of least squares estimate, best linear unbiased estimate, Recursive identification methods, Partial least squares, total least squares, introduction to prediction error methods and Instrumental variable methods. Introduction to commercial softwares on system identification.
5. Nonlinear models: Introduction to ANN based nonlinear model identification. Modeling of complex nonlinear systems using fuzzy decomposition and multi model approach. Modeling of nonlinear systems using Voltera series models. Concept of block oriented nonlinear model identification. Development of nonlinear models using Ortho normal basis functions.
6. Model order: Introduction to concept of structure selection and model order, conventional model order reduction techniques. Introduction to nonlinear model order reduction techniques.

7. Stochastic modeling: Development of stochastic time series models, Introduction to concept of kalman filtering, Introduction to nonlinear ARX and nonlinear ARMAX type models. Introduction to extended kalman filters.

REFERENCE BOOKS

1) System Identification by Torsten Soderstrom and Petre stoica, Prentice Hall International series in systems and control engineering.
2) System Identification Theory for the user, Lennert Ljung, Prentice hall PTR, Upper saddle River, NJ, 07458.
3) Lessons in estimation theory for signal Processing communications and control, by Jerry M.Mendal, Prentice hall signal processing series.
4) Perturbation signals for system identification, Editor Keith Godfrey, Prentice Hall International series
5) System identification special addition, Automatica, 1995 November.

MC126: SEMINAR

Teaching scheme (Hr/week)			**Examination scheme**				
Lecture	**Tutorial**	**Term work**	**Theory**	**Sessional**	**Term work**	**Viva-voce**	**Total**
-	**-**	**6**	**-**	**-**	**50**		**50**

Semester-2
MC223: OPTIMIZATION TECHNIQUES

Teaching scheme(Hr/week)			Examination scheme				
Lecture	**Tutorial**	**Term work**	**Theory**	**Sessional**	**Term work**	**Viva - voce**	**Total**
3	**1**	**2**	**60 Marks 3 Hr**	**40 Marks 1 Hr**	**50 Marks**	**-**	**150**

1) Basics of operation research
2) Linear programming.
3) Transportation model.
4) Assignment model.
5) Sequencing model.
6) Dynamic programming.
7) Inventory model.
8) PERT Computation.
9) CPM Computation.

REFERENCE BOOKS

1) Operations Research
   Gupta, Chand & Co.
2) Optimisation Techniques
   D.Himmelblau, McGraw Hill Publication

MC224: ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS

Teaching scheme (Hr/week)			Examination scheme				
Lecture	**Tutorial**	**Term work**	**Theory**	**Sessional**	**Term work**	**Viva-voce**	**Total**
3	**1**	**-**	**60 Marks 3 Hr**	**40 Marks 1 Hr**	**-**	**-**	**100**

1) Fugacities , activities and departure functions.
2) Phase and chemical equilibrium.
3) Partition functions ;canonical, grand canonical and microcanonical ensembles .
4) Inter molecular potentials.
5) Distribution functions and corresponding states theory.
6) Introduction to irreversible thermodynamics.
7) Computer simulation methods.
8) Extensive problem assignments throughout.

REFERENCE BOOKS

1) Statistical Thermodynamics
   Sontag, McGraw Hill Publication
2) Chemical Engg. Thermodynamics
   Smith & Vanness, McGraw Hill Publication

MC226: SEMINAR

Teaching scheme (Hr/week)			Examination scheme				
Lecture	Tutorial	Term work	Theory	Sessional	Term work	Viva-voce	Total
-	-	6	-	-	50	-	50

Electives subjects for general chemical Engineering
Separation Techniques

Teaching scheme (Hr/week)			Examination scheme				
Lecture	Tutorial	Term work	Theory	Sessional	Term work	Viva-voce	Total
3	1	2	60 Marks 3 Hr	40 Marks 1 Hr	50 Marks	-	150

1. **Introduction to new separation techniques** Introduction to separation process, selection of separation method [2]
2. **Conventional seperation operations:** Design of multicomponent seperation process like distillation, extraction absorption **[10]**

Membrane processes **[10]**

Introduction, principle and mechanism of membrane processes, different processes based on membrane separation processes viz. (1) Reverse osmosis (2) Ultra-filtration (3) Per-vaporation, (4) Supported membrane filtration (5) Emulsion liquid membrane;Membrane selection, Membrane fouling and regeneration, Application of above-mentioned methods to waste water treatment.

3. **Zone melting** **[4]**
   Mechanism of zone melting and applications of zone melting

4. **Super critical fluid extraction** **[9]**

Thermodynamics of supercritical fluid extraction, theory of gas extraction in super critical condition, experimental techniques of super critical fluid extraction, applications of super critical fluid extraction to chemical engineering.

5. **Chromatography** **[5]**

Fundamentals of chromatography, differential migration methods in liquid chromatography, applications of chromatography to chemical engineering.

Text Books:

1. Encyclopedia of Chemical Processing and Design, Mcketta, Vol 29, 48, 56, 59
2. Encyclopedia of Chemical Engineering, J.H.Perry, 7th Ed, McGraw Hill Publication.
3. Hand book of seperation techniques for chemcial engineers, Newyork, Mc Graw Hill 1988.

Reference Books:

1. Super critical fluid technology, JML Penninger, MA Muchugh, VJ Krukonis, Elsvier Publication, 1985.
2. Chrometography (Part I), E. Heftmann, Elsvier Publication.

Process synthesis

Teaching scheme (Hr/week)			Examination scheme				
Lecture	**Tutorial**	**Term work**	**Theory**	**Sessional**	**Term work**	**Viva-voce**	**Total**
3	**1**	**2**	**60 Marks 3 Hr**	**40 Marks 1 Hr**	**50 Marks**	**-**	**150**

Synthesis of reactors and reactor networks: Mathematical approach and Heuristic approach **[10]**

Utility operations and process integration: Synthesis of heat exchanger networks, synthesis of mass exchanger networks, design of reactive distillation **[15]**

Synthesis of seperation schemes **[9]**

Flow sheet synthesis: **[6]**

Text books:

1. Biegler, Grossmann, and Western berg., Systematic methods of chemical process design.
2. Rudd Dole,F,Powers Gray J, Siirola , Jeffrey J, Process , Process synthesis , Engle wood cliffs, Printice hall, 1973.