CH 681 CHEMICAL REACTION ENGINEERING-II

Theory : 100 mark	L-T-P
Theory : 100 marks	3- 1-0
Sessional : 50 marks	

1. Design for multiple reactions: Series and parallel reactions, Series-parallel reactions.

2. Temperature and pressure effects: Single reactions, multiple reactions.

3. Choosing the Right Kind of Reactor

4. Residence Time Distribution (RTD) for Chemical Reactors: Predicting Conversion and Exit Concentration; Reactor Modeling Using the RTD- Zero Parameter Models.

5. Models for Non Ideal Reactors: One Parameter Models- Tanks in Series Model, Dispersion Model; Two Parameter Models- Modeling Real Reactors with Combinations of Ideal Reactors

6. Catalysis and Catalytic Reactors: Catalysts, Steps in a Catalytic Reaction, Synthesizing a Rate Law, Mechanism and Rate Limiting Step; Heterogeneous Data Analysis for Reactor Design.

7. Catalyst Deactivation

Books :-

1. Chemical Reaction Engineering by Levenspiel, Wiley Eastern.

2. Elements of Chemical Reaction engineering, Fogler, Prentice hall

3. Chemical Engineering Kinetics by D.M. Smith, McGraw Hill Publication.

4. Reaction Kinetics for Chemical Engineers by Wales, McGraw Hill Publication.

CH 684 HEAT TRANSFER-OPERATIONS

Theory :100 Marks L-T-P
Sessional: 50 Marks 3-1-3
Practicals: 50 Marks

1.Heat transfer by conduction: One-dimensional Heat Conduction equation, Boundary conditions; One dimensional steady state heat conduction for slab, cylinder, sphere, composite medium, Thermal conduct resistance, critical thickness of insulation, Fourier law, Finned surfaces, temperature dependent K (T), Transient conduction and use of temperature charts. Lumped system analysis for slabs and long cylinder and spheres.
2. Heat Transfer by convection : Flow over a body, flow inside a duct. Forced Convection: Hydrodynamic and thermal boundary layer, simultaneously developing laminar flow, Turbulent flow inside ducts, Heat transfer to liquid metals. FreeConvection : Dimensionless parameters of Free Convection, Correlations of free convection on a vertical plate, Free Convection on a horizontal plate.
3. Condensation: Nusselt equation for horizontal and vertical condenser, Drop and film type condensation, Effect of non-condensable gases. Boiling: Boiling of liquids. Nucleate and film boiling.
4.Heat Transfer by Radiation: Concept of black body , Kirchoff's Law Emissivity, absorptivity, black body and grey body radiation. View factors, Radiation from non- luminous gases,
5. Heat Exchanges: Classification, temperature distribution in heat exchangers, Overall heat transfer co-efficient, the LMTD method for heat exchanger analysis, correction for LMTD for use with cross flow and multipass exchanger.
6.Evaporation : Classification and application, operation of single and multiple effect evaporators.
7.Preliminary design aspect of heat transfer equipments: Heat Exchangers: Hair pin (double pipe exchangers) 1-2 shell and tube exchangers, Extended surface heat exchangers, Calculation of Fin efficiency, LMTD, fouling factor.

Practical: (sessional)
1. Thermal conductivity of solid materials.
2. Heat transfer in double pipe and shell and tube heat exchanger.
3. Condensation Heat transfers.
4. Heat transfer in extended surfaces.

TEXT BOOKS:
1. Heat transfer- Principles and applications; B K Dutta, Prentice Hall India
2. Heat Transfer – A basic approach by M. Necati Ozisik
3. Heat Transfer by W. H. McAdams , Mcgraw-Hill.
4. Fundamentals of Heat Transfer by M. Mikheyev – Mir publications.
5. Unit operations of chemical Engg. W. L. cabe & J. C. Smith – Mcgraw – Hill Publication.

CH 683: MASS TRANSFER OPERATION - I

Theory : 100 marks
Sessional: 50 marks
Practical: 50 marks

L – T – P
3 – 1 – 3

Introduction to mass transfer and diffusion, molecular diffusion in gases , liquids biological solutions and gels. Diffusivity measurements and prediction, multi component diffusion, molecular diffusion in solids, Fick's Law, steady state molecular diffusion in fluids under stagnant and laminar flow conditions. Diffusion through variable cross section

Concept of mass transfer coefficient, boundary layers, theories of mass transfer and their application, interphase mass transfer, equilibrium and diffusion between phases, Momentum , heat and mass transfer analogies

Equipment for Gas – Liquid Operations: sparged and agitated vessels, venturi scrubbers, wetted wall towers , tray and packed towers.

Theory, design of packed towers and plate towers, co-current and counter, multistage absorption. Correlation for mass transfer coefficient in packed towers, Height equivalent of theoretical plate (HETP), number of transfer units (NTU), height of transfer units (HTU), loading flooding criterion.

Drying equilibria, drying rate curve, rate and time of batch drying, mechanism of batch drying, continuous drying

Crystallization: Theory, Solid-Liquid phase equilibrium, Nucleation and crystal growth, solubility and material balance, melt crystallization, Batch crystallization, crystallization equipment

Books recommended:

1. Treybal, R.E.," Mass Transfer operation", McGraw Hill International Edition, 3rd Ed, 1981.
2. McCabe, W.L., Smith, J, and Harriot, P., "Unit operation of Chemical Engineering", McGraw Hill International Edition, 6th Ed, 2001.
3. Geankoplis, C.J., "Transport Process and Unit Operations", Prentice Hall 3rd Ed, India, 1993
4. Dutta, B.K., "Principles of Mass Transfer and Separation Processes", Prentice Hall, India, 2007.
5. Seader, J.D., Henley, J. E., Separation Process Principles" 2nd Ed, Wiley India edition, 2010

CH 685 PETROLEUM REFINING AND PETROCHEMICALS

Theory :100 Marks L – T - P
Sessional: 50 Marks 3- 1 - 3
Practicals: 50 Marks

1. PRIMARY PROCESSING OF CRUDE OIL : Composition & Classification of crude oil, Petrolem products and testing , Atmospheric distillation .Vacuum distillation of residue-products and distillation practice, Pipestill heater design procedures
2. SECONDARY PROCESSING OF CRUDE OIL : FCCU, Hydro cracking, Visbreaking, Thermal cracking. Coking, Reforming, Alkylation, Polymerization and Isomerisation process.
3. TREATMENT-TECHNIQUES : Upgradation techniques for heavy and waxy oils ,Treatment techniques for removal of objectionable gases. Odours to improve performance, Storage stability. Extraction of aromatics, Olefins and recovery operations from petroleum products.
4. PETROCHEMICALS : Chemicals from methane and synthetic gas: Ammonia, Methanol and Hydrogen Cyanide, Chemicals from olefins; Ethylene derivatives, Propylene derivatives and Butylene derivatives, Aromatics, intermediates for synthetic fibers. Plastics and rubber.
5. ENVIRONMENTAL AND SAFETY ASPECTS IN REFINERY AND PETROCHEMICALS : Waste water and effluent gases treatment from alkylation units and petrochemical units, safely aspects in the above industries.

Practical :

i) Determination of Smoke Point of kerosene fraction
ii) Determination of Aniline Point & diesel index of Fuel.
iii) Penetration Index & softening point of bitumen.
iv) ASTM Distillation .
v) Water content by Dean & Stark method.

TEXTBOOKS :

1. W.L. Nelson, "Petroleum Refinery Engineering"' Edn., McGraw Hill , New York 1985
2. B. K. Bhaskara Rao, "Modem Petroleum Refining Processes", 2nd' Edn., Oxford and IBH Publishing Company, New Delhi, 1990. Khanna Publishers.

REFERENCES :

1. G. D. Hobson and W.Pohl., " Modem Petroleum Technology", Gulf Publishers 2nd. Edn., 1990..
2. R. A. Meyers, "Hand book of Petroleum Refining Processes", McGraw Hill , 1st Edn., 1980.
3. F. Hatch md Sumi Malar, "From Hydrocarbons to Petrochemicals", Gulf Publishing Company, 1st Edn. 1981.

CH 686 PROCESS DYNAMICS AND CONTROL

Theory : 100 marks
Sessional: 50 marks
Practical : 50 marks

L – T – P
3 – 1 – 3

Introduction: Incentive for chemical process control, Process variables, Design elements of a control system, Liquid surge tank, Blending process (1 hr)

Modelling the dynamics and static behaviour of chemical process: Development of a mathematical model, Example of modelling of a stirred tank heater, Input – Output models, Degrees of freedom, Linearization of a non-linear model. (4 hrs)

Dynamic behaviour of chemical process: Laplace Transform, Laplace Transform of derivatives, First order process, Significance of First order process, Second order process, Features of process response, Poles and zeroes, Higher order systems. Frequency response analysis, Bode diagram, Bode diagram of pure time delay, Nyquist plot. (12 hrs)

Feedback controllers: Introduction of feedback control, Elements of control loop, Concept of servo and regulatory problems, Types of controller P, PI, PID, on-off, Stability of a closed loop process, Stability analysis, Zeiglar Nichols tuning, Bode stability criterion. (12 hrs)

Advanced control system:
Large dead time, Dead time compensation, Cascade control, Split range control, Feed forward control, Ratio control, Adaptive control, Digital computer control. (6 hrs)

Controllers and final control elements: Self operated, Pneumatic, Hydraulic, Electric Power employed, Actuators, Sensors, Flow measuring devices. (5 hrs)

Practicals:

1. Temperature control.
2. Flow control.
3. Characteristics of control valve.

Books recommended :
1. Automatic Process Control by D.P. Eckman.
2. Chemical Process Control by George Stephanopoulos (1984), Prentice – Hall of India.
3. Process System Analysis & Control by Coughanowr & Koppel (1991), Tata-McGraw Hill publication
4. Process Dynamics and Control, D.E. Seborg, T.F. Edgar and D.A. Mellichamp (2003), Wiley, New York

CH 682 : PROCESS ENGINEERING ECONOMICS & OPTIMISATION

Theory : 100 marks L-T-P
Sessional : 50 marks 3-1-0

Feasibility Analysis : Technology of project. Market Survey analysis.

- **Interest and Economic Equivalence** – Simple interest, Compound interest, Present Worth and Discount, Nominal & Effective interest rates, Uniform annual end of the year amount, i.e. unacost, Uniform annual beginning of year amount, Applications in cost comparison, Cost comparison by present worth for unequal duration of service lives, Cost comparison by unacost, Cost comparison by Capitalized cost.
- **Depreciation & Taxes :** What is depreciation, Depreciation terms and depreciation relationships, Methods of determining depreciation – Straight Line Method, declining Balance Method, Sum-of-the-year Digits Method, Sinking Fund method.
- **Cost Estimation :** Types of Cost Estimation, Process Equipment Cost Estimation, Cost Index, Equipment Cost Size relationship, Production Cost.
- **Profitability :** Introduction, Methods of profitability evaluation – rate of return on investment, rate of return on average investment, Payout time, Payout time with interest, Discounted Cash Flow (DCF) method, venture worth method, Application of profitability relation in alternative investment analysis, cost factor in profitability evaluation.
- **Break Even Analysis :** Introduction, Relation between costs and production. Economic Production chart, Break even chart, Economic Production cost vs rapidity variation, capacity factor, demand factor, load factor, diversity factor, application of break even analysis for project improvement.
- **Financial Statements,** financial analysis and Financial Institutions.
- **Optimization :** Introduction, optimization techniques, nature of optimization, unvariable systems – analytical methods of solution, multivariable systems, method of Lagrangian Multipliers, Search Method, Time Programming.

BOOKS :

1. Chemical Engineering Economics and Division Analysis, Chemical Engineering Education Development Centre, IIT, Madras.
2. Pradip Kumar, Financial Accountancy.
3. Process Plant and Equipment Cost Estimation, Sevak Publication, Mumbai.
4. Jelen, F.C., Cost and Optimization Engineering, McGraw-Hill.