V SEMESTER

MANAGEMENT & ENTREPRENEURSHIP

Subject Code	: 10AL51	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

MANAGEMENT

UNIT 1:

Management: Introduction: Meaning – nature and characteristics of Management, Scope and functional areas of management – Management as a science, art or profession – Management & Administration – Roles of Management, Levels of Management, Development of Management Thought – early management approaches – Modern management approaches. **7 Hours**

UNIT 2:

Planning: Nature, importance and purpose of planning process – Objectives – Types of plans (Meaning only) – Decision making – Importance of planning – Stes in planning & planning premises – Hierarchy of plans. **6 Hours**

UNIT 3:

Organising And Staffing: Nature and purpose of organization – Principles of organization – Types of organization – Departmentation – Committees – Centralization Vs Decentralization of authority and responsibility – Span of control – MBO and MBE(Meaning only) Nature and importance of Staffing – Process of Selection & Recruitment (in brief). **7 Hours**

UNIT 4:

Directing & Controlling: Meaning and nature of directing – Leadership styles, Motivation Theories, Communication – Meaning and importance – Coordination, meaning and importance and Techniques of Co – ordination. Meaning and steps in controlling – Essentials of a sound control system – Methods of establishing control (in brief). **6 Hours**

PART - B

ENTREPRENEURSHIP

UNIT 5:

Entrepreneur: Meaning of Entrepreneur; Evolution of the Concept, Functions of an Entrepreneur, types of Entrepreneur, intrapreneur – an emerging emerging Class. Concept of Entrepreneurship – Evolution of Entrepreneurship, Development of Entrepreneurship. **6 Hours**

UNIT 6:

Small Scale Industry: Definition; Characteristics; Need and rationale: Scope; role of SSI in Economic Development. Advantages of SSI. Steps to Start and SSI – Government policy towards SSI; Different Policies of S.S.I.; Government Support for S.S.I. during 5 year plans. Impact of Liberalization, Privatization, Globalization on S.S.I., Effect of WTO/GATT Supporting Agencies of Government for S.S.I., Meaning; Nature of Support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry (Definition only). **6 Hours**

UNIT 7:

Institutional Support: Different Schemes; TECKSOK; KIADB; KSSICE; KSIMC; DIC Single Window Agency: SISI; NSIC; SIDBI; KSFC. **8 Hours**

UNIT 8:

Preparation Of Project: Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; formulation; Guidelines by Planning Commission Identification of Business Opportunities:

Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. **6 Hours**

TEXT BOOKS:

1. **Principles of Management –** P.C. Tripathi, P.N.Reddy; Tata McGraw Hill.
2. **Dynamics of Entrepreneurial Development & Management –** Vansant Desai – Himalaya Publishing House –
3. **Entrepreneurship Development** – Small Business Enterprises – Poornima M Charantimath – Person Education – 2006.
4. **Management and Enterprenurship** –NVR Naidu and Krishna Rao- I K International – 2008.

REFERENCE BOOKS:

1. **Management Fundamentals –** Concepts, Application, Skill Development – Robert Lusier – Thomson
2. **Entrepreneurship Development –** S S Khanka – S Chand & Co.
3. **Management –** Stephen Robbins – Pearson Education/PHI – 17th Edition, 2003.

CHEMICAL PROCESS INDUSTRIES

Subject Code	: 10CH52	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT 1:

Sulfur: Elemental Sulfur mining, Sulfur from ores, Oxides of Sulfur (SO_2, SO_3).
Industrial Gases: CO_2, H_2, O_2, N_2, Water gas and Shift gas. **7 Hours**

UNIT 2:

Acids: Sulfuric, Nitric, Hydrochloric, phosphoric acid.
Chlor-Alkali Industries: Sodium chloride, Soda ash, Caustic soda, Chlorine, Bleaching powder. **6 Hours**

UNIT 3:

Fertilizers: Ammonia, Urea, Ammonium chloride, Ammonium nitrate, Ammonium phosphate, Ammonium sulfate, DAP, Biofertilizers. **7 Hours**

UNIT 4:

Phosphorous Industries: Manufacture of white and Red Phosphorus, Pentoxide, Phosphatic Fertilizers, Super Phosphate and Triple Super Phosphate. **6 Hours**

PART - B

UNIT 5:

Fermentation Industries: Production of alcohol, acetic acid and citric, penicillin. **6 Hours**

UNIT 6:

Petroleum Industries: Constituents of crude petroleum refining and processing. Production of Ethylene, Propylene. **7 Hours**

UNIT 7:
Polymers and Rubber: Polymerization, PVC, LDPE, Polyproylene, cross linked polymers, natural rubber, synthetic rubber and rubber compounding. **6 Hours**

UNIT 8:
Miscellaneous Industries: Paints, Pigments, Vanishes, Enamel, Lacquers - White Lead and Zinc oxide, Hydrogen peroxide (H_2O_2), Silicon carbide (SiC), Glass, Cement, Chlorine and Fluorine based industries. **7 Hours**

Text Books:

1. Chemical Process Industries, Shreve's, McGraw Hill, 4th Edition.
2. Dryden – Outlines of Chemical Technology for 21st Century, Rao Gopal & Sittig Marshall, 3rd Edition., EWP.
3. Unit Processes in Organic Chemical Industries, Desikan and Sivakumar (Eds.), CEDC, IITM, 1982.

Reference Book:

1. Encyclopedia of Chemical Engineering, McGraw Hill, 1973.

MASS TRANSFER – I

Subject Code	: 10CH53	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT 1:
Introduction: Types of diffusion in fluids. Types of diffusion in solid. Measurement and calculations of diffusivities. **6 Hours**

UNIT 2:
Eddy Diffusion: Mass transfer coefficients and their correlations. Theories of mass Transfer. Interphase mass transfer. J_d factor, Analogies in mass, heat and momentum transfer processes. **6 Hours**

UNIT 3:
Stage-Wise Operations: Material balance for co-current, cross-current and counter-current operations. Concept of stages, cascades operation, NTU and HTU concepts. **6 Hours**

UNIT 4:
Humidification: General theory. Psychrometric chart. Concepts in humidification, dehumidification. Design of cooling towers. **8 Hours**

PART - B

UNIT 5:
Drying: Introduction, Equilibria, Drying rate curves. Mechanism of drying, types of dryers. Design of batch and continuous dryers. **7 Hours**

UNIT 6:

Crystallization: Factors governing nucleation and crystal growth rates. Controlled growth of crystals. Incorporation of principles into design of equipment. Different types of crystallizer equipment. **6 Hours**

UNIT 7:

Adsorption: Theories of adsorption. Isotherms, Industrial adsorbents. Equipment, Batch & continuous multistage Adsorption. **7 Hours**

UNIT 8:

Introduction To Novel Separations: Ion exchange**,** Membrane processes - Reverse Osmosis, Dialysis, Ultra and Micro-filtrations, Super-critical fluid extraction. **6 Hours**

TEXT BOOKS:

1. **Mass Transfer Operations** - Robert E Treybal, 3rd Edition, McGraw Hill, 1981.
2. **Unit Operations in Chemical Engineering** - McCabe & Smith, 6th Edition, McGraw Hill, 2001.

REFERENCE BOOKS:

1. **Chemical Engineering Vol I, II, IV and V** - Coulson and Richardson, 4th Edition, Pergamon Press, 1998.
2. **Introduction to Chemical Engineering** - Badger & Banchero, TMH 6th Reprint 1998.
3. **Principles of Unit Operation** - Foust et.el. 2nd Edition, John Wiley, 1994.
4. **Transport Processes and Unit Operation** - Geankoplis C J, Prentice Hall(I), 2000.
5. **Applied process design for Chemical and petrochemical plant** Ludwig, 2nd Edition, Gulf Publishing, 2002.

CHEMICAL REACTION ENGINEERING – I

Subject Code	: 10CH54	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT 1:

Introduction: Scope of Chemical Reaction Engineering. Classification of reactions. Rate equation and rate of reaction. Factors affecting rate of reaction. Chemical kinetics and Thermodynamics Equilibrium. Temperature dependency of rate constant from Arrhenius, Collision and Transition state theories. Molecularity and order of reaction. **6 Hours**

UNIT 2:

Non-Elementary Reactions: Difference between elementary and non-elementary reactions. Kinetic models and mechanisms for non-elementary reactions. Types of reactors. **6 Hours**

UNIT 3:

Homogeneous Reactions: Interpretation of batch reactor data. Constant & Variable Volume batch reactor. Analysis : Differential method, Integral method, half-life method. Method of excess and method of isolation (For Reverssible and Irriversibale reactions up to second order). Autocatalytic reactions. **7 Hours**

UNIT 4:

Design Of Ideal Reactors: Concept of ideality. Development of design equations for batch, tubular and stirred tank reactors for both constant and variable volume reactions. Evaluation of rate equations from data obtained in these reactors. **7 Hours**

PART - B

UNIT 5:
Comparison Of Ideal Reactors: General graphical comparison.
Multiple Reactor Systems: Plug flow and/or Mixed flow reactors in Series, parallel and series parallel. Reactors of different types and sizes in series. **6 Hours**

UNIT 6:
Design Of Reactors For Multiple Reactions: Design of Batch reactor, Plug and Mixed flow reactors for Parallel, Series and Series-Parallel reactions (Only irreversible reactions must be considered). **7 Hours**

UNIT 7:
Non-Isothermal Reactors: Introduction, Material, Energy balances and conversions. **6 Hours**

UNIT 8:
Analysis Of Non Isothermal Reactor: Design procedure (For single/ simple reactions only). Optimum temperature Progression. **7 Hours**

TEXT BOOKS:

1. **Chemical Reaction Engineering -** Octave Levenspeil, 3rd edition, John Wiley & Sons, 2001.
2. **Elements of Chemical Reaction Engineering -** H. Scott Fogler, 3rd edition, Prentice Hall 2001.

REFERENCE BOOK:

1. **Chemical Engineering Kinetics** - J.M. Smith, 3rd Edition, McGraw Hill, 1984.

POLLUTION PREVENTION AND CONTROL EINGINEERING

Subject Code	: 10CH55	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT 1:
Introduction: Importance of environment for mankind. Biosphere and layers of atmosphere. Hydrological cycle and nutrient cycles. Types of pollution. Damages from environmental pollution. Need of environmental legislations and environmental Acts in India. Functions of central and state pollution control boards. **6 Hours**

UNIT 2:
Sources, Sampling And Analysis Of Wastewater: Water resources. Origin of wastewater. Evaluation, classification and characterization of wastewater. Physical and chemical characteristics. BOD, COD and their importance. Types of water pollutants and their effects.

Sampling, and methods of analysis. **7 Hours**

UNIT 3:

Wastewater Treatment: Preliminary, primary, secondary and tertiary treatments of wastewater. Sludge treatment and disposal. Advanced wastewater treatment. Recovery of materials from process effluents. **7 Hours**

UNIT 4:

Applications To Industries: Norms and standards of treated water. Origin, characters, and treatment methods of typical industries – petroleum refinery, pulp and paper, fertilizer, distillery, tannery, and textile processing. **6 Hours**

PART - B

UNIT 5:

Air Pollution Aspects: Nature of air pollution. Classification of air pollutants. Sources of air pollutants. Air quality criteria and standards. Plume behaviour and dispersion of air pollutants. Effects of air pollution on health, vegetation, and materials. **7 Hours**

UNIT 6:

Air Pollution Treatment: Sampling of pollutants. Methods of estimation of air pollutants. Automobile pollution. Control methods for particulates and gaseous pollutants. Pollution from chemical industries. Origin, control methods, and equipment used in typical industries – Thermal power plants, metallurgical industries, and cement industries. **7 Hours**

UNIT 7:

Solid Waste Treatment: Origin. Classification and microbiology. Properties and their variation. Engineered systems for solid waste management – generation, onsite handling, storage, collection, transfer and transport, composting, sanitary land filling. **6 Hours**

UNIT 8:

Noise Control: Sources and definitions. Determination of noise levels. Noise control criteria and noise exposure index. Administrative and engineering controls. Acoustic absorptive materials. **6 Hours**

TEXT BOOKS:

1. **Environmental Pollution Control Engg** - C. C.S. Rao, New Age International Reprint, 2002.
2. **Pollution Control in Process Industries** - S.S.P. Mahajan, Tata Mc Graw Hill, 1999.

REFERENCE BOOKS:

1. **Chetech-I**, Chemical Engg. Education Development Centre, 1975.
2. **Air Pollution** - H.C. Perkins, McGraw Hill, 1974.
3. **Solid Waste Management** - D.J. Hagery et.al., Van Nostrand Reinhold, 1973.
4. **Industrial Pollution Control Handbook** - Lund, H.F., McGraw Hill, 1971.
5. **Noise Abatement** - Duerden, Buttreworth, 1970.
6. **Introduction to Environmental Engg** - Davis., 3rd Edition, McGraw Hill, 1998.
7. **Waste Water Engineering Treatment Disposal Reuse** - Metcalf and Eddy,, Tata McGraw Hill, 4th Edition, 2003.
8. **Environmental Engineering** - G.N. Pandey and G.C. Carney, Tata McGraw Hill 2002.

9. **Integrated Solid Waste Management -** George Tchobanoglous et al, McGraw Hill & Co, 1993.

CHEMICAL EQUIPMENT DESIGN

Subject Code	: 10CH56	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT 1:
Introduction: Basic considerations in design. General design procedure. Equipment classification. Various components of process equipment. Design parameters. Pressure vessel codes. **6 Hours**

UNIT 2:
Design Considerations: Material selection. Factors affecting design. Stresses due to static and dynamic loads (Internal & External). Temperature effects. Economic considerations. **6 Hours**

UNIT 3:
Design Of Pressure Vessels: Design parameters, conditions & stresses. Design of shell and other vessel components. Vessel at low & high operating temperatures. Numerical design problems using given process parameters. **7 Hours**

UNIT 4:
Vessel Component Design: Design of supports for vessels - Bracket, Lug, Leg, Saddle and Skirt supports. Design of flanges & nozzles – Classification of flanges. Flange thickness calculation, Gasket selection and design, Bolt selection and calculation. Nozzle design. Design of vessel closures – Flat plates, Formed heads, Elliptical & Hemispherical heads. **7 Hours**

PART - B

UNIT 5:
Storage Vessels: Process conditions and design parameters for storage of volatile, non-volatile fluids & gases. Design of cylindrical tanks with fixed roofs. Design of partially filled spherical tanks. Design of components, supports and selection of vessels accessories & mountings. Numerical problems. **7 Hours**

UNIT 6:
Reaction Vessels: Design of reaction tanks with agitation and jacket. Types of agitators, baffles. Power requirement calculations. Design of tank dimensions and agitation system components. Drive calculations & selection of accessories. Design of jackets. Support calculations for the system. Numerical problems. **7 Hours**

UNIT 7:
Tall Vertical Vessels: Vessels subjected to various loads, Multi shell constructions. Determination of shell thickness. Supports for columns. **6 Hours**

UNIT 8:
Pipe Line Design: Pipe line sizing, Condensate and steam pipe design, Optimum size of delivery line in pumping operations. Concepts of P & I Diagrams, P & I Diagram for simple processes. **6 Hours**

TEXT BOOKS:

1. **Process Equipment Design** - M. V. Joshi, Macmillan & Co. India, Delhi, 3rd Edn. reprint 1998.
2. **Process Equipment Design – Vessel Design** - Brownell & Young, John Willey, 1951
3. **Process Design of Equipment – Vol 1** - S. D. Dawande, Central Techno Publications. 3rd. Edn, 2003.

REFERENCE BOOKS:

1. **Chemical Engineers Handbook** - Perry & Green, 7th Edn, McGraw Hill, 1997.
2. **Pressure Vessel Code – IS 2825** - IS Code, B.I.S., New Delhi, 1969.
3. Flow of Fluids through Valves, Fittings & Pipes Crane Amazon-2006.

POLLUTION CONTROL AND INSTRUMENTATION ANALYSIS LABORATORY

Subject Code	: 10CHL57	IA Marks	: 25
No. of Practical Hours/Week	: 03	Exam Hours	: 04
Total No. of Hours	: 39	Exam Marks	: 50

The experiment should be based on the following topics;

1. Analysis of effluents for pH, alkalinity and turbidity
2. Determination of COD and BOD
3. Volatile, Fixed, Filterable and Dissolved solid analysis
4. Analysis by ion selective electrode (any two anions)
5. Measurement of particulate matter in Air
6. Measurement of SO_2 in air
7. Analysis of exhaust be Orsat apparatus
8. Analysis of flue gases by Gas chromatograph
9. UV Spectrophotometer
10. KF Auto titrator
11. Flame photometer
12. Turbidometer
13. Dissolved Oxygen measurement
14. Bomb calorimeter
15. Viscometer
16. Polarograph
17. Potentiometer titration

Note: Minimum of 10 experiments are to be conducted.

HEAT TRANSFER LABORATORY

Subject Code	: 10CHL58	IA Marks	: 25
No. of Practical Hours/Week	: 03	Exam Hours	: 04
Total No. of Hours	: 39	Exam Marks	: 50

The experiment should be based on the following topics;

1. Natural Convection in Bare and Finned tube

2. Vertical Shell and tube Heat exchanger (Condenser)
3. Horizontal Shell and tube Heat exchanger (Condenser)
4. Helical Coil Heat exchanger
5. Emissivity Determination
6. Effect of Geometry on Natural convection
7. Heat Transfer in Packed Beds
8. Double Pipe Heat Exchanger
9. Heat Transfer in Jacketed Vessel
10. Determination of Insulation Thickness
11. Transient Heat Conduction
12. Heat Transfer in Fluidized Beds
13. Evaporator
14. Solar Heater
15. Spiral Plate Heat Exchanger
16. Cross Flow Heat Exchanger

Note: Minimum of 10 experiments are to be conducted.

VI SEMESTER

CHEMICAL PLANT UTILITIES AND SAFETY

Subject Code	: 10CH61	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT 1:

Introduction: Different utilities. Role of utilities in process plant operations and criteria for selection and estimation of suitable utilities.

Water: Water resources. Process water, Cooling water, drinking water and boiler feed water Quality Standards. Water treatment processes for drinking, process and boiler feed. Storage and handling of water. Types and selection of pumps, piping and accessories. Water pre treatment, reuse and recyling. **7 Hours**

UNIT 2:

Air: Compressed air, blower air, fan air. Types of compressor and vacuum pumps and selection. Power requirements, performance and related calculations. Booster and receivers. Quality of compressed air for instruments and processes. Compressed air distribution system- piping and accessories. Air-watervapour system: humidification/ dehumidification and evaporative cooling-related calculations. **6 Hours**

UNIT 3:

Steam And Power: Steam generation in chemical plants. Types of boilers and waste heat boilers. Fuels-types, emissions and global warming, green fuels. Calorific value. Proximate and ultimate analysis. HHV, LHV and related calculations. Cogeneration power plants. CHPs and Boiler performance. Related Calculations. Economy of steam generation with different fuels, related calculation. Steam storage and handling-piping and accessories. **7 Hours**

UNIT 4:

Refrigeration: Different refrigeration systems and their characteristics. Air-conditioning systems. Coefficient of performance. Power requirements and refrigeration effect- related calculations for each type of refrigeration system. Refrigerant properties and selection. Some

commonly used refrigerants and secondary refrigerants. **6 Hours**

PART - B

UNIT 5:
Insulation: Insulation Materials & Selection- Economics of insulation. Insulating factors. Properties & Classification. Cold insulation and cryogenic insulation. **6 Hours**

UNIT 6:
Introduction To Process Safety: Intrinsic & Extrinsic Safety. The Hazards- Toxicity, Flammability, Fire , Explosions. Sources of ignition, Pressure. Hazard and risk assessment methods. MSDS. **6 Hours**

UNIT 7:
Safety Devices: Pressure relief valves. Ruptures discs. Blow down systems. Flare systems. Flame arrestors. Deflagration arrestors and explosion suppression. Personal safety devices. **7 Hours**

UNIT 8:
Process Safety Analysis: HAZAN and HAZOP comparison.. Risk analysis and estimation. Safety check list. Computer based quantitative risk analysis. **7 Hours**

TEXT BOOKS:

1. **Thermal Engineering -** B.K. Sarkar, Tata Mc Grew Hill –1998.
2. **Heat Engines -** K.P. Roy, Media Promoters and Publishers-1995.
3. **Power Plant Engineering -** P.K. Nag, Tata Mc Grew Hill –1998.
4. **Water and Waste water engineering- Vol 2. -** Gordon M Fair, John C. Geyer and Daniel A Okun, Jhon Hutey –1996.
5. **Water and waste water Technology-** Mark J. Hammer Jr.4th Edition. Prentice Hall 1997.
6. **Chemical Engineers Handbook.** – Perry 8th Edition –2007.
7. **Chemical Engineering- Vol 6 -** R.K. Sinnot, Coulson and Richardson's, 3rd Edition, BH, Reprint, 2000.
8. **Loss prevention in chemical process industries', Vol 1,2,3 -** Frank P Lees, Butterworth-Heiremann,1980.

MASS TRANSFER – II

Subject Code	: 10CH62	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT 1:
Gas Liquid Contacting Systems: Types, construction and working of plate and packed columns, types and properties of industrial packings, plate efficiencies, HETP and HTU concepts. **7 Hours**

UNIT 2:
Absorption: Absoption. Solvent selection for absorption. Material balance and concept of driving force and minimum solvent rates. Multistage absorption columns. Design of Plate columns. Absorption and desorption factors. **7 Hours**

UNIT 3:

Packed Tower Absorption: Liquid phase hold up and pressure drop in absorption towers. Operating line and minimum solvent flow rates. Design of packed towers (process design-height and diameter). Multi-component absorption. Absorption with chemical reaction. **6 Hours**

UNIT 4:

Distillation: Introduction. Vapour liquid equilibria (T-x,y, P-x,y. H-x,y and x-y diagrams for binary mixtures). Relative volatility. Prediction of VLE from vapour pressure data using Raoult's law. VLE for multi-component systems. Non-ideal systems. Azeotropes. Immiscible systems. Steam distillation. **6 Hours**

PART - B

UNIT 5:

Distillation (Contd.): Types of distillation. Flash and simple distillation. Multi-stage rectification column. Design using McCabe Thiele method for binary mixtures. **6 Hours**

UNIT 6:

Design Of Distillation Column: Using Ponchon Savarit method. Efficiencies –overall, local, and Murphree plate efficiencies: Introduction to Multicomponent distillation., Vacuum, molecular, extractive and azeotropic distillations. **7 Hours**

UNIT 7:

Liquid-Liquid Extraction: Ternary equilibrium. Solvent selection. Single stage. Multi-stage cross-current, counter-current extraction. Equipment for liquid-liquid extraction. **7 Hours**

UNIT 8:

Leaching Operation: Equipment for leaching. Preparation of solids for leaching. Equilibrium diagrams. Calculation of single stage and multi-stage leaching operation. **6 Hours**

TEXT BOOKS:

1. **Mass Transfer Operations** - Robert E Treybal, 3rd Edition, McGraw Hill 1981.
2. **Unit Operations in Chemical Engineering** - McCabe & Smith, 6th Edition, McGraw Hall, 2001.

REFERENCE BOOKS:

1. **Chemical Engineering Vol I, II, IV and V** - Coulson and Richardson, 4th Edition, Pergmon Press, 1998.
2. **Introduction to Chemical Engineering** - Badger & Banchero, TMH 6th Reprint 1998.
3. **Principals of Unit Operation** - Foust et.el., 2nd Edition, John Wiley, 1994.
4. **Transport Processes and Unit Operation –** Geankoplis ,C J, Prentice Hall(I), 2000.

CHEMICAL REACTION ENGINEERING – II

Subject Code	: 10CH63	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT 1:

Basics Of Non Ideal Flow: Importance & interpretation of RTD, C, E & F curves & Statistical interpretation. Dispersion model. Tanks in series model. Conversion in non- ideal flow reactors for simple systems. **7 Hours**

UNIT 2:
Non Catalytic Systems: Fluid-Fluid reactions and Kinetics. **6 Hours**

UNIT 3:
Fluid Particle Reactions: Mechanism and Kinetics. **6 Hours**

UNIT 4:
Catalysis: Introduction to catalysis. Properties of catalysts. Estimation methods for catalytic properties. Promoters, inhibitors etc, Mechanism of catalysis. Rate equations for different rate controlling steps **7 Hours**

PART – B

UNIT 5:
Deactivation: Deactivating catalyst. Mechanism, rate & performance equation. **6 Hours**

UNIT 6:
Solid Catalyzed Reactions: Heterogeneous reactions-Introduction., Kinetic regimes. Rate equation for surface kinetics. Pore diffusion resistance combined with surface kinetics. Thiele modulus and enhancement factor, Porous catalyst particles. Heat effects during reaction. **7 Hours**

UNIT 7:
Solid Catalyzed Reactions (Contd): Performance equations for reactors containing porous catalyst particles. Experimental methods for finding rates. Packed bed catalytic reactor & reactors with suspended solid catalyst. Fluidized reactors of various type. **7 Hours**

UNIT 8:
Gas-Liquid Reactors: Trickle bed, slurry reactors. Three phase fluidized bed. **6 Hours**

TEXT BOOKS:

1. **Chemical Reaction Engineering** - Octave Levenspiel, 3rd Edition, John Wiley & Sons - 2001.
2. **Chemical Engineering Kinetics** - J.M. Smith, 3rd Edition, McGraw Hill
3. **Elements of Chemical Reaction Engineering** - H. Scott Foggler, 3rd Edition, Prentice Hall - 2001.

REFERENCE BOOK:

1. **Chemical & Catalytic Reaction Engineering** - James J. Carberry, McGraw Hill - 1976.

ENERGY TECHNOLOGY

Subject Code	: 10CH64	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT 1:

Introduction To Energy Sources: Conventional energy sources; non-conventional energy sources; advantages; limitations. **4 Hours**

UNIT 2:

Solar Energy: Solar radiation and its measurement – solar constant, solar radiation at earths surface, solar radiation geometry, solar radiation measurement. Introduction to solar energy. Applications – solar water heating, space heating, space cooling, solar thermal electric conversion. Agriculture and industrial process heating, solar distillation, solar pumping, solar cooking. **8 Hours**

UNIT 3:

Energy From Biomass (Bio-Energy): Introduction. Biomass conversion Technologies. Wet processes. Dry processes. Biogas generation. Factors affecting biodigestion or generation of gas. Classification of biogas plants. Advantages and disadvantages of floating drum plant. Advantages and disadvantages of fixed dome type plant. Types of biogas plants (KVIC model & Janata model). Selection of site for biogas plant. **8 Hours**

UNIT 4:

Bio-Energy (Thermal Conversion): Methods of obtaining energy from biomass. Thermal gasification of biomass. Classification of biomass gasifiers. Chemistry of gasification process. Applications of the gasifiers. **6 Hours**

PART - B

UNIT 5:

Wind Energy: Introduction. Basic components of WECS (wind energy conversion system). Classification of WECS. Types of wind machines- horizontal axis machines, vertical axis machines. Applications of wind energy. **8 Hours**

UNIT 6:

Energy Form The Oceans: Introduction. Ocean thermal electric conversion (OTEC). Methods of ocean thermal electric power generation. Open cycle OTEC system. Closed or Anderson OTEC cycle, hybrid cycle. Application of energy from oceans. **6 Hours**

UNIT 7:

Energy From Tides: Basic principles of tidal power. Components of tidal power plants. Operation methods of utilization of tidal energy. Advantages and limitations of tidal power generation. Applications of tidal energy. **6 Hours**

UNIT 8:

Fuels: Introduction. Classification of fuels. Calorific value. Characteristics of good fuels. Comparison between solid, liquid and gaseous fuels. **6 Hours**

TEXT BOOKS:

1. **Non-Conventional Energy Sources** - G.D. Rai, Khanna Publications, 4th Edition, Second Reprint, 1997.
2. **Engineering Chemistry** - P.C. Jain & M. Jain, Dhanpat Rai & Sons, 10th Edition, 3rd Reprint, 1995.

REFERENCE BOOKS:

1. **Solar Energy, Second Edition** - S.P. Sukhatme, 3rd Reprint, Tata McGraw Hill, New Delhi, 1998.
2. **Solar Energy Utilization** - G.D. Rai, 4th Edition, Khanna Publications-2006.

PROCESS EQUIPMENT DESIGN & DRAWING

Subject Code	: 10CH65	IA Marks	: 25
No. of Lecture Hours/Week	: 02 + 02	Exam Hours	: 04
Total No. of Lecture Hours	: 26 + 26	Exam Marks	: 100

Detailed chemical engineering process design of the following equipment. Necessary aspects studied in "10CH56 Chemical Equipment Design" is to be applied for mechanical design. Use of standard code books to be taught. The detailed dimensional drawings shall include sectional front view, Full Top/side view depending on equipment and major component drawing with dimensioning and part Template.

1. Double pipe Heat exchanger
2. Shell and Tube Heat exchanger
3. Condensers – Horizontal and vertical
4. Evaporator – Single effect
5. Bubble Cap Distillation Column
6. Packed Bed Absorption Column
7. Rotary Dryer.

REFERENCE BOOKS:

1. **Chemical Engineers Handbook -** R.H. Perry & D.W. Green, 7th Edition, McGraw Hill, 1998.
2. **Process Heat Transfer -** Donald Q. Kern, McGraw Hill, 1997.
3. **Mass Transfer Operations -** Robert E, Treybal, McGraw Hill, 1981.
4. **Chemical Engineering- Vol 6 -** J.M. Coulson & J.F. Richardson, Pergemen Press, 1993
5. **Shell & Tube Heat Exchanger -** IS Code, IS 4503, BIS, New Delhi, 1969.
6. **Process Equipment Design** - Brownell & Young, Vessel Design, John Wiley, 1951.
7. **Process Equipment Design**- M.V. Joshi, McMillan & Co., India, Delhi, 3rd Edition, Reprint, 1998.
8. **Process Design of Equipment**- S.D. Dawande, Vol II, Central Techno Publications, 3rd Edition, 2003.

ELECTIVE - I (Group A)

PETROLEUM REFINERY ENGINEERING

Subject Code	: 10CH661	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT 1:

Indian Petroleum Industry: Prospects & Future. Major companies. World production, Markets, Offshore and onshore, Oil well technology. **6 Hours**

UNIT 2:

Composition Of Crude: Classification. Evaluation of petroleum. UOP-k factor. TBP analysis. EFV analysis. Average boiling point. ASTM curves. Thermal properties of petroleum fractions. **6 Hours**

UNIT 3:

Product Properties And Test Methods: Gas. Various types of gas and LPG. Reid vapor pressure analysis. Gasoline and naptha. Octane No. Oxidation stability. Additives for gasoline. Kerosene. Characterization for flash point or fire point, volatility, burning qualities etc, Diesel, octane testing, viscosity etc. Grades of diesels e.g. HSD, LDO. Diesel additives. Lube oils : Types, tests-carbon residue and viscosity index. **7 Hours**

UNIT 4:

Crude Pretreatment: Pumping of crude oils. Dehydration of crude by chemical, gravity, centrifugal, electrical de-salter and comparision of each. Heating of crude- heater, different types of pipe still heaters including box type, cylindrical etc. Crude distillation, arrangement of towers for various types of reflux. Design aspects for atmospheric and vacuum column. Atmospheric distillation distillation unit: internals and operational. **7 Hours**

PART - B

UNIT 5:

Treatment Techniques: Types of impurities present and various desulfurisation processes. Production and treatment of LPG. LNG technology. Sweetening operations for gases including merox, ethanolamine, copper chloride, stertford etc. Catalytic de sulphonisation. Treatment of kerosene, De-aromatisation and merox. Treatment of diesel, naptha: desulpurisation by hydrogen and catalysts. Treatment of lubes: sulphuric acid, clay treatment, solvent treatment-phenol, furfural. **6 Hours**

UNIT 6:

Thermal Processes: Thermal cracking reactions- theory of thermal cracking. Properties of cracked materials and factors influencing the properties of cracked materials. Visbreaking, dubbs two coil cracking process. **6 Hours**

UNIT 7:

Catalytic Cracking: Comparision of thermal and catalytic cracking. Carbonium ion chemistry. Feedback requirements. Cracking conditions. Commercial cracking analysis. Various catalytic cracking processes. Fixed bed crackers. Moving bed crackers. Fluid catalytic cracking-flexi cracking-ortho-flow reactor. Theory of coking: various types of coking processes. Delayed coking, fluid coking, contact coking, flexi coking. Naptha cracking, naptha cracking for ethylene as feed selection and gas yield. Hydro cracking. Theory of hydro cracking. Catalysts for hydro cracking. **7 Hours**

UNIT 8:

Catalystic Reforming: Theory of reforming. Factors influencing, reforming, reforming catalysts, feedstock requirements. Plat-forming, isoplus hondriforming, refining forming, power forming and flexi forming etc. **7 Hours**

TEXT BOOKS:

1. **Petroleum Refinery Engineering** - Nelson, McGraw Hill, 4th Edition, 14th Reprint, 1982.
2. **Modern Petroleum Refining Processes** - Bhaskara Rao, Oxford & IBH Publication, 3rd Edition, Reprint, 1999.

REFERENCE BOOKS:

1. **Petroleum Refining Technology**- Ram Prasad, Khanna Publishers, I Edition, 2000.
2. **Challenges in Crude Oil Evaluation**- Nagnal J.M., Gate, McGraw Hill.
3. **Petroleum Processing** - Sland W.F. and Davidson R.L. McGraw Hill, 1967.

OPERATIONS RESEARCH

Subject Code	: 10CH662	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT 1:
Introduction: Definition. Scope of Operations Research (OR). Approach and limitations of O.R. Models. Characteristics and phases of O.R.
Linear Programming Problems: Mathematical formulation of L.P. Problems. Graphical solution method. **7 Hours**

UNIT 2:
The Simplex Method: 1 & 2 – slack, surplus and artificial variables. Dual simplex method. Degeneracy and procedure for resolving degenerate cases. **7 Hours**

UNIT 3:
Assignment Problems: Balanced and Unbalanced assignment problems. Maximization assignment problems. Travelling salesman problems. **6 Hours**

UNIT 4:
Transportation Problem: Basic feasible solutions by different methods. Finding optimal solution. MODI method. Degeneracy. Unbalanced transportation problems. Maximization Problems. **6 Hours**

PART – B

UNIT 5:
Sequencing: Johnson's algorithm. n jobs - 2 machines, n jobs -3 machines, and n jobs-n machines without passing sequence. 2 jobs-n machines. Graphical solutions. **6 Hours**

UNIT 6:
Deterministic Models: Inventory, EOQ Models. With and without shortages. Ordering cost. Carrying cost. **6 Hours**

UNIT 7:
Pert-Cpm Techniques: Network construction. Determining critical path. Variance and probability of completing the project. Calculation of different floats. Project duration. Crashing of simple networks. **8 Hours**

UNIT 8:
Waiting Lines: Queuing systems and their characteristics. Poisson queues. M/M/1 queuing system. **6 Hours**

TEXT BOOKS:

1. **Introduction to Pert and CPM -** L. S. Srinath,, 3 Edition, East West, 1998
2. **Operation Research -** Kantiswaroop, P. K. Gupta and Manmohan,, 9th Edition, S Chand & Co. 1999.
3. **Scientific Inventory Management -** Hospach Buchan and Earnest Koenigberg 1989.
4. **Operation Research -** S. D. Sharma, 8th Edition, Kedarnath & Co, 2003.

PHARMACEUTICAL TECHNOLOGY

Subject Code	: 10CH663	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT 1:
Electrophilic Substitution Reaction: Preparation of cyclo alkane. Bayer's strain theory and orbital picture of angle stream. **6 Hours**

UNIT 2:
Electrophilic Substitution Reaction Mechanism & Application: Dehydrogenation of alkyl halides. 1-2 elimination kinetics: E2 and E1 mechanisms. Isotope effect. Dehydration of alcohols. Ease of dehydration. **6 Hours**

UNIT 3:
Nucleophilic Addition Reaction: Mechanism. Important chemicals. Oxidation-Reduction reactions. **6 Hours**

UNIT 4:
Rheology of Fluids in Mixing and Blending. **8 Hours**

PART - B

UNIT 5:
Preparation: Test for purity and medical uses of Chlorobutal, Dimercopral, Glycerol trinitrate. **7 Hours**

UNIT 6:
Preparation: Test for purity and medical uses of Urea, ethylene diamine dihydrate, vanillin, paraldehyde. **7 Hours**

UNIT 7:
Preparation: Test for purity and medical uses of lactic acid, citric acid, salicylic acid, saccharin sodium. **6 Hours**

UNIT 8:
Preparation: Test for purity and medical uses of Ethyl borate, dimethyl phthalate, aspirin. **6 Hours**

TEXT BOOKS:

1. **Organic Chemistry -** T.R. Morisson and R. Boyd, 6th edition, Prentice Hall of India Pvt. Ltd., New Delhi – 1992.
2. **Organic Chemistry Fundamentals -** I. L. Finar, 2nd edition, ELBS, Pergemon Press – 1965.

POLYMER TECHNOLOGY

Subject Code	: 10CH664	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART – A

UNIT 1:

Principles Of Processing Of Polymers: Melt processing of thermoplastics. Classification of processes. Thermoset plasting processing, crystallization, orientation & shrinkage, co polymers blendings, compounding for engineering application, stress – strain behavior, WLF equation, practical assessment for long term behavior. **6 Hours**

UNIT 2:

Polymer Extrusion: Requirements of Polymer for extrusion. Single screw and double screw plasticating extruder zones in extrusion, breaker plates, extruder screw, power calculation. PVC extruder. Die and calibration equipment prime mover for extrusion, co extrusion, extrusion coating, extrusion film blowing reactive extrusion. Extrusion blow moulding for PET bottles, wire drawing-PVC, spinning – various types and applications. Application of various extruded products. Rheological aspects of extrusion and extrusion defects. Operational and maintenance of extrusion equipments. **7 Hours**

UNIT 3:

Injection Moulding: Polymer characteristics for injection moulding. Reciprocating screw injection moulding. Single impression mould. Multi impression moulds. Cooling requirements in moulds. Hot runner moulds, gate, mould clamping force calculations. Control of pressure, temperature and time of injection thermostat and fiber reinforced polymer injection moulding, sandwich moulding and injection blow moulding. Rheological aspects and defects of injection. Comparision of injection moulding and extrusion of injection. Operational and maintenance of injection moulding equiments. Reaction injection moulding. Applications. **7 Hours**

UNIT 4:

Compression Moulding: Applications. Principles. Comparison with other processing methods. Derivation of compression mould thickness or compaction force. Transfer moulding. **6 Hours**

PART – B

UNIT 5:

Calendering: Characteristics of polymer for calendering. Principles and operation of calendaring. Derivation of film thickness and pressure required for rollers. Guage control during calendaring. Application of PVC calendered products. **6 Hours**

UNIT 6:

Thermoforming: Basic principles. Vacuum forming. Pressure forming. Description of operations. Product design. Application. Derivation of thermoformed product thickness.**7 Hours**

UNIT 7:

Rotational Moulding: Principles. Operation & applications. Thickeness. Cooling calculations. **6 Hours**

UNIT 8:

Testing Of Plastics: Thermal, electrical, optical, mechanical properties testing. **7 Hours**

TEXT BOOKS:

1. **Principles of Polymer Processing** - Morton Johnes chapman –Hall 1989.
2. **Plastic Engineering. -** R.J. Crawford 3rd Edition Research Studies-1996.

REFERENCE BOOKS:

1. **Principles of Polymer Engineering.** - N.G. McCrum, C.P. Buckley Oxford University Press – 1988.
2. **Polymer Materials –**Vol 1,2 & 3., Springer, Manas Chanda , Univ Press-1997. Tailer and Frances-2008

CHEMICAL REACTION ENGINEERING LABORATORY

Subject Code	: 10CHL67	IA Marks	: 25
No. of Practical Hours/Week	: 03	Exam Hours	: 04
Total No. of Hours	: 39	Exam Marks	: 50

The experiment should be based on the following topics;

1. Batch Reactor
2. Isothermal plug flow reactor
3. Mixed flow reactor
4. Semi batch reactor
5. Heterogeneous catalytic Reactor
6. Segregated flow reactor
7. Adiabatic Reactor
8. Packed bed Reactor
9. RTD Studies in Tubular Reactor
10. Effect of temperature on Rate of reaction
11. Bio Chemical Reaction (Batch)
12. Enzyme catalyzed reactions in batch reactor
13. RTD Studies in mixed flow reactor
14. Sono-chemical reactor.
15. Photochemical reactor

Note: Minimum of 10 experiments are to be conducted.

MASS TRANSFER LABORATORY

Subject Code	: 10CHL68	IA Marks	: 25
No. of Practical Hours/Week	: 03	Exam Hours	: 04
Total No. of Hours	: 39	Exam Marks	: 50

The experiment should be based on the following topics;

1. Diffusion of organic vapours in air
2. Simple Distillation
3. Packed column/ plate column distillation
4. Steam distillation
5. Solid – liquid leaching
6. Surface evaporation
7. Tray dryer
8. Adsorption studies
9. Liquid-liquid/Vapour –liquid equilibrium
10. Liquid extraction – (cross current: 1 and 2 or 3 stage)
11. Hold up studies in packed columns
12. Rotary/ vacuum dryers
13. Wetted wall column
14. Cooling tower

15. Solid dissolution
16. Gel-electrophoresis

Note: Minimum of 10 experiments are to be conducted.