Second Year (III Semester) B Tech Petrochemical Engineering

3PC1 Mechanical Operations

B.Tech. (Petrochemical) III semester **Max. Marks: 80**
3L **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Particulate Solid**: Properties of particulate solids Evaluation of size & shape, surface and population of particles, standard screens	2
	Screen analysis of solids. Size measurement by Kics's law, Rittinger's law Screening, Particle size distribution. Mean particle size. Efficiency of separation and grade efficiency.	2
	Agglomeration:. Resistance to shear and tensile forces. Angles of repose and of friction.	2
	Flow of solids in hoppers. Flow of solids through orifices. Measurement and control of solids flow rate.	2
II	**Size Reduction**: Mechanism of size reduction. Energy for size reduction. Methods of operating crushers. Nature of the material to be crushed.	4
	Type of crushing equipment. Coarse crushers. Intermediate crushers.	2
	Fine crushers. Specialized applications. Brief outline of particle size enlargement/reduction	2
III	**Separation:** :Theory of motion of particles through fluids, motion under gravitational and centrifugal fields,	2
	Terminal settling velocity of particles in a fluid (Stroke's law, Newton's law region and K-criteria for settling)	2
	Free settling and hindered settling. Gravity settling, centrifugal separation (cyclone separator) and sedimentation: Principles of sedimentation. Kynch theory of sedimentation. Flocculation	4
IV	**Mixing and Conveying:** Agitation and mixing of fluids and solids, types of mixers, Standard design of mixing vessel, Transportation and Handling of Solids	2
	Selection of conveying devices for solids: Belt, Chain, Screw – conveyors, Elevators and pneumatic conveying devices; Elementary design aspects of the devices. Visit to Chemical Engg. Industry Engaged mainly with Mechanical Operations	2
	Types of Agitators: axial flow impellers and radial flow impellers, Power number and Reynolds number for mixing,	2
	Power consumption of agitated vessels, Suspension of solids, the degree of mixing, The rate of mixing	2
V	**Filtration Theory**. Relation between thickness of cake and volume of filtrate. Flow of liquid through the cloth. Flow of filtrate through the cloth and cake combined.	4
	Compressible filter cakes. Filtration Practice. The filter medium. Blocking filtration.	4
	TOTAL	**40**

Text Book:-

1. Anup K Swain, Hemlata Patra, G. K. Roy Mechnical Operation, Tata McGraw Hill New Delhi

Reference Books

1. McCabe, W.L., Smith, Julian C. & Harriett, Peter, "Unit Operations of Chemical Engineering", McGraw Hill, New Delhi, 7/e,2005.
2. Narayanan, C.M., Bhattacharya, B.C., "Mechanical Operations for Chemical Engineers", Khanna Publishers, Delhi., 3/e, 2005.
3. Brown G.G., "Unit Operations", John Wiley and Sons, New York, 1950.

3PC2 Chemical Process Calculations

B.Tech. (Petrochemical) III semester **Max. Marks: 80**
3L,1T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction:** Introduction to unit operations and unit processes. Units and Dimensions. Conversion of units.	**2**
	Basic process variables: Mass,Volume. Flow rate. Chemical composition. Volume, Mass and mol fractions.	**2**
	Wet basis and dry basis, Average molecular weight, specific gravity, API gravity, Behaviour of gases: ideal and Van der Waal Gases. Specific volume of gas mixtures.	**3**
II	**Material Balance:** Overall and Component balances. Steady state and unsteady state Processes. Degrees of Freedom analysis for given process unit	**3**
	Material balance on non-reacting systems. Recycle, Bypass and Purge calculations. Calculations for Absorber- Stripper, Extraction-	**3**
	Distillation. Unsteady state process calculations for a mixer	**2**
III	**Stoichiomerty:** Introduction to Stoichiometry, molar table for converter, Balances on reacting systems. Limiting reactants. Fractional conversion.	**4**
	Extent of reactions. Multiple reactions. Yield and selectivity. Recycle and Purge calculations involving chemical reactions.	**4**
IV	**Energy Balance:** General energy balance equation for open systems, Reduced version in terms of enthalpy for process application.	**3**
	Enthalpy calculations, heat capacities of solid, liquid and gases, sensible and latent heats,	**2**
	Problems involving enthalpy change for gaseous and liquid streams, energy balance for phase change processes such as condensation.	**3**

	Boiling, Balances on dissolution and heat of mixing processes, Acid Mixing. Unsteady state heating or cooling of a mixed liquid.	**2**
V	**Heat of Reaction:** Heat effects accompanying chemical reactions**,** Hess's Law, Standard Heat of Reaction, combustion and formation.	**3**
	Effect of temperature on standard heat of reaction, Adiabatic Reaction Temperature, Heat Load and utility Calculations for non adiabatic operations	**4**
	TOTAL	**40**

Text Book

1. K.V. Narayanan, B Lakshmikutty, Stoichiometry and Process Calculations, PHI learning Private Limited Delhi 2013

Reference Books

1. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering ", EEE Sixth Edition, Prentice Hall Inc., 2003
2. Bhatt, B.L., Vora, S.M., "Stoichiometry ", 4th Edition,Tata McGraw-Hill (2004)
3. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes", 3rd Edn., John Wiley & Sons, New York, 2000.
4. Hougen O A, Watson K M and Ragatz R. A, "Chemical Process Principles" Part I, CBS publishers (1973).
5. McCabe, W.L., Smith, Julian C. & Harriett, Peter, "Unit Operations of Chemical Engineering", McGraw Hill, New Delhi, 7/e,2005

3PC3 Fluid Mechanics

B.Tech. (Petrochemical) III semester **Max. Marks: 80**
3L,1T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Properties of fluids;** Classification; Ideal fluid, Newtonian and Non-Newtonian fluids; Newton's law of viscosity.	**3**
	Pascal's and Hydrostatic law, manometers. Types of manometer Fluid	**3**
	Statics: fluid pressure and its measurement. Fluid Kinetics: Continuity equation; types of flow.	**2**
II	**Fluid dynamics:** One dimensional equation of motion; Navier Stokes theorem Bernoulli's equation; application; application of Bernoulli's equation.	**2**
	Friction losses in pipe flow, valves and fittings, k-values, sudden expansion and contraction, pipe flow problems Nozzle. introduction to laminar & turbulent flow.	**3**
	Velocity Distribution for turbulent flow, concept of Reynolds number & friction factor.	**2**

III	**Flow through Pipes** – Darcy – Weisbach's equation. Head loss in pipes	**2**
	Pipes in series/ Parallel. Classification, basic construction and application of different types of pumps.	**2**
	Pump: Centrifugal pump, Principles and application in Bernoulli's theorem, Boundary layer Separation Drag force, drag coefficient	**4**
IV	**Types of Pump:** Axial pumps, Gear pump, Plunger Pumps Vane pump, Reciprocation pump and Screw pump.	**3**
	Characteristic Curves of Pumps. Turbines - Gas, Steam and Hydraulic turbines, fan, blower, valves, types of valves.	**4**
V	**Flow Metering:** Classification, Basic construction and applications of compressor.	**3**
	(Centrifugal, axial, rotary vane type, Reciprocating and Screw compressor).	**2**
	Metering of fluids; orifice meter, venturimeter, pitot tube, rota meter, notches, gas flow meters, coefficient of discharge.	**5**
	TOTAL	**40**

Text Book

1. McCabe, W.L., Smith, Julian C. & Harriett, Peter, "Unit Operations of Chemical Engineering", McGraw Hill, New Delhi, 7/e,2005

Reference Book

1. Dr. P N Modi Dr. S M Seth Hydraulics and Fluid Mechanics - Standard Books House
2. Engineering Fluid Mechanics, Kumar K.L. ,S Chand
3. R.K Bansal, Fluid Mechanics and Hydraulic Machine. S Chand

3PC4 Material Science and Technology

B.Tech. (Petrochemical) III semester **Max. Marks: 80**
3L **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction to materials** :– basis of materials properties , atomic structure, bonding aggregates of atom Iron & Steel : Crystals Structure – brief outlines of atomic bonding crystal structure , periodicity in crystal, different types of structures – SC, BCC, FCC and HCP	**3**
	Crystals system, crystal lattice unit cell crystal direction, crystal planes, Miller indices, inter planar spacing , X-ray analysis, Crystals	**2**

	Defects – classifications and impact on the properties of engineering materials	**3**
II	**Phase equilibria** – phase rule phase changes in pure Iron, binary systems, solid solution, Eutectic, Eutectoid, Peritectic and Peritectoid reactions.	**4**
	General principles of heat treatment: Annealing, normalizing, Hardening, tempering and age hardening	**4**
III	Properties and applications of materials of equipments and construction, factors affecting selection of materials,	**4**
	Corrosion ,Types of Corrosion in Industries, corrosion of materials in construction , pipe line and in equipments and its control	**4**
IV	**Characterization of Material:** of microstructure using Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) and its sample preparation techniques, EDS/EDX,	**4**
	Atomic force microscopy (AFM), Dielectric spectroscopy, Fluorescence spectroscopy. Materials. Criteria for selection of materials for special applications in Industries such as smart materials.	**4**
V	**Properties of materials** **Mechanical properties:** Hardness, Strength, Toughness, Stiffness, Ductility, Malleability, Hardenability, Creep fatigue and Rheology **Electrical properties:** Conductors, Semiconductors and insulators, dielectric materials.	**2**
	Optical properties: Absorption, Reflection, Transmission and Refraction, optical fibers and lasers.	**2**
	Magnetic properties: various types of magnetic materials, Diamagnetic, Paramagnetic, Ferromagnetic, Ant ferromagnetic and Ferromagnetic materials, Domain theory, Hard and soft magnetic materials.	**2**
	Thermal Properties: Thermal expansion, Heat capacity, Thermal Conduction, Thermal Stresses.	**2**
	TOTAL	**40**

Text Book

1. O P Khanna, A Text Books on Material Science and Metallurgy, Dhanpat Rai Publication.

Reference Books

1. Kenneth G.Budinski and Michael K.Budinski, Engineering Materials Prentice-Hall of India
2. William D Callister, Material Science and Engineering, John Wiley and Sons.
3. Raghavan.V. Materials Science and Engineering, Prentice Hall of India.
4. Avner, S. H. Introduction to Physical Metallurgy: Tata McGraw-Hill

3PC5 Chemistry of Hydrocarbons

B.Tech. (Petrochemical) III semester **Max. Marks: 80**
3L **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Origin and formation of Petroleum:** Reserves and deposits of Hydrocarbon in INDIA, Indian Petroleum Industry.	**2**
	Composition of crude Oils, ultimate and chemical composition , non-	**2**
	Hydrocarbons in petroleum, Asphltenes and Resins, classification of petroleum, evaluation of crude oil, Bench mark crudes.	4
II	**Characterization of crude oils** : TBP and ASTM distillation, Classification by chemical composition, Correlation Index.	**3**
	Density, API gravity,Viscosity, UOP characterization factor, etc. Physical & Thermal properties of petroleum, ASTM, TBP, EFV distillation curves.	**5**
III	**Properties of crude oil:** Distillation: Properties of crude oil octane no. etc Pre-treatment, Electric desalting.	**4**
	Atmospheric and vacuum distillation, petroleum products and their quality control tests.	**4**
IV	**Value addition of petrochemicals** :from feedstock to consumer end products, chemical reactions of hydrocarbons like Decomposition (Thermal & Catalytic)	**4**
	Halogenations, Isomerisation, Hydrogenation, Alkylation, Nitration, Sulfonation, etc. with chemistry and reaction mechanism.	**4**
V	**Gaseous fuels**: Natural gas, Synthetic gases, their composition & properties.	**4**
	Producer gas, Water gas, Coal Gas, LPG, CNG, and Hydrogen as fuel.	**4**
	TOTAL	**40**

Text Book:

1. Bhaskar Rao,., "Modern Petroleum Refining Processes", Oxford & IBH Co. Pvt. Ltd., New Delhi, 4/e,2002,

Reference Books

1. Speight, J.C.; "The Chemistry and Technology of Petroleum", Marcel Dekkar, New York, 3/e1999.
2. Lucas, A.G. (ed.), "Modern Petroleum Technology", Vol. 2, Downstream, John Wiley & Sons Limited, New York, 6/e, 2000.
3. Hobson, G.D., "Modern Petroleum Technology" Vol I & II, John Wiley & Sons, New York, 5/e, 1984
4. Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000

3PC6 Advanced Engineering Mathematics -I

COMMON WITH 3PE6

B.Tech. (Petrochemical) III Semester **Max. Marks: 80**
3L +1T **Exam Hours :3**

Unit	Contents	Contact Hours
I	**LAPLACE TRANSFORM -** Laplace transform with its simple properties, applications to the solution of ordinary.	**3**
	Partial differential equations having constant coefficients with special reference to the wave and diffusion equations.	**2**
II	**FOURIER SERIES & Z TRANSFORM –** Expansion of simple functions in Fourier series. Half range series, Change of intervals,	**4**
	Harmonic analysis. Z TRANSFORM **-** Introduction, Properties, Inverse Z Transform.	**4**
III	**FOURIER TRANSFORM -** Complex form of Fourier Transform and its inverse, Fourier sine and cosine transform and their inversion.	**4**
	Applications of Fourier Transform to solution of partial differential equations.	**4**
	Equations having constant co-efficient with special reference to heat equation and wave equation.	**3**
IV	**COMPLEX VARIABLES -** Analytic functions, Cauchy-Riemann equations, Elementary conformal mapping with simple applications,	**4**
	Line integral in complex domain, Cauchy's theorem. Cauchy's integral formula	**4**
V	**COMPLEX VARIABLES -**Taylor's series Laurent's series poles, Residues.	**4**
	Evaluation of simple definite real integrals using the theorem of residues. Simple contour integration.	**4**
	TOTAL	**40**

Suggested Readings

1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley India New Delhi
2. Mathematics for Engineers, Chandrika Prasad, Prasad Mudranalya, Allahabad
3. Advanced Mathematics for Engineers, Chandrika Prasad, Prasad Mudranalya, Allahabad
4. Higher Engineering Mathematics, B V Ramana, Tata McGraw Hill

Laboratory

3PC7–Process Computations Lab

B.Tech. (Petrochemical) III semester **Max. Marks: 100**
Hours per week: 02

1. Introduction to Microsoft Excel for process calculation
2. Basic Operations Using excel function
4. Unit conversions of chemical process using excel.
5. Material Balance solution using Excel.
6. Energy Balance Solution Using Excel.
7. Calculation of multi variable equations.(i.e. gauss elimination method)
8. Problems related to flow measurement on excel
9. Problems related to Roults law and ideal gas equations. On excel
10. Problems related to material balance (i.e stichiometry, crystallization etc)
11. Problems related to energy balance on excel.

3PC8 Fluid Mechanics Lab

B.Tech. (Petrochemical) III semester **Max. Marks: 100**
Hours per week: 02

List of Experiments
1. Reynolds experiment for Laminar, transitional and turbulent flow identification, through Reynolds apparatus
2. Verification of Bernoulli's Equation through Bernoulli's Theorem Apparatus.
3. Determination of co efficient of Discharge for Orifice, Venturimeter through venturimeter and orifice meter test rig.
4. Estimation of losses through pipe fitting, sudden enlargement and contraction frictional Pressure drop in Circular pipes.
5. . Verification of Darcy's Law through Darcy apparatus.
6. Demonstration of Gas-Liquid Multiphase flow regimes in horizontal and vertical flow through pipe and Numericals based on Lockhart Martinelli equation
7. To Study Construction, Working of Centrifugal, Reciprocating, Gear and Plunger Pumps through test rig
8. To Study pitot tube apparatus and cavitation apparatus in a pipe flow.

3PC9 Programming Lab

B.Tech. (Petrochemical) III semester **Max. Marks: 75**
Hours per week: 02

Programming in C++
1. To write a simple program for understanding of C++ program structure without any CLASS declaration. Program may be based on simple input output, understanding of keyword using.
2. Write a C++ program to demonstrate concept of declaration of class with public & private member, constructors, object creation using constructors, access restrictions, defining member functions within and outside a class. Scope resolution operators, accessing an object's data members and functions through different type of object handle name of object, reference to object, pointer to object, assigning class objects to each other.

3. Program involving multiple classes (without inheritance) to accomplish a task. Demonstrate composition of class.

4. Demonstration Friend function friend classes and this pointer.

5. Demonstration dynamic memory management using new & delete & static class members.

6. Demonstration of restrictions an operator overloading, operator functions as member function and/ or friend function, overloading stream insertion and stream extraction, operators, overloading operators etc.

7. Demonstrator use of protected members, public & private protected classes, multilevel inheritance etc.

8. Demonstrating multiple inheritance, virtual functions, virtual base classes, abstract classes

3PC10 Energy and Geopolitics

B.Tech. (Petrochemical) III semester **Max. Marks: 75**
Hours per week: 02

1. Basic concepts of demand, supply and pricing; price and output determination under perfect competition, derivation of the supply function, price and output determination under monopoly, oligopoly, and monopolistic competition
2. Energy and society: Social, economic, political and environmental dimensions of energy
3. Major types and sources of energy at the global and at the national level
4. Reserves and resources of petroleum, coal and nuclear minerals: Globally and in India
5. Other resources of energy: Hydroelectric power, solar energy, wind, wave, and biomass based energy
6. Energy sources and power generation: Thermal, nuclear, hydroelectric, solar, wind and wave; relative merits and demerits including conversion efficiency, generation cost and environmental impact, clean coal initiatives
7. Power transmission and distribution
8. Carbon sequestration, coal gasification, CBM, Shale gas, gas hydrates: current status and future prospects
9. Solar energy, hydrogen energy, and fuel cells: current status and future prospects
10. Carbon credits and its impact on hydrocarbon business
11. International oil markets, developments of Indian oil industry
12. NELP (New Exploration Licensing Policy), Mines rules and regulations
13. Pipelines: Current status and future prospects
14. LNG, CNG and other forms of natural gas: global and Indian scenario
15. Global energy politics

3PC11 DECA

4PC1 Advanced Engineering Mathematics-II

COMMON WITH 4PE1

B.Tech. (PetroChemical) IV Semester **Max. Marks: 80**

3L+ 1 T **Exam Hours: 3**

Unit	Contents	Contact Hours
I	**NUMERICAL ANALYSIS** - Finite differences – Forward, Backward and Central differences.Newton's forward and backward differences, interpolation formula.	**4**
	Stirling's formula, Lagrange's interpolation formula.	**4**
II	**NUMERICAL ANALYSIS**- Integration-Trapezoidal rule, Simpson's one third and three-eighth rules.	**4**
	Numerical solution of ordinary differential equations of first order - Picard's mathod, Euler's and modified Euler's methods,	**4**
	Miline's method and Runga-Kutta fourth order method.,Differentiation	
III	**SPECIAL FUNCTIONS** – Bessel's functions of first and second kind, simple recurrence relations, orthogonal property of Bessel's.	**4**
	Transformation, Generating functions, Legendre's function of first kind. Simple recurrence relations, Orthogonal property, Generating function.	**4**
IV	**STATISTICS AND PROBABILITY** - Elementary theory of probability, Baye's theorem with simple applications, Expected value,	**4**
	theoretical probability distributions-Binomial, Poisson and Normal distributions. Lines of regression, co-relation and rank correlation.	**4**
V	**CALCULUS OF VARIATIONS** - Functional, strong and weak variations	**4**
	simple variation problems, the Euler's equation.	**4**
	TOTAL	**40**

Suggested Readings

1. Numerical Method for Engineers:- Canal & Chapra
2. Applied Numerical Analysis;- Curits F Gerald
3. Introduction to Numerical Analysis:- Sastry SS
4. Statistics for Geologists Ed. II by John C. Davis, Pub. John Wiley & Sons
5. Statistics for Petroleum Engineers and Geoscientists, by Jerry.J., Larry W. Lake, Patrick W.M., Corbett and David J. Goggin, Elsevier

4PC2 Heat Transfer

B.Tech. (Petrochemical) III semester **Max. Marks: 80**
3L,1T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Conduction** Heat transfer modes, laws; General Differential equation;	2
	Steady state problems in plane and composite systems; Thermal resistance;	2
	Insulation and critical radius; Unsteady state heat conduction; Extended surfaces as Fins.	4
II	**Principles, Dimensional analysis of Heat Transfer by Natural Convection:** Principle Heat balance Equation in laminar flow; Natural convection heat transfer from plate and cylinder.	4
	Principles, Dimensional analysis of Heat Transfer by Forced Convection: Laminar and Turbulent Boundary layers; Laminar and turbulent flow heat transfer in a circular pipe. Dimensional groups in Heat Transfer	4
III	**Heat Exchangers** Basic types of heat exchangers; Flow arrangements; Overall heat transfer coefficient	2
	fouling factor calculations; Classification of heat exchangers,Analysis of Heat Exchangers,	2
	Mean temperature difference; Effectiveness – NTU Method; Concept of Heat Exchange Networks TEMA	4
IV	**Radiation** Basic concepts; Emission characteristics and laws of black body radiation; Radiation incident on a surface; Solid angle and radiation intensity.	4
	Heat exchange by radiation between two black surface elements; Heat	2
	exchange by radiation between two finite black surfaces; The shape factor; Radiation shields.	2
V	**Condensation, Boiling and Evaporator** Types of condensation; Drop and Film condensation on a vertical plate, vertical tube and horizontal tubes.	2
	Effect of superheated vapor and non-condensable gases.	2
	Types of boiling; Pool and Forced Convection boiling; boiling curves; Simplified relations for boiling heat transfer with water; Critical Flux;	2
	The concept of heat pipe. Evaporator, steam consumption, economy, types of evaporator method of feeding **TOTA**	2

	TOTAL	**40**

TEXT BOOKS

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 6th Edn., McGraw-Hill, 2001.

Reference Book

1. Holman, J. P., 'Heat Transfer ', 8th Edn., McGraw Hill, 1997.
2. Ozisik, M. N., Heat Transfer: A Basic Approach, McGraw-Hill, 1984
3. Kern, D.Q., "Process Heat Transfer ", McGraw-Hill, 1999.
4. Coulson, J.M. and Richardson, J.F., "Chemical Engineering " Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, 1998

4PC3 Mass Transfer

B.Tech. (Petrochemical) III semester **Max. Marks: 80**
3L,1T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Fundamentals of Mass Transfer** Individual and film coefficients, overall mass transfer Coefficient and their inter relationships;	**2**
	Analogies in transfer processes, determination of mass transfer co-efficient;	**2**
	Two phase flow in packed beds, co-current and counter current	**2**
	Processes Flooding loading, column internals: types of trays/ plates and packing, point and plate efficiency.	**2**
II	**Diffusion phenomenon**: Molecular and eddy diffusion in gases, liquids and solids, Interface mass transfer.	**3**
	Mass transfer theories: film theory Penetration theory and surface renewal theory.	**4**
III	**Humidification and Dehumidification**: Humidification : General Theory, psychometric chart.	**2**
	Fundamental concepts in humidification & dehumidification, wet bulb temperature.	**2**
	Adiabatic saturation temperature, measurement of humidification calculation of humidification operation, cooling towers and related equipments.	**4**
IV	**Drying:** Equilibrium mechanism theory of drying, drying rate curve. Batch and continuous drying for tray driers,	**3**
	Drum dryers, spray and tunnel dryers.	**2**
V	**Absorption**: Absorption and Extraction in continuous contact columns, co-current, counter current and cross current contacting.	**4**

	Absorption , calculations of NTU and HTU,	**2**
	Concept of HETP, Introduction to Adsorption	**2**
	TOTAL	**40**

Text Book

1. Binay. K. Dutta. Principles of Mass transfer and separation Process, PHI Learning Pvt Ltd.

References:

1. Mc-Cabe W.L, Smith J.M.; Unit Operation In Chemical Engineering; Tat Mc-GrawHill.
2. Coulson J. M. Richardson; Chemical Engineering – Vol 2; Butserworth Heinmann, Oxford, Delhi
3. Treybal R.E; Mass Transfer Operatio; Mc. Graw Hill.
4. Sherwood, T.K. Pigford R.L. and Wilke, C.R.; Mass Transfer; Mc. Graw Hill.

4PC4 Introduction to Petroleum Engineering

B.Tech. (Petrochemical) IV semester **Max. Marks: 80**
3L **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	Global/Indian petroleum and petrochemical industry.	**4**
	Origin and occurrence of oil & gas. Migration and accumulation of oil and gas.	**4**
II	Source, reservoir and cap rocks, Petroleum Traps.	**4**
	Physical properties of oil bearing rocks.	**4**
III	Oil & gas exploration methods, direct oil finding methods	**4**
	Geological and geophysical methods.	**4**
IV	Introduction to drilling operations, drilling equipment – drilling rigs and drill string, drilling fluids and mud testing,	**4**
	Mud circulation and treating equipment, etc.	**4**
V	Production principles, Fundamental properties of reservoir fluids, types of reservoir drives, primary oil recovery.	**4**
	Secondary oil recovery, enhanced oil recovery methods.	**4**
	TOTAL	**40**

Text Book:

1. Dawe, R.A. (ed.), "Modern Petroleum Technology", Volume 1, John Wiley & Sons Limited, New York, 6/e, 2000

Reference Book

1. Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production, Penn Well Corporation, Oklahoma, USA, 2/e, 2001 50

2. Mian, M.A., "Petroleum Processing Handbook for Practicing Engineer", Penn Well Corporation, Oklahoma, USA, 1992
3. Deshpande, B.G., "The world of Petroleum", Wiley Eastern Industry.

4PC5 Introduction to Petrochemicals

B.Tech. (Petrochemical) III semester **Max. Marks: 80**
3L **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	History and importance of Petrochemical industry, growth in India, Classification of Petrochemicals, Feedstock of the Petrochemicals.	4
	Preparation of feedstrock from ethane / propane and naphtha / gas oil cracking, syngas.	4
II	Petrochemicals from C1, C2, C3, C4, Syngas & aromatics.	4
	Oleins, Aromatics hydrocarbons, Isopropanol	4
III	Chemistry and technology for the production of Methanol	4
	Formaldehyde, Ethylene oxide , glycoand Vinyl Chloride, PVC	4
IV	Chemistry and Technology for the Production of Butene,	4
	Cumene, Acrylonitrile, Linear alkyl benzene etc	4
V	Petrochemical feedstock; Manufacture of Isoprene, Chloroprene,	4
	Phenol, Different Amines, di - isocynates,Poly- isocynates, polyurethanes	4
	TOTAL	**40**

Text Book:
1 Waddams, A.L., 'Chemicals from Petroleum', 4th edition, Gulf Publishing Company, London, 1980.

Reference Books

1. Lewis F. Hatch & S Matar, From Hydrocarbon to Petrochemicals, 2nd Edition , 2000, Gulf Publishing Co. Houston, Texas, USA.
2. Chauvel and B. Lefebvre, Petrochemical Processes 1 & 2; Gulf Publishing Co. Houston, Texas, USA.
3. M. Gopala Rao and Marshall Sitting, Outlines of Chemical Technology, 3/e, Affiliated East –West Press Pvt. Ltd, New Delhi.

4PC6 Process Instrumentation

B.Tech. (Petrochemical) IV semester **Max. Marks: 80**

3L **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction**: to chemical process instrumentation, process variables, static and dynamic characteristics of instruments	**4**
	General classification of instruments	**4**
II	Elements of measuring systems & their functions, principles.	**4**
	Construction and operation of Instruments for measurement.	**4**
III	Control/ indication/ recording of process variables like pressure,.	**4**
	Flow level, humidity and composition.	**4**
IV	Principles of transducers electro pneumatic.	**4**
	Pneumatic, electrical & multi-pressure.	**4**
V	Process instrumentation diagram and symbols, process instrumentation for process equipments such as distillation column,	**4**
	Heat exchanger, fluid storage vessel	**4**
	TOTAL	**40**

Text Book:

1. Donal P Eckman-Industrial Instrumentation. Wiley 1995

Reference Books:

1. Albert D. Cooper- Modern Electronic Instrumentation, PHI
2. H.S. Kalsi- Electronic Instrumentation, Tata McGraw Hill, 2004.
3. Curties Johnson- Process Control Instrumentation Technique, IV Edn, PHI
4. Patranabis; Principles of Process Control; TMH

Laboratory

4PC7 Applied Numerical Methods

B.Tech. (Petrochemical) IV semester **Max. Marks: 75**

Hours per week: 02

1. Numerical solution of non-linear algebraic and transcendental equation by bisection, iteration, false position, secant and Newton Raphson methods.
2. Numerical solution of system of linear simultaneous equations by Gauss elimination and Gausss Seidel methods.
3. Interpolation by Lagrange's interpolation formula
4. Numerical evaluation of definite integral by Trapezoidal, Simpson's 1/3rd, Simpson's 3/8th, Weddle and Gaussian quadrature formulae.
5. Numerical solution of first order ordinary differential equation by Euler's, Modified Euler's, second and fourth order Runge-Kutta, Adams-Moulton and Milne's methods.

B. Scope of practice sessions:
Computation of raw moments, central moments, coefficient of variation, coefficients of skewness and kurtosis; Fitting of straight line, second degree polynomial (parabola), power curve and exponential curve; Computation of product moment correlation, multiple and partial correlation coefficients; Regression coefficients and regression lines, plane and regression. Application of tests of significance based on numerical data

4PC8 Mass Transfer Lab

B.Tech. (Petrochemical) IV semester **Max. Marks: 100**
Hours per week: 02

List of Experiments

1. To determine diffusion coefficient of solid vapour in air
2. To determine diffusion coefficient of Liquid vapour in air
3. To study the rate dissolution of a rotating cylinder and then to calculate the mass transfer coefficient.(Mass Tranfer with and without chemical Reaction)
4. To investigate the mass transfer characteristic of a wetted surface column unit.
5. To investigate the characteristics of cooling tower.
6. To study the drying characteristics of a wet granular material using natural and forced circulation in tray dryer.
7. To prepare the drying rate curve for force draft tray dryer.
8. To study the characteristics of spray dryer.
9. To study Absorption of gas in absorption column

4PC9 Heat Transfer Lab

B.Tech. (Petrochemical) IV semester **Max. Marks: 100**
Hours per week: 02

List of Experiment
1. To determine the thermal conductivity of Liquid.
2. To determine the equivalent thermal conductivity of composite wall.
3. To determine heat transfer coefficient in force convection and natural convection
4. Study of Unsteady state Heat Transfer Unit
5. To determine heat transfer coefficient with the help of Stefan Boltzmann Apparatus.
6. To calculate emissivity of the test plate by emissivity measurement apparatus.
7. To determine heat transfer coefficient in double pipe heat exchanger.
8. To study the heat transfer characteristics of a shell and tube heat exchanger (heating/cooling) of water.
10. To measure the rate of film wise and drop wise condensation of pure water vapour and to determine the heat transfer coefficient.
11. To determine rate of evaporation through single effect evaporator.

4PC10 Petroleum Product Testing Lab

B.Tech. (Petrochemical) IV semester **Max. Marks: 75**
Hours per week: 02

1. Measurement of fire point- Flash point
2. Measurement of Cloud point and pour point.
3. Measurement of Aniline point & Bromine number
4. Measurement of Reid Vapour Pressure
5. Measurement of Sulphur Content
6. Measurement of Carbon Residue.
7. ASTM Distillation of Petroleum products.
8. Measurement of surface tension by Tensiometer.
9. Measurement of surface tension by Platinum ring method.
10. Determination of smoke point

4PC11 DECA

Third Year (V Semester) B Tech Petrochemical Engineering

5PC1 Separation Process

B.Tech. (Petrochemical) V semester **Max. Marks: 80**
3L,1T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Adsorption**: Adsorption theories, types of adsorbent; activated carbon, silica and molecular sieves.	4
	Batch and column, adsorption; Break through curves, Liquid percolation and gas adsorption, ,	2
	Absorption Model BDST models for adsorption calculation.	2
II	**Distillation** Vapour liquid Equilibrium, Boiling point diagram, Relative volatility, flash Distillation.	4
	Differential distillation for two component mixture, steam distillation, azeotropic distillation, Extractive distillation.	4
III	**Continuous and Differential contact Distillation** Rectification, reflux ratio, calculation of numbers of plates by NTU.	2

	optimum reflux ratio, open steam, multiple feed and multiple product calculations, Enthalpy concentration diagram	**2**
	Mecab Theile and Panchon-Savarit method for calculation of number of theoretical plates. Approximate equation; Fensky equation for minimum numbers of plate calculation., Batch distillation.	**4**
IV	**Leaching and Crystallization**: Leaching: solid liquid equilibrium, Equipment, principles of leaching.	**2**
	concurrent and counter current systems and calculation of number of stage required.	**2**
	Crystallization: Factors governing nucleation and crystal growth rates, controlled – growth of crystals, super saturation curve, principle and design of batch and continuous type equipment.	**4**
V	**Liquid –Liquid extraction:** Liquid equilibrium & Ponchon – Savarit method, Mc-Cabe- Thiele method, packed & spray column,	**2**
	Conjugate curve and tie line data, plait point, ternary liquid – liquid extraction.	**2**
	Operation and design of extraction towers analytical & graphical solution of single and multistage operation in extraction	**2**
	Co-current, counter current and parallel current system.	**2**
	TOTAL	**40**

Text Book:

2. Binay. K. Dutta. Principles of Mass transfer and separation Process, PHI Learing PVT Ltd.

Reference Books:

1.Mc-Cabe, W.L. Smith J.M. – Unit Operations in Chemical Engineering – 5th edition TataMcGraw Hill – Hogakusha, Tokyo, New Delhi.
2.Coulson J.M. Richardson J.F. - CHEMICAL ENGG. – Vol – 2 Edition-2, Butserworth Heinmann, Oxford, New Delhi.
3.Treybal R.E. – Mass Transfer Operation – 3rd edition, Mc. Graw Hill Book Co. New York.

5PC2 Chemical Reaction Engineering

B.Tech. (Petrochemical) V semester **Max. Marks: 80**
3L **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Classification of reactions**, Definition of reaction rate, Variables affecting the rate, concept of reaction equilibrium.	**4**
	Order of reaction and its determination, theoretical study of reaction rates, collision and activated complex theory.	**2**

	Mechanism of reaction series, Parallel and consecutive reaction, autocatalytic reactions, chain reaction, polymerization reaction	**4**
II	**Interpretation of kinetic data**, Integral and differential method of analysis,	**4**
	Variable volume reactions, total pressure method of kinetic analysis	**4**
III	**Classification of Reactors:** Concept of ideality, Development of design equations for batch, semi batch, tubular and stirred tank reactor.	**4**
	Design of Isothermal and non-isothermal batch, CSTR, PFR, reactors.	**2**
	Combination of reactors, Reactors with recycle, yield and selectivity in multiple reactions.	**2**
IV	**Multiple Reactions in Batch**, continuous stirred tank and Plug flow reactors uniqueness of steady state in continuous stirred tank reactor.	**4**
	Optimum temperature progression, thermal characteristics of reactors. Thiele modulus.	**4**
V	**Non ideal reaction,** RTD dispersion model, Tank and series model, recycle model, segregated flow in mixed models.	**4**
	Residence time Distribution, evaluation of RTD characteristics.	**2**
	TOTAL	**40**

Text Books

1. Fogler H.S; Elements Of Chemical Reaction Engineering; PHI

Reference Books:

1. Smith J.M; Chemical Engineering Kinetics; Mc Graw Hill.
2. Denbigh & Turner K.G; Chemical Reaction Theory an Introduction; United Press.
3. Copper & Jeffery's GVJ; Chemical Kinetics and Reactor Engineering; Prentice Hall
4. Levenspiel O; Chemical Reaction Engg; Willey Eastern, Singapore.
5. Houghen Watson & Ragatz; Chemical Process Principles Part II; Asian Publication House Mumbai

5PC3 Applied Thermodynamics

Common with 5PE3

B.Tech. (Petrochemical) V semester **Max. Marks: 80**
3L,1T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction and First law:** The scope of thermodynamics, dimensions and units, measures of amount or size, force, temperature, pressure, work, energy and heat.	**2**
	The first law of thermodynamics and other basic concepts, Joules' experiment, internal energy.	**2**
	The first law of thermodynamics, energy balance for closed systems, thermodynamic state and state functions, equilibrium, the phase rule,	**2**
	The reversible process, constant volume and constant pressure process, enthalpy, heat capacity.	**2**
II	**The second law of thermodynamics**statements of the second law, heat engines, thermodynamic temperature scales, entropy.	**2**
	entropy changes of an ideal gas, mathematical statement of the second law, entropy balance for open systems,	**2**
	calculation of ideal work, the third law of thermodynamics. Classification and performance of internal combustion engines.	**4**
III	**Refrigeration and Liquefaction:** the Carnot refrigerator-V and T-S diagrams. Analysis of air standard cycles. Carnot cycle,	**2**
	The vapour –compression cycle, the choice of refrigerant, absorption refrigeration, the heat pump, liquefaction process.	**2**
	Vapour- Liquid Equilibrium: The nature of equilibrium, the phase rule VLE – Quantitative behaviour, VLE by modified Raoult's Law, VLE from k-value correlations.	**4**
IV	**Solution thermodynamics**: theory, fundamental property relation, the chemical potential and phase equilibria, partial properties.	**4**
	Ideal-gas mixtures, fugacity and fugacity coefficients, pure species, species in solution, generalized correlations for the fugacity coefficient, the ideal solution, excess properties.	
	Application ; liquid phase properties from VLE data, models for the excess Gibb's energy,	**2**
	Property changes of mixing, heat effects of mixing processes	**2**
V	**Chemical Reaction Equilibria:** The reaction coordinate, application of equilibrium criteria to chemical reactions, the standard Gibbs. Energy change and the equilibrium constant,	**4**
	Effect of temperature on the equilibrium constants, relation of equilibrium constants to composition.	**2**
	Equilibrium conversions for single reactions, phase rule and Duhem's theorem for reacting systems.	**2**
	TOTAL	**40**

Text Books

1.Smith, J.M., Van Ness, H.C. and Abbott, M.M., "Chemical Engineering Thermodynamics", Tata McGraw-Hill Publishing, New Delhi, 6/e, 2003.

Reference Books:

1. Rao, Y.V.C. "Chemical Engineering Thermodynamics", Universities Press, India 2/e, 2001.
2.. Kyle; B.G., "Chemical and Process Thermodynamics"; Prentice Hall, New York, 3/e, 1999
3. K V Narayanan Chemical Engineering Thermodynamics, PHI Learning, 2004.

5PC4 Process Equipments and Design

B.Tech. (Petrochemical) V semester **Max. Marks: 80**
3L,1T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Mechanics of Materials**: Stress- Strain relationships of elastic materials subjected to tensile, force.	2
	Compressive and shear forces, Elastic and plastic deformation, General design considerations; Design of shell, bottom plates.	4
	Self supported, and column supported roofs, wind girder, nozzles and other accessories.	2
II	**Unfired Pressure Vessel**: Pressure vessel codes, classification of pressure vessels,	2
	Design of cylindrical and spherical shells under internal and external pressures.	2
	Selection and Design of flat plate, tor-spherical, ellipsoidal, and conical closures, compensations of openings. High pressure Vessels:	2
	Stress analysis of thick walled cylindrical shell, Design of monobloc and multiplayer vessels.	2
III	**Tall vertical & horizontal vessels**: Pressure, dead weight, wind, earthquake and eccentric loads and induced stresses; combined stresses.	4
	Shell design of skirt supported vessels. Vessel supports;	2
	Design of skirt, lug, and saddle supports.	2
IV	**Bolted Flanges**: Types of Flanges, and selection, Gaskets, Design of non- standard flanges,	4
	Application of flanges,Specifications of standard flanges.	4
V	Fabrication of Equipment; major fabrication steps; welding,	2

	Non destructive tests of welded joints,	**2**
	Inspection and testing, vessel lining, materials used in fabrication of some selected chemical industries.	**4**
	TOTAL	**40**

Text Book

1. Bhattacharya, B.C; Introduction Of Chemical Equipment Design; CBS Publishers, Delhi.

Reference Books:

1. Brownell, N.E and Young, H.E; Process Equipment Design; John Wiley
2. Perry RH; Hand book of Chemical Engrs; Mc Graw Hill Pub
3. Joshi, M.V.; Process Equipment Design.

5PC5 Petrochemical Technology

B.Tech. (Petrochemical) V semester **Max. Marks: 80**
3L **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction :** Chemistry and technology for the production of Phenol, Maleic anhydride,	**2**
	Chemistry and technology for the production of Phthalic anhydride.	**2**
	Chemistry and technology for the production of Styrene methyl ethyl ketone, chlorobenzene etc.	**4**
II	Chemistry and technology for the production of DMT.	**4**
	Chemistry and technology for the production of Terephalic acid, Acrylic acid.	**2**
	Chemistry and technology for the production of , Methyl methacrylate etc.	**2**
III	**Properties and applications:** Properties of production technologies of the following commodity polymers polystyrene, PVC	**4**
	Properties of production technologies of the following commodity polymers. polyethylene, LLDPE .	**2**
	HDPE, polypropylene,	**2**
IV	**Polymer :**Properties, applications and production technologies of the following engineering and thermoset polymers:	**3**
	ABS plastic, nylon-6,polycarbonate,	**3**
	epoxy resin, unsaturated polyester resin, rubber	**2**
V	**Chemistry and Technology: P**roduction of acetic anhydride.	**3**
	Acetone, acetic acid	**3**
	Benzoic acid, Benzyl chloride, Butyl Acetate	**2**
	TOTAL	**40**

Text Book:
1 Waddams, A.L., 'Chemicals from Petroleum', 4th edition, Gulf Publishing Company, London, 1980.

Reference Books:

4. 1 Lewis F. Hatch & S Matar, From Hydrocarbon to Petrochemicals, 2nd Edition , 2000, Gulf Publishing Co. Houston, Texas, USA.
5. B.K. Bhaskara Rao, A Text on Petrochemicals, 2/e, Khanna Publishers, Delhi, 1998.
6. Mall, I.D., "Petrochemical Process Technology", Macmillan India Limited, Delhi, 2007.
7. F.A. Lowenheim and M. K. Moran; Industrial Chemicals, John Wiley & Son Inc.,USA

5PC6 Health Safety and Environment

Common with 5PE2

B.Tech. (Petroleum) V semester **Max. Marks: 80**
3L **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Importance of Safety** Industrial safety and loss trends, safety and environmental concerns, development of industrial safety and loss prevention approaches – loss prevention.	**4**
	Total loss control, quality assurance, total quality management, concept of hazard system.	**2**
	The characterization of hazards, hazard sources and their realization.	**2**
II	**Safety Hazards** Major process hazards: self heating, flame propagation, limits of flammability, explosion, detonation and deflagration, toxic materials.	**2**
	Dosage, acute and chronic effects, threshold limits, fire, explosion and toxic release, effects of hazards.	**2**
	Building a Safe Environment Parameters determining probability and consequence of hazards, occupational health and hygiene, personal safety.	**2**
	methods, work permit, material safety data sheet.	**2**
III	**Hazard identification**: use of hazard indices, hazard and operability studies	**2**
	Hazard Control Major hazard control, legislation and laws, case studies of major hazard events.	**3**

IV	**Impact on Air** Air pollution: major pollutants, meteorology, lapse rate, dispersion, engineering control of air pollution.	**4**
	Safety aspects of H_2S leakage from oil and gas fields. Air pollution causes, remedies in fertilizer plants, petrochemical plants etc.	**4**
V	**Impact on Water** Water pollution: physical, chemical and biological water quality parameters, pollution by oil spills. Ground water pollution near oil dispensing stations.	**3**
	Pollution Control Remediation of the environment, engineered systems for water purification, sludge treatment and disposal.	**3**
	Water pollution causes and remedies in oil production sites, refiners and in production of petrochemicals	**2**
	TOTAL	**40**

Text Book:

1.Daniel A. Crown chemical Process Safety Fundamental with Application Prentice Hall International Series

Reference Books:

1. Loss Prevention in the Process Industries, Less, F. P., 2nd ed. Butterworth Heinemann, UK,
2. Environmental Engineering; Peavy, H. S., Rowe, D. R. and Tchobanoglous, G., McGraw Hill.
3. Chemical Process Safety, Sanders, R. E., Butterworth Heinemann,UK
4. Critical Aspects of Safety and Loss Prevention, Kletz, T. A., Butterworth Heinemann, UK.
5. StefenT Orszulik Environmental Technology in Oil Industry – Springer.

Laboratory

5PC7 Separation Process Lab

B.Tech. (Petrochemical) V semester **Max. Marks: 100**

Hours per week: 02

List of Experiments

10. To study operation of sieve Plate Distillation Coloumn.
11. Liquid- Liquid extraction in a packed column for co-current and counter current flow of binary systems.
12. Studies on solid-liquid extraction column.
13. Study of the Swenson walker Crystallizer
14. To investigate the characteristics of cooling tower.
15. To study the drying characteristics of a wet granular material using natural and forced circulation in tray dryer.

16. To prepare the drying rate curve for fluidized bed dryer.
17. To study vapour Liquid equilibrium Set up.

5PC8 Chemical Reaction Engineering Lab

B.Tech. (Petrochemical) V semester **Max. Marks: 100**
Hours per week: 02

List of Experiment

1. Determine the rate constant and order of reaction in Batch reactor
2. To study temperature dependency of rate constant, evaluation of activation energy and Verification of Arrhenius law in plug Flow Reactor
4. To study a parallel reaction system in cascade CSTR.
5. To study a homogeneous reaction in a semi-Batch reactor under isothermal conditions.
6. Study of non catalytic homogeneous saponification reaction in CSTR.
7. To study a non-catalytic homogeneous reaction in a plug flow reactor.
8. To study the residence time distribution behavior of a Packed bed reactor.
9. To study the RTD behavior of a tubular reactor.
10. To study rate constant in Adiabatic batch Reactor.

5PC9 Health Safety and Environment Lab

B.Tech. (Petrochemical) V semester **Max. Marks: 50**
Hours per week: 02

List of Experiments

1. To determine the BOD of a given water Sample.
2. To determine the D O of a given water Sample.
3. To determine the COD of a given water Sample.
4. To determine the ph value of a given water Sample.
5. To determine the Chlorides in a given water Sample.
6. To determine the Acidity in a given water Sample.
7. To determine the Alkalinity in a given water Sample.
8. To determine the Total Hardness in a given water Sample.
9. To determine the Turbidity of a given water Sample.
10. To determine the Aerobic Microbial colony count.
11. To determine the Total dissolve solid of a given sample.
12. Study of aeration unit, aerobic digester and sedimentation studies apparatus

5PC10 Process Equipments Design

B.Tech. (Petrochemical) V semester **Max. Marks: 50**
Hours per week: 02

Study of the design of the following equipments :

1.Tall vessel design study
2.Unfired pressure vessel
3.Tall vertical & horizontal vessels
4. study of Bolted Flanges:

5. Design of non- standard flanges.etc

5PC11 DECA

6PC1 Petroleum Refinery Engineering

Common with 6PE6.3

B.Tech. (Petrochemical) VI semester **Max. Marks: 80**
L3 **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Cracking Process:** Atmospheric and Vaccum Distillation. Thermal conversion processes.	**4**
	conventional thermal cracking process. Visbreaking, Coking – Fluid coking, flexicoking, delayed coking etc.	**4**
II	**Reforming:** Catalytic conversion processes – fluid catalytic cracking,	**3**
	Hydrocracking, hydrogen production, Reforming.	**4**
III	**Purification process** Alkylation, Polymerization process of crude oil.	**4**
	Isomerisation and Hydrotreating processes crude oil.	**4**
IV	**Crude oil Evalution :** Evaluation of crude oil for LOBS (Lube oil base Stock).	**4**
	Steps in preparation of LOBS, deasphalting.	**4**
V	**Solvent Extraction**: Types of solvents available and their comparison, dewaxing.	**3**
	Hydro finishing of LOBS Hydrogenation processes for LOBS production.	**4**
	TOTAL	**38**

Text Books

Petroleum Refining Technology and Economics', James H. Gary. and Glenn E. H. 4 ed., Marcel Dekker, Inc., 2001 CRC

Reference Books

1. Petroleum Refinery Engineering, Nelson N.L., McGraw Hill Book Co., 1985
2. Petroleum Refining, Waquier, J.P., Vol .I and II, 2 ed., Technip, 1995
3. Petroleum Processing Handbook, Mcketta S.S., Marcel Dekker, Inc., 1992

4. Modern Petroleum Refining Processes, B.K.Bhaskara Rao, 5 ed.Oxford and IBH Publishing Co. Pvt. Ltd., 2007

6PC2 Energy Resources and Utilities

B.Tech. (Petrochemical) VI Semester **Max. Marks: 80**
3L **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	Process utilities electricity, air, fuel oil, refrigerant. Classification and	2
	application of refrigerant.Classification, specification and application of fuel oils.	4
	Handling and preparation of fuel oil. Burneroperation and maintenance.	2
II	Sources uses, impurities & treatment methods for water, refinery water system. Efficient generation and utilization of steam.	4
	High pressure, low pressure and exhaust steams, Steam traps.	4
III	Properties of Steam, problems based on Steam, Types of Steam Generator such as Solid Fuel	2
	Fired Boiler, Waste Gas Fired Boiler and Fluidized Bed Boiler.	4
	Scaling and Trouble Shooting. Steam Traps and Accessories.	2
IV	Energy Management approach, Energy Audit, Energy conservation in major equipment used in refining,	2
	Petrochemical and fertilizer industries like furnace, boilers, pumps, heat exchangers.	3
	Distillation and extraction columns. Introduction to pinch technology.	3
V	Energy conservation equipment like waste heat boiler, recuperator.	3
	Regenerator, heat pipe, heat pump, direct contact heat exchanger,.	2
	Economizer, fluidized bed boiler, continuous furnaces	3
	TOTAL	**40**

Text Books:

1. Rajan, G. G., "Optimizing Energy Efficiencies in Industry", Tata McGraw Hill Publishing Company, New Delhi, 2000

.

Reference Books

2. PCRA's Thermal Booklet Series, Petroleum Conservation Research Association, Sanrakshan Bhawan, New Delhi

3. Sinnot, R.K. " Coulson and Richardson's Chemical Engineering, Volume 6 – Chemical Process Design", Elsevier, New Delhi, 4/e, 2008.

4. O'Callaghan, P.W., "Energy Management", McGraw Hill Company, 1993.

6PC3 Process Design

B.Tech. (Petrochemical) VI semester **Max. Marks: 80**
3L,1T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	Scale up criteria and scale up of process equipment. Process design calculations for heat exchanges equipment.	3
	Shell and tube heat exchangers general description, Application and Clasiffication of heat exchanger	2
	Heat transfer coefficients and pressure drop by Kern's & Bell's methods rating on existing unit.	3
II	Design of a new system having one or more units in series.	4
	Single effect evaporation, multiple effect evaporators with boiling point elevation.	4
III	Process design calculations for mass exchange equipment plate.	4
	Packed column for distribution hand adsorption including column diameter and height.	4
IV	Detailed process and mechanical design, Flash drum , Kettle reboiler.	4
	Condenser, cooling tower, Application of colling tower and rotary drier.	4
V	Design of decanter, Heat load calculations for furnace heaters used in Crude refining.	4
	Basic constructional features, Different furnace types, Review of factors to be considered in the design of fired heaters	4
	TOTAL	**40**

Text Books

1.Ludwig E; Applied process design in chemical petrochemical plants; Gulf publishing co.

Reference Books:

1. Perry, Robert etal; Perry's Chemical Engg. Handbook; TMH
2. Mahajani V V, Umarji SB; Process Eqipment Design; MacMillan Pub.
3. Kern D; Process Heat Transfer; TMH
4. Smith B. D; Design of Equilibrium Stage Processes, Mc graw Hill.
5. Coulson JM. Richardson JF; Chemical engg. Vol ;. Pergaman process

6PC4 Heterogeneous Reaction Engineering

B.Tech. (Petrochemical) VI semester **Max. Marks: 80**
3L **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	Heterogeneous processes: Catalysis and adsorption; Classification of catalysts, Preparation of catalysts, Promoters and Inhibitors.	3
	General mechanism of catalytic reactions surface area and pore size distribution Rate equation of fluid solid catalytic reactions.	2
	Hougen Watson & Poinule law models, Procurement and analysis of kinetic data, kinetics of catalyst deactivation.	3
II	External transport processes and their effects on heterogeneous reactions yield.	2
	selectivity Reaction and diffusion in porous catalysts.	2
	Isothermal and non-isothermal effectiveness factors.	2
	Effect of intra phase transport on yield, selectivity & poisoning, Global reaction rate.	2
III	Design of catalytic reactors, Isothermal & adiabatic fixed bad reactor staged adiabatic reactors, Non isothermal, non adiabatic fixed bed reactors.	4
	Fluidized bed reactors, Slurry reactors, Trickle bed reactors and its applications.	4
IV	Models for fluid - solid non-catalytic reactions, controlling mechanisms, Diffusion through gas film controls.	4
	Diffusion through ash layer controls, Chemical reaction controls, fluidized bed reactors with and without elutriation.	4
V	Gas-liquid reactions and liquid-liquid reaction, Rate equation based on film theory, Reaction design for instantaneous reactions.	4
	Slow reactions, Aerobic Fermentation, Application to Design Tools for Fast Reactions.	4
	TOTAL	**40**

Text Book
1.Fogler, HS; Elements of Chemical Reaction Engineering. PHI

Reference Books:
1. Smiili J.M; Chemical Engg. Kinetics; TMH
2. Denbig K.G & Turner KG; Chemical Theory - An introduction to Reactors; United press
3. Cooper G. & Jeffery JVJ; Chemical Kinetics and Reactor Engineering.; PHI
4. Rajaram J, Kuriacose JC; Kinetics and mech. of Chemical Transformations; MacMillan
5. Levenspiel O; Chemical Reaction Engg; Wiley Eastern Singapore.
6. Hougen, Watson & Ragatz; Chemical Process Principles part 2 CBS Publishers

6PC5 Fertilizer Technology

B.Tech. (Petrochemical) VI semester **Max. Marks: 80**
3L **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**NITROGENOUS FERTILISERS –**macro and micro nutrients,Fertilizers Grades, Various fertilizers and their demand and production in India.	**2**
	Biofertilizer Methods of production of nitrogenous fertilizer-ammonium sulphate, nitrate.	**3**
	Urea and calcium ammonium nitrate; ammonium chloride and their methods of production, characteristics and specifications, storage and handling.	**3**
II	**PHOSPHATIC FERTILISERS** Raw materials; phosphate rock, sulphur; pyrites etc. its application	**2**
	Processes for the production of sulphuric and phosphoric acids.	**2**
	Phosphates fertilizers - ground rock phosphate; bone meal-single superphosphate, triple superphosphate, triple superphosphate.	**2**
	Thermal phosphates and their methods of production, characteristics and specifications	**2**
III	**POTASSIC FERTILISERS** Methods of production of potassium chloride and its application.	**4**
	Potassium schoenite their characteristics and specifications. Secondary Nutrient Fertilizer, Triple super phosphate.	**4**
IV	**COMPLEX AND NPK FERTILISERS** Methods of production of ammonium phosphate, sulphate diammonium phosphate, nitro phosphates, urea,	**4**
	Ammonium phosphate, mono-ammonium phosphate and various grades of NPK fertilizers produced in the country.	**4**
V	**MISCELLANEOUS FERTILISERS** Mixed fertilizers and granulated mixtures; bio fertilizers, nutrients.	**4**

	Secondary nutrients and micro nutrients; fluid fertilizers, controlled release fertilizers, controlled release fertilizers.	**4**
	TOTAL	**40**

TEXT BOOKS

Menno, M.G.; "Fertilizer Industry - An Introductory Survey", Higginbothams Pvt. Ltd., 1973.

Reference Books

1. "Handbook of fertilizer technology", Association of India, New Delhi, 1977. 26
2. Menno, M.G.; "Fertilizer Industry - An Introductory Survey", Higginbothams Pvt. Ltd., 1973.
3. Slack, A.V. and James, G.R., "Fertilizers Science and Technology Series", Marcel Dekker Inc. New York, 1983.
4. Rao, M.G. and Marshall Sittig, "Out lines of Chemical Technology", East-West Press, 1996.
5. Pandey G.N. and Shukla, B.D. "A Text Book of Chemical Technology, Vol I, Vikas. Publishing House, New Delhi.

6PC6.1 Advanced Separation Process

B.Tech. (Petrochemical) VI semester **Max. Marks: 80**
3L,1T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**BASICS OF SEPARATION PROCESS** Review of Conventional Processes, Recent advances in Separation Techniques based on size, surface properties, ionic properties.	**3**
	Special characteristics of substances, Process concept, Theory and Equipment used in cross flow Filtration,	**3**
	Second cross flow Electro Filtration, Surface based solid – liquid separations involving a liquid.	**2**
II	**MEMBRANE SEPARATIONS** Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fiber Membrane Reactors and their relative merits.	**4**
	Commercial, Pilot Plant and Laboratory Membrane permeates involving Dialysis, Reverse Osmosis, Nan filtration.	**2**
	Ultra filtration and Micro filtration, Ceramic- Hybrid process and Biological Membranes.	**2**
III	**SEPARATION BY ADSORPTION** Types and choice of Adsorbents, Adsorption Techniques,	**4**
	Dehumidification Techniques, Affinity Chromatography and Immuno Chromatography, Recent Trends in Adsorption.	**4**
IV	**INORGANIC SEPARATIONS** Controlling factors, Applications, Types of Equipment employed for	**4**

	Electrophoresis, Dielectrophoresis, Ion Exchange Chromatography and Eletrodialysis, EDR, Bipolar Membranes.	**4**
V	**OTHER TECHNIQUES** Separation involving Lyophilisation, Pervaporation and Permeation	**2**
	Techniques for solids, liquids and gases, zone melting, Adductive Crystallization, other Separation Processes,	**2**
	Supercritical fluid Extraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques.	**4**
	TOTAL	**40**

Text Book

1. King, C. J., "Separation Processes", Tata McGraw Hill, 1982.

Reference Books:

1. Roussel, R. W., "Handbook of Separation Process Technology", John Wiley, New York, 1987
2. Nakagawal, O. V., "Membrane Science and Technology"' Marcel Dekkar, 1992.

6PC6.2 Fluidization Engineering

B.Tech. (Petrochemical) III semester **Max. Marks: 80**
3L,1T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	Introduction; Industrial Applications of Fluidized Beds;Height of Fluidized bed.	**4**
	Fluidization and Mapping of Regimes.	**4**
II	The Dense Bed: Distributors, Gas Jets, and Pumping Power;	**4**
	Bubbles in Dense Beds; Bubbling Fluidized Beds.	**4**
III	Entrainment and Elutriation from Fluidized Beds; High-Velocity Fluidization; Solid Movement.	**4**
	Mixing, Segregation, and Staging; Gas Dispersion and Gas Interchange in Bubbling Beds.	**4**
IV	Particle-to-Gas Mass and Heat Transfer; Conversion of Gas in Catalytic Reactions;	**4**
	Heat Transfer between Fluidized Beds and Surfaces;	**2**

	The RTD and Size Distribution of Solids in Fluidized Beds,Circulation Systems.	**2**
V	Design for Physical Operations; Design of Catalytic Reactors.	**4**
	The Design of Non catalytic Gas- Solid Reactors	**4**
	TOTAL	**40**

TEXT BOOK

1. Kunii, D. and O. Levenspiel, "Fluidization Engineering", Butterworth – Heinmann Edn. 2, 1991.

Reference Books:

1. Rowe, P.N. and J.F. Davidson, "Fluidization", Academic Press, 1971
2. Leva, M., "Fluidization", McGraw Hill Book Co. New York, 1959.
3. Perry, R.H.; Green, D.W. (Eds.) "Chemical Engineers Handbook", Edn. 7, McGraw Hill Book Co. Singapore, 1997

6PC6.3 Transportation of Petroleum Product

B.Tech. (Petrochemical) VI semester **Max. Marks: 80**
3L,1T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	Transportation of petroleum & Petroleum products.	**4**
	Basics of pipeline construction, Operation and protection.	**4**
II	Pump and compressor stations. Instrumentation and control.	**4**
	Metering and measurements of oil and gas.	**4**
III	Traffic management, Fire and safety rules. Indian and Global supply scenario of petroleum and petroleum products.	**4**
	Product quality control and management.	**2**
IV	Bulk distribution and handling-domestic, commercial and industrial..	**4**
	Storage of petroleum products in fixed installations Standards and regulations.	**4**
V	Role of International oil companies and OPEC pricing mechanism.	**4**
	Administered and market determined pricing mechanism in India.	**2**
	Conservation of petroleum & its products. Spot and other market control mechanism.	**4**
	TOTAL	**40**

Text Books:
Production and Transport of Oil and Gas, Szilas, A. P, Part B: Gathering and Transport, Development in Petroleum Series, 18 B, Elsevier, 1986,
Reference Books:
1 Offshore Pipeline Design, Analysis and Methods, Mouselli, A. H. Pennwell Books, Tulsa, Oklahoma
2. Surface Production Operations, Arnold, Ken and Stewart, Maurice Volume I and II, Gulf Publishing Company, London.
3. Modeling of Oil Product and Gas Pipeline Transport, Lurie Mikhail, Wiley, 2008

Laboratory

6PC7 Mechanical Operations Lab

B.Tech. (Petrochemical) VI semester **Max. Marks: 100**
Hours per week: 02

List of Experiments

1. To determine particle size distribution for a given sample. Using standard sieve series.
2. Experiment on blending of solid particles using a simple Fluid Mixing Apparatus
3. Experiment on the working of gas-solid cyclone separator.
4. Experiment on particle size reduction in Ball Mill.
5. Experiment on characteristics of fluidized beds.
6. Experiment on magnetic Separation
7. Study of the froth Flotation cell through magnetic separator
7. Experiment on agitation and mixing and filtration of rotator vacuum filter
8. Experiment on batch Sedimentation.
9. Experiment on leaf filter.
10. Experiment on Jaw Crusher
11. Experiments on study of thickner

6PC8 Professional Ethics and Human Values

B.Tech. (Petrochemical) VI semester **Max. Marks: 50**
Hours per week: 02

Human Values
Morals, Values and Ethics – Integrity – Work Ethic – Service Learning – Civic Virtue – Respect for Others – Living Peacefully – caring – Sharing – Honesty – Courage – Valuing Time – Co-operation – Commitment – Empathy – Self-Confidence – Character – Spirituality.
Engineering Ethics
Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry – moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - theories about right action – Self interest - customs and religion - uses of ethical theories.

Engineering as a Social Experimentation

Engineering as experimentation - engineers as responsible experimenters - codes of ethics - a balanced outlook on law - the challenger case study. The Three Mile Island, Fukoshima and Chernobyl case studies.

Safety, Responsibilities and Rights

Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk -. Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest - occupational crime - professional rights - employee rights - Intellectual Property Rights (IPR) - discrimination.

Global Issues

Multinational corporations - Environmental ethics - computer ethics .Engineers as managers-consulting engineers-engineers as expert witnesses and advisors -moral leadership-sample code of Ethics.

Suggested Readings

1. Ethics in engineering, Mike Martin and Roland Schinzinger, McGraw-Hill, New York1996.
2, Engineering Ethics, Govindarajan M., Natarajan S., Senthil Kumar V. S., Prentice Hall, New Delhi, 2004.
3. Engineering Ethics, Fleddermann, Charles D., Pearson Education
4. Engineering Ethics- Concepts and Cases, Harris, Charles E., Protchard, Michael S. and Rabins, Michael, J., Wadsworth Thompson Learning, 2000
5. Ethics and the Conduct of Business, Boatright, John, R., Pearson Education, New Delhi, 2003.

6PC9 Process Design

B.Tech. (Petrochemical) VI semester **Max. Marks: 100**
Hours per week: 02

Sessionals related to design of Following Equipments

1. Heat Exchanger, Furnace condenser, reboiler, Cooling Tower etc.

6PC10 Transportation of Petroleum Products

B.Tech. (Petrochemical) VI semester **Max. Marks: 100**
Hours per week: 02

Study of Basics of pipeline construction, operation and protection. Fire and safety rules.Indian and Global supply scenario of petroleum and petroleum products. Product quality

6PC11 DECA