Scheme and Syllabus PC.pdf

Scheme & Syllabus

of

Bachelor of Technology

Petrochemical Engineering

From III to VIII Semester

For students admitted in session 2017-18

University Teaching Departments

Rajasthan Technical University, Kota

Approved
Dean, FA & UD

HAN TECHNICAL UNIVERSITY KOTA
ch. Petrochemical Engineering Scheme
For
University Teaching Departments

SEMESTER III		Course Title	L	T	P	Marks		
						IA	EX	Total
SN	Subject Code	Theory Papers						
1	3PCU01	Mechanical Operations	3	1	0	50	100	150
2	3PCU02	Chemical process Calculations	3	0	0	50	100	150
3	3PCU03	Fluid Mechanics	3	0	0	50	100	150
4	3PCU04	Material Science and Technology	3	0	0	50	100	150
5	3PCU05	Chemistry of Hydrocarbons	3	0	0	50	100	150
6	3PCU06	Advanced Engineering Mathematics-I	3	1	0	50	100	150
		TOTAL	18	2	0	300	600	900
		Practical and Sessional						
7	3PCU07	Process Computations Sessional	0	0	3	50	25	75
8	3PCU08	Fluid Mechanics Lab	0	0	3	50	25	75
9	3PCU09	Mechanical Operations Lab	0	0	2	50	25	75
10	3PCU10	Data Base Management System Lab	0	0	2	50	25	75
11	3PCU12	Discipline & Extra Curricular activity	0	0	0	-	-	50
		TOTAL						350
		GRAND TOTAL	18	2	10	200	100	1250

25.11.16

23/11/16

22/11/16

Chairman (Exam. UD)
Rajasthan Technical University, Kota

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Semester- IV		Course Title		Hrs./Week				Marks		
SN	Subject Code	Theory Papers	C	L	T	P	IA	End Term Exam	Total
1	4PCU1 4PCU06	Advanced Engineering Mathematics-II	4	3	1	0	50	100	150
2	4PCU2 01	Heat Transfer	4	3	1	0	50	100	150
3	4PCU3 02	Mass Transfer	3	3	0	0	50	100	150
4	4PCU4 03	Introduction to Petrochemicals	3	3	0	0	50	100	150
5	4PCU5	Process Instrumentation	3	3	0	0	50	100	150
6	4PCU6	Introduction to Petroleum Engineering	2	2	0	0	50	100	150
		Practical and Sessional							
7	4PCU7	Mass Transfer Lab	2	0	0	3	50	25	75
8	4PCU8	Heat Transfer Lab	1	0	0	2	50	25	75
9	4PCU9	Applied Numerical Methods Sessional	1	0	0	2	50	25	75
10	4PCU10	Process Instrumentation Sessional	1	0	0	2	50	25	75
11	4PCU12	Discipline & Extra Curricular activity	1	0	0	0	50	0	50
		GRAND TOTAL	25	17	2	9	550	700	1250

L = Lecture, T = Tutorial, P = Practical, C= Credits

(Naveen Kumar Verma)

(Riteshpatidar)

06/01/2017

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Semester- V		Course Title		Hrs./Week				Marks		
SN	Subject Code	Theory Papers	C	L	T	P	IA	End Term Exam	Total
1	5PCU1	Separation Process	4	3	1	0	50	100	150
2	5PCU2	Chemical Reaction Engineering	4	3	1	0	50	100	150
3	5PCU3	Applied Thermodynamics	3	3	0	0	50	100	150
4	5PCU4	Process Equipment and Design-I	3	3	0	0	50	100	150
5	5PCU5	Elective –I 1. Petrochemical Technology 2. Interfacial Science & Technology	3	3	0	0	50	100	150
6	5PCU6	Elective –II 1. Health Safety & Environment 2. Introduction to Nano-Science 3. Polymer Science and Technology	2	2	0	0	50	100	150
		Practical and Sessio							
7	5PCU7	Chemical Reaction Engineering Lab	2	0	0	3	50	25	75
8	5PCU8	Separation Process Lab	1	0	0	2	50	25	75
9	5PCU9	Process Equipment Design-I Sessions	1	0	0	2	50	25	75
10	5PCU10	Health Safety & Environment Lab.	1	0	0	2	50	25	75
11	5PCU12	Discipline & Extra Curricular activity	1	0	0	0	50	0	50
		GRAND TOTAL	25	16	2	9	550	700	1250

L = Lecture, T = Tutorial, P = Practical, C= Credits

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Semester- VI		Course Title		Hrs./Week			Marks		
SN	Subject Code	Theory Papers	C	L	T	P	IA	End Term Exam	Total
1	6PCU1	Heterogeneous Reaction Engineering	4	3	1	0	50	100	150
2	6PCU2	Transport Phenomenon	4	3	1	0	50	100	150
3	6PCU3	Process Equipment Design-II	3	3	0	0	50	100	150
4	6PCU4	Petroleum Refinery Engineering	3	3	0	0	50	100	150
5	6PCU5	Electives-III 1. Renewable Energy Resources 2. Fluidization Engineering	3	3	0	0	50	100	150
6	6PCU6	Electives-IV 1. Transportation of Petroleum Products 2. Oil & Gas Field Development 3. Multi-Phase Flow	2	2	0	0	50	100	150
		Practical and Sessional							
7	6PCU7	Petroleum Product Testing Lab.	2	0	0	3	50	25	75
8	6PCU8	Heterogeneous Reaction Engineering Sessional	1	0	0	2	50	25	75
9	6PCU9	Process Equipment Design-II Sessional	1	0	0	2	50	25	75
10	6PCU10	Transport phenomena sessional	1	0	0	2	50	25	75
11	6PCU12	Discipline & Extra Curricular activity	1	0	0	0	50	0	50
		GRAND TOTAL	25	17	2	9	550	700	1250

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Semester- VII		Course Title		Hrs./Week				Marks		
SN	Subject Code	Theory Papers	C	L	T	P	IA	End Term Exam	Total
1	7PCU1	Process Dynamics & Control	4	3	1	0	50	100	150
2	7PCU2	Refinery Engineering Design	4	3	1	0	50	100	150
3	7PCU3	Plant Design & Economics	3	3	0	0	50	100	150
4	7PCU4	Pipeline Engineering	3	3	0	0	50	100	150
5	7PCU5	Elective-V 1. Fertilizer Technology 2. Modern Separation Techniques 2. Process Plant Utilities	3	3	0	0	50	100	150
		Practical and Sessional							
7	7PCU7	Process Dynamics & Control Lab.	2	0	0	3	50	25	75
8	7PCU8	Pipeline Design Sessional	1	0	0	2	50	25	75
9	7PCU9	Report Writing	1	0	0	2	50	25	75
10	7PCU10	Practical Training	4	0	0	4	150	75	225
11	7PCU12	Discipline & Extra Curricular activity	1				50		50
		GRAND TOTAL	26	15	2	11	600	650	1250

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Semester- VIII		Course Title		Hrs./Week			Marks		
SN	Subject Code	Theory Papers	C	L	T	P	IA	End Term Exam	Total
1	8PCU1	Process Modeling & Simulation	4	3	1	0	50	100	150
2	8PCU2	Natural Gas Engineering	4	3	1	0	50	100	150
3	8PCU3	Electives -IV 1. Oil & Gas Processing Plant Design 2. Industrial Engineering Management 3. Optimization of Chemical Processes	3	3	0	0	50	100	150
		Practical and Sessionls							
7	8PCU7	Process Modeling & Simulation Lab.	1	0	0	2	50	25	75
8	8PCU8	Comprehensive Viva	1	0	0	2	50	25	75
9	8PCU9	Seminar	4	0	0	4	150	75	225
10	8PCU10	Project	8	0	0	12	250	125	375
11	8PCU12	Discipline & Extra Curricular activity	1				50		50
		GRAND TOTAL	26	9	2	20	700	550	1250

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06

3PCU1 ADVANCED ENGINEERING MATHEMATICS-I
(Common for AE, CE, EC, EE, EI, ME, P&I, PE, PCE)

Laplace Transform: Definition and existence of Laplace transform, properties and formulae, unit step function, Dirac Delta function, Heaviside function, inverse Laplace transform, Convolution theorem, application of Laplace transform to ordinary differential equation, solution of integral equations.

Fourier Transforms: Fourier Complex, Sine and Cosine transform, properties and formulae, inverse Fourier transforms, Convolution theorem, application of Fourier transforms to partial ordinary differential equation (One dimensional heat and wave equations).

Z-Transform: Definition, properties and formulae, Convolution theorem, inverse Z-transform, application of Z-transform to difference equation.

Numerical Analysis: Interpolation, difference operators- forward, backward, central, shift and average operators, Newton's forward and backward interpolation formulae, Gauss's forward and backward interpolation formulae, Stirling's formula, Lagrange interpolation formula for unequal intervals. Inverse interpolation. Numerical differentiation by Newton's, Gauss's and Stirling's formula. Numerical integration: Trapezoidal Rule, Simpson's 1/3 and 3/8 Rule.

Numerical solution of ODE of first order: Picard's method, Euler's method, Modified Euler's method, Runge-Kutta forth order method, Milne's Method.

TEXT BOOKS

1. Advanced Engineering Mathematics, Jain and Iyengar, Narosa Publications.
2. Engineering Mathematics for semesters III and IV, C.B. Gupta, Mc Graw Hill Education, India.
3. Advanced Engineering Mathematics, Denis Zill and Warren Wright, Jones & Bartlett India Private Limited.
4. Advanced Engineering Mathematics, O'neil, Cengage Learning, India.

REFERENCE BOOKS

1. Advanced Engineering Mathematics, Irvin Kreyszig, Wiley, India.
2. Advanced Engineering Mathematics, M. Greenberg, Pearson Education, India.
3. Advance Engineering Mathematics, Potter, Oxford, India.
4. Engineering Mathematics, Pal and Bhunia, Oxford, India.
5. Higher Engineering Mathematics, B. V. Ramana, Mc Graw Hill Education, India.
6. Numerical Methods for Scientific & Engineering Computation, Jain and Iyengar, Jain, New Age International Publication, India.
7. A First Course in Numerical Methods, Uri M Asher and Chen Greif, SIAM Publication, India.
8. Introductory Methods of Numerical Analysis, S. S. Sastry, PHI Lerning, India.
9. Numerical Methods for Engineers, Chapra, Mc Graw Hill Education, India. Engineering Mathematics, Paras Ram, CBS Publisher, India.

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3PCU2 CHEMICAL PROCESS CALCULATIONS

Introduction: Unit Operations and Unit Processes and their industrial examples; Steady state and unsteady state processes; Batch, Continuous and Semi-batch Processes.

Units and Dimensions: Dimensions, Basic Units and Derived Units, Units Systems Conversion of units systems; Density and Specific gravity: API, Baume', Twaddell and Brix scale.

Basic process variables: Temperature, Pressure, Volume, Mass and Mole, Volume Fractions, Mass Fraction and Mole Fraction, Mass Flow Rate, Volume Flow Rate, Molar Flow Rate **Chemical Composition:** Weight ratio, Mole ratio, Molality, Molarity, Normality, Wet basis and dry basis, Average molecular weight.

Behavior of gases: Ideal and Van der Waal Gases, Assumptions of Ideal gas, Ideal Gas Law and Van-der-Wall Equation, Gaseous Mixture, Specific volume of gas mixtures.

Material Balance: Law of Conservation of Mass, Overall and Component balances; Degree of Freedom, Degrees of Freedom analysis for given process unit; Material Balances and Calculations for Non-reacting Systems: Absorber, Stripper, Extraction, Distillation; Recycle, bypass and Purge calculations.

Stoichiometry: Introduction to Stoichiometry, Limiting Reactants, Excessive Reactant, Percentage Excess, Fractional conversion, Extent of reactions, Relation between fractional conversion and extent of reaction, Yield and selectivity, Balances and calculations for on reacting systems; Recycle, Bypass and Purge material balances and calculations involving chemical reaction.

Energy Balance: General energy balance equation for open systems and close system. Heat capacities of solid, liquid and gases; Sensible and Latent heat. Problems involving enthalpy change for gaseous and liquid streams. Energy balance for phase change in Condensation and Boiling; Balances on dissolution and heat of mixing processes.

Unsteady State Process Calculations: for a mixer, heating or cooling of a mixed liquid.

Heat of Reaction: Standard State, Heat of formation, Heat of combustion, Heat of reaction, Heat of mixing; Heat effects accompanying chemical reactions, Hess's Law, Kopp's law; Standard Heat of Reaction, combustion and formation. Effect of temperature on standard heat; Adiabatic Reaction Temperature, Theoretical Flame Temperature.

TEXT BOOKS

1. K.V. Narayanan, B Lakshmikutty, Stoichiometry and Process Calculations, PHI learning Private Limited Delhi 2013
2. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering ", EEE Sixth Edition, Prentice Hall Inc., 2003

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

3PCU3 MECHANICAL OPERATION

Particulate Solid: Properties of particulate solids Evaluation of size & shape, surface and population of particles, standard screens Particle size distribution. Mean particle size. Screen analysis of solids. Size measurement, Efficiency of separation and grade efficiency.

Size Reduction: Mechanism of size reduction. Energy for size reduction. Kics's law, Rittinger's law Screening, Methods of operating crushers. Nature of the material to be crushed. Type of crushing equipment. Coarse crushers. Intermediate crushers. Fine crushers. Specialized applications. Brief outline of particle size enlargement/reduction

Agglomeration: Resistance to shear and tensile forces. Angles of repose and of friction.

Separation: :Theory of motion of particles through fluids, motion under gravitational and centrifugal fields, Terminal settling velocity of particles in a fluid (Stroke's law, Newton's law region and K-criteria for settling) Free settling and hindered settling. Gravity settling, centrifugal separation (cyclone separator) and sedimentation: Principles of sedimentation.

Mixing and Conveying: Transportation and Handling of Solids Selection of conveying devices for solids: Belt, Chain, Screw – conveyors, Elevators and pneumatic conveying devices; Elementary design aspects of the devices. Storage of solids-hoppers, silos. Agitation and mixing of fluids and solids, types of mixers, Standard design of mixing vessel **Types of Agitators:** axial flow impellers and radial flow impellers, Power number and Reynolds number for mixing, Power consumption of agitated vessels, Suspension of solids, the degree of mixing, Rate of mixing.

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. Compressible filter cakes. Filtration Practice. The filter medium. Blocking filtration. Common Industrial filters

TEXT BOOK
1. Anup K Swain, Hemlata Patra, G. K. Roy Mechanical 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

3PCU4 FLUID MECHANICS

Common with Petroleum Engineering 3PE3

Properties of fluids; Classification; Ideal fluid, Newtonian and Non-Newtonian fluids; Newton's law of viscosity. Pascal's and Hydrostatic law, manometers. Types of manometer
Fluid Statics: fluid pressure and its measurement. **Fluid Kinetics:** Continuity equation; types of flow.
Fluid dynamics: One dimensional equation of motion; Bernoulli's equation; application; application of Bernoulli's equation. Friction losses in pipe flow, valves and fittings, k-values, sudden expansion and contraction, pipe flow problems Nozzle. Introduction to laminar & turbulent flow. Velocity Distribution for turbulent flow, concept of Reynolds number & friction factor.
Flow through Pipes – Darcy – Weisbach's equation. Head loss in pipes. Pipes in series/ Parallel. Classification, basic construction and application of different types of pumps.
Pump: Centrifugal pump, Principles and application in Bernoulli's theorem Types of Pump: Axial pumps, Gear pump, Plunger Pumps Vane pump, Reciprocation pump and Screw pump. Characteristic Curves of Pumps. Valves, types of valves.
Flow Metering: Metering of fluids; orifice meter, Venturimeter, Pitot tube, Rotameter, Notches, Gas flow meters, coefficient of discharge.

TEXT BOOK

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

REFERENCE BOOKS

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

3PCU05 CHEMISTRY OF HYDROCARBONS

Origin and Formation of Petroleum: Organic and Inorganic Theories, Reserves and deposits of Hydrocarbon in India, Indian Petroleum Industry, Benchmark crudes.

Composition of Crude Oils: Ultimate, chemical and bulk composition, Asphltenes and Resins.

Classification of Crude Oils: Classification, Correlation Indexes: UOP characterization factor, BMCI.

Characterization of Crude Oils: Evaluation of crude oil, ASTM, TBP and EFV distillation curves.

Properties of Crude Oil: Physical & Thermal properties: Density, Specific gravity, Viscosity, Salt Content, Sulfur Content, Ash Content, Metal Content, Nitrogen Content, S&W etc.

Distillation: Pre-treatment, Electric desalting, Atmospheric and vacuum distillation, Distillation products of Crude oil and their quality control tests such as Viscosity, Octane Number, Cetane Number, sulfur content, Pour Point, cloud point, freezing point, Flash point, Fire Point, Smoke Point, Reid Vapor Pressure, Aniline Point, Carbon Residue.

Chemical reactions of hydrocarbons: Cracking (Thermal & Catalytic), Isomerization, Hydrogenation, Alkylation, Reforming with chemistry and reaction mechanism.

Gaseous fuels: Composition & properties of Natural gas, Synthetic gases, Producer gas, Water gas, Coal Gas, LPG, CNG.

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

04

3PCU6 MATERIAL SCIENCE AND TECHNOLOGY

Introduction to materials: Atomic structure, bonding aggregates of atom. **Crystals Structure**: crystal structure, periodicity in crystal, types of structures: SC, BCC, FCC and HCP Crystals system, crystal lattice, unit cell, crystal direction, crystal planes, Miller indices, inter planar

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spacing, X-ray analysis, **Crystals Defects**: classifications and impact on the properties of engineering materials

Phase Equilibria – phase rule phase changes in pure Iron, binary systems, solid solution, Eutectic, Eutectoid, Peritectic and Peritectoid reactions. General principles of heat treatment: Annealing, normalizing, hardening, tempering and age hardening

Corrosion: Types of Corrosion in Industries, corrosion of materials in construction, pipe line and in equipments and its control

Materials and their properties: Mechanical properties: Hardness, Strength, Toughness, Stiffness, Ductility, Malleability, Hardenability, Creep fatigue and Rheology. **Electrical properties:** Conductors, Semiconductors and insulators, dielectric materials. **Optical properties:** Absorption, Reflection, Transmission and Refraction, optical fibers and lasers. **Magnetic properties:** various types of magnetic materials, Diamagnetic, Paramagnetic, Ferromagnetic, Ant ferromagnetic and Ferromagnetic materials, Domain theory, Hard and soft magnetic materials. **Thermal Properties:** Thermal expansion, Heat capacity, Thermal Conduction, Thermal Stresses. Criteria for selection of materials for special applications in Industries such as smart materials.
Smart materials.

Characterization of Material: Principle, Construction and Procedure for characterization of material using Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), EDS/EDX, Atomic force microscopy (AFM), Dielectric spectroscopy, Fluorescence spectroscopy.

TEXT BOOK

1. O P Khanna, A Text Books on Material Science and Metallurgy, Dhanpat Rai Publication.
2. William D Callister, Material Science and Engineering, John Wiley and Sons.

REFERENCE BOOKS

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

LABORATORIES

3PCU7 MECHANICAL OPERATIONS LAB

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
8. Experiment on agitation and mixing and filtration of rotator vacuum filter
9. Experiment on batch Sedimentation.
10. Experiment on leaf filter.

3PCU8 FLUID MECHANICS LAB

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. To Study Construction, Working of Centrifugal, Reciprocating, Gear and Plunger Pumps through test rig
7. To Study pitot tube apparatus and cavitation apparatus in a pipe flow.

3PCU9 PROCESS COMPUTATIONS LAB

1. Introduction to Microsoft Excel for process calculation
2. Basic Operations Using excel function
3. Unit conversions of chemical process using excel.
4. Material Balance solution using Excel.
5. Energy Balance Solution Using Excel.
6. Calculation of multi variable equations.(i.e. gauss elimination method)
7. Problems related to Roults law and ideal gas equations. On excel

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8. Problems related to material balance (i.e stichiometry, crystallization etc)
9. Problems related to energy balance on excel.

3PCU10 DATA BASE MANAGEMENT SYSTEM LAB

Objectives: At the end of the semester, the students should have clearly understood and implemented the following:

1. Stating a database design & application problem.
2. Preparing ER diagram
3. Finding the data fields to be used in the database.
4. Selecting fields for keys.
5. Normalizing the database including analysis of functional dependencies.
6. Installing and configuring the database server and the front end tools.
7. Designing database and writing applications for manipulation of data for a standalone and shared data base including concepts like concurrency control, transaction roll back, logging, report generation etc.
8. Get acquainted with SQL.

In order to achieve the above objectives, it is expected that each students will chose one problem. The implementation shall being with the statement of the objectives to be achieved, preparing ER diagram, designing of database, normalization and finally manipulation of the database including generation of reports, views etc. The problem may first be implemented for a standalone system to be used by a single user. All the above steps may then be followed for development of a database application to be used by multiple users in a client server environment with access control. The application shall NOT use web techniques. One exercise may be assigned on creation of table, manipulation of data and report generation using SQL.

Suggested Tools:
For standalone environment, Visual FoxPro or any similar database having both the database and manipulation language may be used.
For multi-user application, MYSql is suggested. However, any other database may also be used.
For front end, VB.Net, Java, VB Script or any other convenient but currently used by industry may be chosen.
Indicative List of exercises:

1. Student information system for your college.
2. Student grievance registration and redressal system.
3. A video library management system for a shop.
4. Inventory management system for a hardware/ sanitary item shop.
5. Inventory management system for your college.
6. Guarantee management system for the equipments in your college.

3PCU12 DECA

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PCUI ADVANCED ENGINEERING MATHEMATICS-II
(Common for AE, EC, EE, ME, P&I, PE, PCE)

Complex Analysis: Differentiability and Analytic functions, Cauchy-Riemann equations (Cartesian and Polar forms), Harmonic functions, Conformal mapping.
Complex Line integral, M-L inequality, Cauchy theorem, Morera's theorem, Cauchy integral formulae, Taylor series and Laurent series.
Singularities and Zeros, residues at poles and infinity, residues at isolated essential singular point, Cauchy residue theorem, evaluation of real definite integrals and improper integrals.

Special Functions: Legendre's function, Rodrigues formula, generating function, Simple recurrence relations, orthogonal property.
Bessel's functions of first and second kind, generating function, simple recurrence relations, orthogonal property.

Statistics & Probability: Basic concepts of probability, conditional probability, Baye's theorem. Random variable and distributions: Discrete and continuous random variables, Moments, Expectation, Moment generating function, Binomial, Poisson and Normal distribution.

TEXT BOOKS:

1. Advanced Engineering Mathematics, Jain and Iyengar, Narosa Publications.
2. Advanced Engineering Mathematics, Denis Zill and Warren Wright, Jones & Bartlett India Private Limited.
3. Introduction to Probability and Statistics, Seymour Lipschutz and John J. Schiller, Mc Graw Hill Education, India.
4. Advanced Engineering Mathematics, O'neil, Cengage Learning, India.

REFERENCE:

1. Advanced Engineering Mathematics, Irvin Kreyszig, Wiley, India.
2. Advanced Engineering Mathematics, M. Greenberg, Pearson Education, India.
3. Advance Engineering Mathematics, Potter, Oxford, India.
4. Engineering Mathematics, Pal and Bhunia, Oxford, India.
5. Higher Engineering Mathematics, B.V. Ramana, Mc Graw Hill Education, India.
6. Complex Variables and Applications, J.W. Brown & R.V. Churchill, Mc Graw Hill Education, India.
7. Probability and Statistics, Murray Spiegel, John Schiller, R. Alu Srinivasan, McGraw Hill Education, India.
8. Engineering Mathematics, Paras Ram, CBS Publisher, India.

(Ritesh Pathidar

PCU2 HEAT TRANSFER

Conduction: Heat transfer modes, laws; General heat equation; Steady state problems in plane and composite systems; Thermal resistance; Insulation and critical radius; unsteady state heat conduction; Extended surfaces as Fins.

Convection: Principle Heat balance Equation in laminar flow; Natural convection heat transfer from plate and cylinder. Principles, Dimensional analysis of Heat Transfer by Forced, Principles, Dimensional analysis of Heat Transfer by Natural, Laminar and Turbulent Boundary layers; Laminar and turbulent flow heat transfer in a circular pipe. Dimensional groups in Heat Transfer

Condensation and Boiling: Types of condensation: Drop and Film condensation, Condensation on a vertical plate, vertical tube and horizontal tubes. Effect of superheated vapor and non-condensable gases. Types of boiling: Pool and forced boiling; boiling curves; Simplified relations for boiling heat transfer with water; Critical Flux.

Radiation: Basic concepts; Emission characteristics and laws of black body radiation; Radiation incident on a surface; Solid angle and radiation intensity. Heat exchange by radiation between two black surface elements; Heat exchange by radiation between two finite black surfaces; shape factor; Radiation shields.

Heat Exchangers Classification of heat exchangers; Overall heat transfer coefficient, fouling factor calculations; Analysis of Heat Exchangers: Logarithmic Mean temperature difference, Effectiveness – NTU Method.

Evaporator: Evaporators, types of evaporator method of feeding steam consumption, economy.

TEXT BOOK

1. Holman, J. P., 'Heat Transfer ', 8th Edn. McGraw Hill, 1997.

REFERENCE BOOK

1. Ozisik, M. N., Heat Transfer: A Basic Approach, McGraw-Hill, 1984
2. Kern, D.Q., "Process Heat Transfer ", McGraw-Hill, 1999.
3. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I, 4th Edn. Asian Books Pvt. Ltd., India, 1998
4. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 6th Edn. McGraw-Hill, 2001.

CRitesh Patidar

Anil K. Mathur

MASS TRANSFER

damentals of Mass Transfer: Individual and film coefficients, overall mass transfer oefficient and their inter relationships; Analogies in transfer processes, determination of mass transfer coefficient.

Diffusion phenomenon: Molecular and eddy diffusion in gases, liquids and solids, Interface mass transfer. Mass transfer theories: film theory Penetration theory and surface renewal theory.

Humidification and Dehumidification: Humidification: General Theory, psychometric chart. Fundamental concepts in humidification & dehumidification, wet bulb temperature. Adiabatic saturation temperature, measurement of humidification calculation of humidification operation, cooling towers and related equipments.

Drying: Equilibrium mechanism theory of drying, drying rate curve. Batch and continuous drying for tray driers, Drum dryers, spray and tunnel dryers.

Absorption: Introduction to Adsorption, Absorption and Extraction in continuous contact columns; co-current, counter current and cross current contacting Absorption, calculations of NTU and HTU, Concept of HETP, Two phase flow in packed beds, co-current and counter current Processes Flooding loading, column internals: types of trays/ plates and packing, point and plate efficiency.

TEXT BOOK

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

REFERENCES BOOKS

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
2. Treybal R.E; Mass Transfer Operatio; Mc. Graw Hill.
3. Sherwood, T.K. Pigford R.L. and Wilke, C.R.; Mass Transfer; Mc. Graw Hill.
4. Badger, W.L., Banchero, J.T., "Introduction to Chemical Engineering", McGraw-Hill Book Company.

CU4 INTRODUCTION TO PETROCHEMICALS

Introduction: Introduction to Petrochemicals, Applications of Petrochemicals, History and growth of petrochemical industry in India, Petrochemical Industries in India.

Classification Petrochemicals: Based on processing stage, Number of carbon atoms; Petrochemicals from C1, C2, C3, C4, C5, Syngas and Aromatics.

Petrochemical Feed Stoke: Classification: Solid, Liquid, Gaseous;

Chemistry and Technology: Production of Methanol, Formaldehyde, Vinyl Chloride, Ethylene oxide , Isopropanol, Cumene, Acrylonitrile, Isoprene, Ethylene glycol, Linear alkyl benzene, Amines.

TEXT BOOKS

1. Waddams, A.L., 'Chemicals from Petroleum', 4th edition, Gulf Publishing Company, London, 1980.
2. M. Gopala Rao and Marshall Sitting, Outlines of Chemical Technology, 3/e, Affiliated East –West Press Pvt. Ltd, New Delhi

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.

4PCU5 PROCESS INSTRUMENTATION

Introduction:-Introduction to chemical process instrumentation, Process variables, Static and dynamic characteristics of instruments; General classification of instruments, Principles, construction and operation of Instruments for measurement. Elements of measuring systems & their functions.

Temperature measurement: Classification of thermometers and pyrometers, response of thermometers, protecting wells. Fluid filled expansion thermometers. Thermocouples: Resistance thermometers. Radiation and optical pyrometers.

Pressure and vacuum measurement: Classification, Manometers- Inverted well pressure gauges. Bourdon tube pressure gauges, diagram of pressure gauges. McLeod gauge. Classification of sensors and transducers.

r Measurement Instruments:-Measurement of flow, Fluid level, pH, Conductivity, midity and composition.

Process instrumentation diagram and symbols, process instrumentation for Process equipments such as distillation column, Heat exchanger, fluid storage vessel. Classification of sensors and transducers.

TEXT BOOK:

1. Donal P Eckman-Industrial Instrumentation. Wiley 1995
2. Sarika Garg- Process Control and Instrumentation. BBP Publications Pvt. Ltd.

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

4PCU6 INTRODUCTION TO PETROLEUM ENGINEERING

Introduction to Petroleum Geology & Exploration methods
Origin and occurrence of Hydrocarbon, Migration and accumulation of oil and gas, Source, reservoir and cap rocks, Petroleum Traps. Physical properties of oil bearing rocks. Introduction of Geophysical & Geological method of oil & gas exploration.
Introduction to drilling operations
Drilling equipment – drilling rigs and drill string, drilling fluids: types & function
Production principles- Inflow performance curve Fundamental properties of reservoir fluids, Introduction to Production Equipment-Well head, Christmas tree, primary oil recovery
Introduction to unconventional Hydrocarbon resources- CBM, Shale Gas & Gas Hydrate

EXT 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

ORATORY

4PCU7 MASS TRANSFER LAB

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 Transfer 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

4PCU8 HEAT TRANSFER LAB

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.
9. To measure determine the heat transfer coefficient and heat transfer rate of film wise and drop wise condensation of pure water vapor.
10. To determine rate of evaporation through single effect evaporator.

4PEU9 APPLIED NUMERICAL METHODS (SESSIONAL)

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 Method.

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4PCU10 PROCESS INSTRUMENTATION (SESSIONAL)

1. Study of temperature measuring instruments.
2. Study of pressure measuring instruments.
3. Study of flow measuring instruments.
4. Study of liquid level measuring instruments.
5. Study of composition measuring instruments.
6. Study of thermal conductivity measuring instruments.
7. Study of pH measuring instruments.
8. Study of transducers and sensors.

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5PCU1 Separation Process

Adsorption: Adsorption theories, types of adsorbent; activated carbon, silica and molecular sieves. Batch and column, adsorption; Break through curves, Liquid percolation and gas adsorption, Absorption models for adsorption calculation.

Distillation- Vapour liquid Equilibrium, Boiling point diagram, Relative volatility, flash Distillation. Differential distillation for two component mixture, steam distillation, azeotropic distillation, Extractive distillation.

Continuous and differential contact Distillation Rectification, reflux ratio, calculation of numbers of plates by NTU. Optimum reflux ratio, open steam, multiple feed and multiple product calculations, Enthalpy concentration diagram .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.

Liquid –Liquid extraction: Liquid equilibrium & Ponchon – Savarit method, Mc-Cabe- Thiele method, packed & spray column, Conjugate curve and tie line data, plait point, ternary liquid – liquid extraction. Operation and design of extraction towers analytical & graphical solution of single and multistage operation in extraction -Co-current, counter current and parallel current system

Leaching and Crystallization: Leaching: solid liquid equilibrium, Equipment, principles of leaching. cocurrent and counter current systems and calculation of number of stage required. Crystallization: Factors governing nucleation and crystal growth rates, controlled – growth of crystals, super saturation curve, principle and design of batch and continuous type equipment.

Text Book:

1. 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

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5PCU2 Chemical Reaction Engineering

Introduction: Mole Balance, Industrial Reactor Batch Reactor, CSTR,PFR
Classification of reactions: Definition of reaction rate, Variables affecting the rate, concept of reaction equilibrium. Order of reaction and its determination, theoretical study of reaction rates, collision and activated complex theory. Mechanism of reaction series, Parallel and consecutive reaction, autocatalytic reactions, chain reaction, polymerization reaction
Interpretation of kinetic data: Integral and differential method of analysis, Variable volume reactions, total pressure method of kinetic analysis.
Classification of Reactors: Concept of ideality, Development of design equations for batch, semi batch, tubular and stirred tank reactor .Design of Isothermal and non-isothermal batch, CSTR, PFR, reactors. Combination of reactors, Reactors with recycles.
Multiple Reactions: yield and selectivity in multiple reactions. Continuous stirred tank and Plug flow reactors uniqueness of steady state in continuous stirred tank reactor. Optimum temperature progression, thermal characteristics of reactors. Thiele modulus.
RTD and Models: RTD dispersion model, Tank and series model recycle model, segregated flow in mixed models. Residence time Distribution, evaluation of RTD characteristics.

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

5PCU3 Applied Thermodynamics

Introduction and First law:
The scope of thermodynamics, dimensions and units, measures of amount or size, force, temperature, pressure, work, energy and heat. The first law of thermodynamics and other basic concepts, Joules' experiment, internal energy. The first law of thermodynamics, energy balance for closed systems, thermodynamic state and state functions, equilibrium, the phase rule,
The reversible process, constant volume and constant pressure process, enthalpy, heat capacity.

The second law of thermodynamics statements of the second law, heat engines, thermodynamic temperature scales, entropy, entropy changes of an ideal gas, mathematical statement of the second law, entropy balance for open systems, calculation of ideal work, the third law of thermodynamics. Classification and performance of internal combustion engines.

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Refrigeration and Liquefaction: the Carnot refrigerator-V and T-S diagrams. Analysis of air standard cycles. Carnot cycle, vapour –compression cycle, the choice of refrigerant, absorption refrigeration, the heat pump, liquefaction process.

Vapour- Liquid Equilibrium: The nature of equilibrium, the phase rule VLE – Quantitative behavior, VLE by modified Raoult's Law, VLE from k-value correlations.

Solution thermodynamics: theory, fundamental property relation, the chemical potential and phase equilibria, partial properties. 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, Property changes of mixing, heat effects of mixing processes

Chemical Reaction Equilibria: The reaction coordinate, application of equilibrium criteria to chemical reactions, the standard Gibbs. Energy change and the equilibrium constant, Effect of temperature on the equilibrium constants, relation of equilibrium constants to composition. Equilibrium conversions for single reactions, phase rule and Duhem's theorem for reacting systems.

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.

5PCU4 Process Equipment and Design-I

Mechanics of Materials: Stress, Strain, Stress- Strain relationships of elastic materials subjected to tensile force, Elastic and plastic deformation, Factor of safety.

Pressure Vessel: Pressure Vessel, Classification of Pressure Vessels, Pressure vessel codes, General design considerations, Materials of construction.

Components of pressure vessel: Head, Shell, Supports, Bolted flanges, roofs, wind girder, nozzles and other accessories.

Design of thin wall vessel under internal and external pressures: Design of Shell, Design of Head, Design of Supports, Design of bottom plates. Compensations of openings.

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Design of Tall Vertical Vessels: Pressure, dead weight, wind, earthquake and eccentric loads; combined stresses and induced stresses.

Design of High Pressure Vessels: Stress analysis of thick walled cylindrical shell, Design of Monobloc and multiplayer vessels.

Fabrication of Vessel: Major fabrication steps; Welding, Welding Joints, Types of welding.

Inspection and testing: Inspection during Manufacture, Inspection of Completed Pressure Vessels, Pressure Tests, Nondestructive tests of welded joints.

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.
4. R. K. Sinnott; Coulson & Richardson's Chemical Engineering Design, Vol-6.

5PCU5.1 Petrochemical Technology

Chemistry and Technology:

Chemistry and technology for the production of following: Phenol, Maleic anhydride, Phthalic anhydride, Styrene, methyl ethyl ketone, chlorobenzene, DMT, Terephalic acid, Acrylic acid, Methyl methacrylate, acetic anhydride, Acetone, acetic acid, Benzoic acid, Benzyl chloride, Butyl Acetate.

Polymers:

Properties, applications and production technologies of the following engineering polymers:
ABS plastic, nylon-6, polycarbonate, epoxy resin, unsaturated polyester resin, rubber, polystyrene, PVC, polyethylene, LLDPE, HDPE, polypropylene

Text Book:

1. 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. B.K. Bhaskara Rao, A Text on Petrochemicals, 2/e, Khanna Publishers, Delhi, 1998.
3. Mall, I.D., "Petrochemical Process Technology", Macmillan India Limited, Delhi, 2007.

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5. F.A. Lowenheim and M. K. Moran; Industrial Chemicals, John Wiley & Son Inc.,USA

5PCU5.2 Interfacial Science & Technology

Basic concepts of colloids and interfaces; properties of colloidal dispersions; surfactants and their properties; micelles, bilayers, vesicles and liquid crystals; surface and interfacial tension; Young–Laplace equation; Kelvin equation; contact angle; intermolecular and surface forces; DLVO theory; adsorption at interfaces; characterization of solid surfaces; applications in detergents, personal-care products, pharmaceuticals, nanotechnology, and food, textile, paint and petroleum industries.

Texts Book:

1. P. C. Hiemenz and R. Rajagopalan, *Principles of Colloid and Surface Chemistry*, Marcel Dekker, New York, 1997.

References Books:

1. J. C. Berg, *An Introduction to Interfaces and Colloids: The Bridge to Nanoscience*, World Scientific, Singapore, 2010.
2. P. Ghosh, *Colloid and Interface Science*, PHI Learning, New Delhi, 2009.
3. A. W. Adamson and A. P. Gast, *Physical Chemistry of Surfaces*, John Wiley & Sons, New York, 1997.
4. J. Israelachvili, *Intermolecular and Surface Forces*, Academic Press, New York, 1992.
5. R. J. Hunter, *Foundations of Colloid Science*, Oxford University Press, New York, 2005.

5PCU6.1 Health Safety & Environment

Importance of Safety
Industrial safety and loss trends, safety and environmental concerns, development of industrial safety and loss prevention approaches – loss prevention. Total loss control, quality assurance, total quality management, concept of hazard system. The characterization of hazards, hazard sources and their realization.

Safety Hazards
Major process hazards: self-heating, flame propagation, limits of flammability, explosion, detonation and deflagration, toxic materials. Dosage, acute and chronic effects, threshold limits, fire, explosion and toxic release, effects of hazards.

Building a Safe Environment
Parameters determining probability and consequence of hazards, occupational health and hygiene, personal safety methods, work permit, material safety data sheet.

Hazard identification: use of hazard indices, hazard and operability studies

(Ritesh Pathak)

Anil K. Mathur

Hazard Control: Major hazard control, legislation and laws, case studies of major hazard events.

Impact on Air

Air pollution: major pollutants, meteorology, lapse rate, dispersion, engineering control of air pollution. Safety aspects of H2S leakage from oil and gas fields. Air pollution causes, remedies in fertilizer plants, petrochemical plants etc.

Impact on Water

Water pollution: physical, chemical and biological water quality parameters, pollution by oil spills. Ground water pollution near oil dispensing stations.

Pollution Control

Remediation of the environment, engineered systems for water purification, sludge treatment and disposal. Water pollution causes and remedies in oil production sites, refiners and in production of petrochemicals

Text Book:

1. 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.
2. Chemical Process Safety, Sanders, R. E., Butterworth Heinemann,UK
5. Critical Aspects of Safety and Loss Prevention, Kletz, T. A., Butterworth Heinemann, UK.
6. StefenT Orszulik Environmental Technology in Oil Industry – Springer.

5PCU6.2 Introduction to Nano-Science

Introduction:

Fundamental concept, size, quantum effect, size Moore's law, Band gap, photon, Different interactions at nanoscale (electrostatic, Van der Walls, hydrophobic, hydrogen bonding, dipole dipole).

Nanostructured Materials:

Classification: Zero dimensional, One dimensional, two dimensional and three dimensional nanomaterials. Advanced materials such as quantum dots, polymeric nanoparticles, Carbon nono tubes, Graphene, Aerogels;

Application of nanomaterials: Nano Catalyst in refinery diesel oxidation catalyst and petrochemical, crude production, nano material in exploration and production as a smart fluid, drilling fluid etc.

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Anil K. Mathur

Properties of Nanomaterials:

Surface to volume ratio; Surface properties of nanoparticles; mechanical, optical, electronic, magnetic, thermal and chemical properties of nanomaterials. Size dependent properties, size dependent absorption spectra, Shape impact on properties of nanomaterials,

Nanomaterials synthesis:

Top down and bottom up approach, Chemical methods (sol-gel technique, metal reduction, chemical vapor deposition, combustion technique.)

Mechanical methods (Grinding, lithography, Microfluidics). Preparations of catalysts, Regeneration of catalysts.

General Characterization Techniques:

Beam probe Methods (SEM, TEM, XRD), Scanning Probe Methods (AFM, ASTM), BET area analyzer, UV-vis Spectroscopy.

Text Book:

1. Introduction to Nanoscience by G.L. Hornyak, J. Dutta, H.F. Tibbals, A.K. Rao, CRC Press
2. Chemistry of nanomaterials : Synthesis, properties and applications by CNR Rao et.al.

Reference Books:

1. Nanochemistry: A chemical approach to nanomaterials by G. A. Ozin, A. C. Aresnault, L. Cadematriri, RSC Publishing
2. Processing & properties of structural naonmaterials - Leon L. Shaw (editor)
3. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
4. Nanoscale materials -Liz Marzan and Kamat.
5. Nano: The essentials by T. Pradeep, Tata Mcgraw Hill.

5PCU6.3 Polymer Science and Technology

Classification of polymers, Linear branched and cross-linked polymers, Molecular weights of polymers.

Polydispersity and Mol. Wt. distribution in polymers.

Random, alternate, block and graft co-polymers, polymer characterization techniques, polymer degradation.

Kinetics of chain & Step polymerization, techniques of molecular weight control.

Initiators, Chain transfer agents, Inhibitors. Techniques of polymerization.

Bulk, Solution, Suspension & Emulsion polymerization.

(Ritesh Paliwal)

Introduction to polymer rheology, Newtons law of viscosity, viscometris plots, rheometers.

Rheological models, theory of viscoelasticity, Heat distortion temperature.

Basic concept of polymer processing: Compounding methods, Extrusion moulding, Injection moulding.

Blow moulding, Rotational moulding. Introduction to fibre reinforced plastics.

Text Book:

1. Kumar, A., "Fundamentals of Polymer Engineering", 2/e, Marcel Dekker, New York, 2003

Reference Books:

1. Gowariker, V.R., Viswanathan, N.V. and Sreedhar, J., "Polymer Science", New Age International (P) Ltd, New Delhi, 1986.
2. Odian, G., "Principles of Polymerization", John Wiley & Sons Inc, New York, 1991.
3. Tager, A., "Physical Chemistry of Polymers", Mir Publishers, Moscow, 1978.
4. Perepechko, I.I., "An Introduction to Polymer Physics", Mir Publishers, Moscow, 1981.
5. Billmeyer, F. W. "Textbook of Polymer Science", John Wiley & Sons, New York, 1984.

Practical and Sessional

5PCU7 Chemical Reaction Engg. Lab

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
3. 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.

5PCU8 Separation Process Lab

List of Experiment

1. Studies on solid-liquid extraction column.
2. Study of the Swenson walker Crystallizer
3. To investigate the characteristics of cooling tower.
4. To study the drying characteristics of a wet granular material using natural and forced circulation in tray dryer
5. To study vapour Liquid equilibrium set up

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6. Column for co-current and counter current flow of binary systems.

5PCU9 Process Equipment Design-I Sessional

Study of the design of the following equipments:

1. Thin wall vessel under internal pressure
2. Thin wall vessel under external pressure
3. Tall vertical vessel
4. High pressure vessel
5. Bolted Flanges

5PCU10 Health Safety & Environment Lab.

List of Experiments

1. To determine the pH value of a given water Sample.
2. To determine the DO of a given water Sample.
3. To determine the COD of a given water Sample.
4. To determine the Chlorides in a given water Sample.
5. To determine the Fluoride content of 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 Total dissolved solids of a given water sample

5PCU12 Discipline & Extra Curricular Activity

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6PCU1 Heterogeneous Reaction Engineering

Heterogeneous processes: Catalysis and adsorption; Classification of catalysts, Preparation of catalysts, Promoters and Inhibitors. General mechanism of catalytic reactions surface area and pore size distribution Rate.

Catalyst Deactivation: Types of catalyst deactivation, kinetics of catalyst deactivation. Pseudo steady state hypothesis. Michaelis- Menten kinetics.

Design of catalytic reactors Steady State Non Isothermal reactor Design, energy Balance, Non Isothermal Continuous Flow reactor, Non Adiabatic Reactor Operation, Adiabatic tubular reactor. Isothermal and non-isothermal effectiveness factors.

Kinetics of Fluid Particle Reaction:-Progressive Conversation models, Shrinking Core Models, Models for fluid - solid non-catalytic reactions, controlling mechanisms, Diffusion through gas film controls. Diffusion through ash layer controls, Chemical reaction controls. Global reaction rate.

Multiphase Reactor: Fluidized bed reactors, Slurry reactors, Trickle bed reactors and its applications. Fluidized bed reactors with and without elutriation. Gas Liquid reaction on solid Catalyst.

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

6PCU2 Transport Phenomenon

Similarity in momentum, heat and mass-transport - Newton's laws of viscosity.

Fourier's laws of conduction and Fick's laws of diffusion, Flux-transport property relationships.

Estimation of transport properties measurement and correlations, velocity distribution in Laminar flow of falling film.

Flow over an inclined plane, a circular tube an annulus and between two parallel plates.

Shell balance approach for developing equations of change for momentum, heat andmass transport.

Shell balance approach for developing equations of change for momentum, heat and mass transport.

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Anil K. Mathur
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Transport equations in turbulent flow and equations for turbulent fluxes. Velocity, Temperature and concentration profiles for laminar and turbulent flow conditions.

Temperature and concentration profiles for conductive and convective transport in solids and fluids.

Macroscopic momentum and heat balance equations, Kinetic energy calculations, Constant area and variable area flow problems.

Flow through bends, time determination for emptying of vessels.

Text Book:

1. Bird R.B., Stewart W.E. and Lightfoot EW; Transport phenomena; Wiley tappon

Reference Books:

1. Brodkey RS and Hershey -Transport phenomena a unified approach; TMH
2. Geancoplis; Transport processes & separation process principles; PHI learning.

6PCU3 Process Equipment Design-II

Heat Exchanger Design:

Introduction: Heat Exchanger, Classification and Application of heat exchanger, Heat exchanger analysis, Overall heat transfer coefficient, Fouling factor, Heat exchanger design procedure, Heat-exchanger standards and codes, General design considerations for heat exchangers, Shell and Tube heat exchanger, Components of Shell & Tube heat exchanger, Types of Shell & Tube heat exchangers .

Design Calculations: Tube: Dimensions, Tube arrangements, Tube-side passes; Shell: Dimensions, Shell passes; Baffles: Types; Support plates and tie rods, Tube sheets, Tube-sheet layout, Shell and header nozzles, Flow-induced tube vibrations, Mean Temperature Difference, Tube side calculations: Heat transfer coefficients and pressure drop; Shell side calculations: Heat transfer coefficients and pressure by Kern's & Bell's Methods.

Condensers Design:

Introduction: Condensation, Film-wise and dropwise condensation, Types of condensers: Vertical condenser and Horizontal condenser, De-superheating and sub-cooling.

Design Calculations: Mean temperature difference, Tube side calculations: Heat transfer coefficients and pressure drop; Shell side calculations: Heat transfer coefficients and pressure.

Reboiler Design:

Introduction: Boiling, Pool boiling, Convection boiling, Reboiler, Classification of reboilers

Design of kettle reboiler: Design considerations, Individual heat transfer co-efficient hot fluid and boiling liquid, allowable vapor velocity, Tube side and shell side pressure drop.

(Ritesh Pahidar)

Text Book:

1. R. K. Sinnott, Coulson & Richardson"s Chemical Engineering: Chemical Engineering Design (volume 6), Butterworth-Heinemann, 3rd ed. 1999.

Reference Book:

1. Indian Standard (IS: 4503-1967): Specification for Shell and Tube Type Heat Exchangers, BIS 2007, New Delhi.
2. D. Q. Kern, Process Heat Transfer, McGraw-Hill Book Company, Int. ed. 1965.
3. Standards of the Tubular Exchanger Manufacturers Association (TEMA), Inc. 18 ed., 1999, New York.
4. Ludwig E; Applied process design in chemical petrochemical plants; Gulf publishing co.

6PCU4 Petroleum Refinery Engineering

Separation Processes: Atmospheric Distillation, Vacuum Distillation.

Cracking Process:
Thermal conversion processes. Conventional thermal cracking process. Visbreaking, Coking – Fluid coking, flexicoking, delayed coking etc.

Reforming:
Catalytic conversion processes – fluid catalytic cracking, Hydrocracking, hydrogen production, Reforming.

Purification process
Alkylation, Polymerization process of crude oil. Isomerisation and Hydrotreating processes crude oil.
Crude oil Evaluation: Evaluation of crude oil for LOBS (Lube oil base Stock). Steps in preparation of LOBS, deasphalting.
Solvent Extraction: Types of solvents available and their comparison, dewaxing. Hydro finishing of LOBS Hydrogenation processes for LOBS production.

Text Books

1. 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

Ritesh Patidar

6PCU5.1 Renewable Energy Resources

Solar Energy
Introduction to renewable energy and its importance in context of global warming. Solar radiation, solar thermal energy systems: active and passive systems, concentrating collectors, solar flat plate collector, solar thermal energy storage, photovoltaic cells and their arrangements.

Biomass Energy
Energy from biomass and solid wastes: thermal route-pyrolysis and gasification, biochemical route-ethanol production, refuse derived fuel. Biofuels, Jatropha, Bio-diesel, Biogas production and storage. Examples of failures and successes of biofuels, say with case studies of Brazil and USA.

Wind Energy
Wind energy: types of turbines and principles of operation, OTEC, Wave and tidal energy, Geo-thermal energy, hydrothermal energy. Case Studies of India and Netherlands

Fuel Cells
Fuel cells, basic design, types Hydrogen Energy, Economics of hydrogen production methods and storage and transportation. Applications

Environmental Aspects
Environmental consequences of various renewable energy resources. Energy management: Energy efficiency, Energy audit, Energy conservation. Energy policy. Examples of Electric vehicles as part of energy and transportation policy of California and Brazil.

Text Books
1. Principles of Solar Engineering, Kreith, F. and Kreider, J.F., McGraw-Hill, 1978

Reference Books
1. Solar Energy Handbook, Kreider, J.F. and Kreith, F., McGraw-Hill 1981.
2. Alternative Energy Sources, T.N. Veziroglu, Vol 5 and 6, McGraw-Hill, 1978.
2. Non-conventional Energy Resources, Khan, B.H., Tata McGraw Hill, New Delhi, 2008.
3. Solar Energy: Principles of Thermal Collection and Storage", Sukhatme, S.P., Tata McGraw-Hill, NewDelhi, 1984.
4. Solar Engineering of Thermal Processes, Duffie, J. A. and Beckman, W. A., John Wiley
5. "Renewable Energy, Sorensen, B., Academic press, New York, 2/e, 2000.

6PCU5.2 Fluidization Engineering

Introduction; Industrial Applications of Fluidized Beds; Height of Fluidized bed. Fluidization and Mapping of Regimes. The Dense Bed: Distributors, Gas Jets, and Pumping Power; Bubbles in Dense Beds; Bubbling Fluidized Beds. Entrainment and Elutriation from Fluidized Beds; High-Velocity, Fluidization; Solid Movement. Mixing, Segregation, and Staging; Gas Dispersion and Gas. Interchange in Bubbling Beds. Particle-to-Gas Mass and Heat

Ritesh Paliday

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Anil K. Mathur

Transfer; Conversion of Gas in Catalytic Reactions; Heat Transfer between Fluidized Beds and Surfaces; The RTD and Size Distribution of Solids in Fluidized Beds, Circulation Systems. Design for Physical Operations; Design of Catalytic Reactors. The Design of Non catalytic Gas-Solid Reactors.

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

6PCU5.3 Dyes and Dyes Intermediates

Introduction: Definition, classification & importance of dyes, Chemical Feedstock for dye stuff industry-fossil feedstock – coal, petroleum coal-tar primaries: renewable raw materials.

Chemistry of benzenoid aromatics: Electrophilic aromatic substitution reactions with the mechanisms, one carbon electrophiles & their utility. Nucleophilic aromatic substitution reaction Orientations in aromatic substitution reaction. Hammet substitution constants. Introduction of various functional groups into benzenoid aromatics, functional group interconversions. Synthesis of typical dyestuff intermediates based on benzene, xylene, toluene

Chemistry of naphthalene-Electrophilic aromatic substitution reactions: Bucherer reaction, Reverse Bucherer reaction. Synthesis of naphthols, naphthyl amines, naphthol sulphonic acid, naphthyl amine sulphonic acids, aminona phthol sulphonic acids. Bon acid arylides as Azocoupling components. Anthracene& condensed aromatics.

Anthraquinone & benzanthrone. Reactions of anthraquinone, benzanthrone & synthesis of dyestuff intermediates based on anthr aquinone & benzanthrone.

Active methylene compounds: Acetoacetic ester, malonic ester, malononitrile & their use in synthesis of dyestuff intermediates, diketene, aceto acetanalides Simple hetero cyclic compounds like pyrazolones, aminopyrazoles, pyrimidines, pyridines. Evolution of dye stuff chemistry.

Text Books:

1. Shreve's Chemical Process Industries", George T. Austin, McGraw Hill Publication, 5th edition

(Rituraj Purohit)

Anil K. Mathur

2. "DRYDENS outlines of chemical technology for the 21st century", M Gopalarao & Marshal Sitting, pub East-West Press, 3rd edition.

Reference Books:

1. Industrial Dyes: Chemistry, Properties, Applications by Klaus Hunger- WILEY-VCH Verlag GmbH & Co.
2. Advances in Color Chemistry Vol I to Vol III by Peters A.T – Blackie
3. Colorants for Non – Textile Applications by Freeman - Elseiver, 2000.
4. Modern Colorants: Synthesis and Structure by A T Peters and H S Freeman - Springer, 1995
5. Fundamental Processes of Dye Chemistry by Fierz, David - Blangey, Interscience Publishers, 1955
6. Industrial Organic Chemistry by Arpe H.J.VCH - Weinheim, Weissermal K.1993
7. Chemistry of Synthetic Dyes by Lubs H.A. - Robert E Krieger Publishing Company New York, 1995
8. Chemistry of Synthetic Dyes by Lubs H.A. - Robert E Krieger Publishing Company New York, 1st Ed., 1995

6PCU6.1 Transportation of Petroleum Products

Transportation of petroleum & Petroleum products. Basics of pipeline construction, Operation and protection. Pump and compressor stations. Instrumentation and control. Metering and measurements of oil and gas.

Traffic management, Fire and safety rules. Indian and Global supply scenario of petroleum and petroleum products. Product quality control and management.

Bulk distribution and handling-domestic, commercial and industrial. Storage of petroleum products in fixed installations Standards and regulations.

Role of International oil companies and OPEC pricing mechanism. Administered and market determined pricing mechanism in India.
Conservation of petroleum & its products. Spot and other market control mechanism.

Text Books:

1. 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, m 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

6PCU6.2 Oil & Gas Field Development

Types of reserves – Proved, proved subeconomic and inferred reserves. Classification of reserves – Proved: Categories A, B, C1; Proved subeconomic – Category 2; and inferred: Category C2. SPE/WPC definitions and classification of reserves – Proved, unproved, probable and possible reserves.

Classification of simulations based on type of reservoir –gas reservoir simulations, black oil reservoir simulators and compositional reservoir simulations. Input data for black oil simulation. General data of the reservoir, rock and fluid data, grid data, production / injection and well data. History matching – Verification of input initial data, pressure matching and saturation matching.

Field Development: Criteria for field development – Basic geological data for development planning. Data collection from initial wells. Discovery well – Delineation of the field limits

Volumetric estimation of in place reserves – Planning development wells based on the reservoir parameters and economic criteria – Well spacing - Final development plan – Rate of production – Oil recovery factor – Water injection – Pressure maintenance – Abandoning the field – Abandonment pressure.

Bottom Hole Studies:
Collection of reservoir samples, performance of routine reservoir tests like productivity index, build-up test, draw down test, interference test, back pressure test, and isochronal test. Calculation of reservoir parameters like, K, Kh, Skin, flow efficiency, P.I. etc. and other PVT parameters. Significance of pressure and temperature data in hydrocarbon exploration and exploitation.

Identification and Treatment of Sick Wells Definition of a sick well, criteria for identification of sick well. Sickness due to leakage – Detection of leakage, temperature survey, temperature anomaly, Radioactive isotope (tracer) survey, Activated oxygen log, isolation by packers. Reperforation and activation.

Text Books

1. Cole, F.W. 1961, Reservoir Engineering Manual, 2nd Edn.Gulf Eng Co, Huston, Texas.

Reference Books

1. Advance Reservoir Engineering by T. Ahmed, P. D. McKinney, Elsevier.

2. Craft, B.C. and Hawkins, F.W. 1959. Petroleum Applied Reservoir Engineering practice Hall, New Jersey
3. Oil and Gas Pipeline Fundamentals:- Kennedy
4. Oil and Gas Field Development – Sant Kumar

6PCU6.3 Multi-Phase Flow

Multiphase Flow: Scope and significance of multiphase flows, Dimensionless numbers in multiphase flows; Flow Pattern and Flow Regimes. Fluid-Solid System, Fluid-Fluid Systems, Solid-Fluid-Fluid systems.

Flow Classification: Two-phase Co-current flow of Gas-Liquid, Gas-Solid and Liquid-Liquid, Upward and Downward Flow in Vertical pipes. Suspensions of Solid and their transport in Horizontal Pipes. Drag Reduction Phenomena, Laminar, Turbulent and Creeping Flow Regimes.

Mixing Power Correlations - Theories of Intensity and Scale of Turbulence. Calculation of Circulation Velocities and Power Consumption in Agitated Vessels for Newtonian and Non-Newtonian Fluids. Blending and Mixing of Phases. Power requires for aeration to suspend to an Immiscible Liquid or Solids in Slurry Reactors, Prediction of optimum speed of Impeller Rotor and Design Criteria for Scale up.

Quantification Of Flow System - Prediction of Holdup, Pressure Drop and bubble size in pipe flow, Lockhart –Martinelli Parameters, Bubble Column and its Design aspects; Flow through Packed Bed and Fluidized Bed, Minimum Carryover Velocity. Holdup Ratios, Pressure Drop and Transport Velocities and their prediction. Solid-Fluid Conveying and Settling.

Flow In Three - Phase Systems - Gas, solid and Liquid Composites Slurries in Horizontal Pipes, Flow through Porous Media of Composite Mixtures, Prediction of Holdup, Pressure Drop and throughput velocities in three – phase system. Design of Multiphase Contactors involving Solids, Liquids and Gases.

Text Book:

1. Govier, G. W. and Aziz. K., "The Flow of Complex Mixture in Pipes", Van Nostrand Reinhold, New York, 1972.

Reference Books:

1. Wallis, G.B., "One Dimensional Two Phase Flow", McGraw Hill Book Co., New York, 1969.
2. Brodkey, R. S., "The Phenomena of Fluid Motions", Addision – Weseley, New York, 1967.
3. Hestroni, G., (Ed.) "Hand book of Multiphase systems", Hemisphere Publishing, Washington, 1982

Practical and Sessional

6PCU7 Petroleum Product Testing Lab.

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.

6PCU8 Heterogeneous Reaction Engineering Sessional

1. Preparation of catalysts
2. Design of Steady State Non Isothermal reactor
3. Design of Non Isothermal Continuous Flow reactor,
4. Design of Non Adiabatic Reactor
5. Design of Adiabatic tubular reactor
6. Design of Fluidized bed reactors
7. Design of Slurry reactors
8. Design of Trickle bed reactors

6PCU9 Process Equipment Design-II Sessional

Sessionals related to design of Following Equipments:

1. Shell & Tube Heat Exchanger: Tube Calculations
2. Shell & Tube Heat Exchanger: Shell Calculations by Bell's Method
3. Shell & Tube Heat Exchanger: Shell Calculations by Kern's Method
4. Condensers
5. Reboiler

6PCU10 Transportation ~~of Petroleum Products~~ phenomenon Sessional

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.

6PCU12 Discipline & Extra Curricular Activity

(Ritesh Patidar)

Anil K. Mathur
Approved
Dean, FA & UD

7PCU1 Process Dynamics & Control

First–order Systems: Introduction, Transfer Function, Linear Open-Loop Systems, Transient response (step response, impulse response, and sinusoidal response), response of first order systems in series. Non-interacting systems and interacting systems.
Second-order systems: Transfer function, step response, impulse response, k sinusoidal response, transportation lag.
Linear closed-loop Systems: Control System: components of a control system block diagram. Negative feedback and positive feedback, servo problem and regulator problem.
Closed-Loop Transfer functions: Overall transfer function for single loop systems, overall transfer function for set-point change and load change, multi-loop control systems. Transient Response of simple control systems: P and PI control for set point change and for load change.
Controller and final control element: Mechanism of control valve and controller, transfer functions of control valve and controllers (P, PI, PD, and PID). Examples of a chemical reactor control system. **Stability**: Concept of Stability, Stability criteria, Routh test for stability, Root Locus.
Frequency Response: Introduction to Frequency Response, Bode Diagrams for First and second order systems, Bode stability Criteria, Ziegler-Nichols and Cohen-coon Tuning rules.

Text Book:

1. Process Systems Analysis and control, Coughanowr, D.R., McGraw –Hill, 1991.
2. Chemical Process Control, Stephanopoulos, G, PHI,

Reference Books:

1. Process Instrumentation R.P.Vyas Dinut publication.
2. Process Modelling, Simulation and Control for Chemical Engineers, Luyben, W.L,McGraw Hill,
3. Process Control Principles and Application, Surekha Bhanot, Oxford Higher Education/Oxford University Press, 2008
4. Process Control, Peter Harriott, Tata McGraw-Hill Publishing Company, 1964

7PCU2 Refinery Engineering Design

Overview of Refinery: Global and Indian Refining Industry, Refinery configurations, ASTM Distillation TBP Distillation, EFV distillation. Analysis of crude petroleum and its fractions. Different types of Boiling point, VABP, WABP, MABP, MeBP, CABP Computation of the curves , Calculation of ASTM temperature to TBP and EFV temperature, Average boiling points, Separation criteria in crude oil fractionation. Calculation for characterizing crude oil.

Atmospheric distillation: Atmospheric distillation tower, types of refluxes, pump around reflux pump back reflux top tray reflux, converting crude TBP to product TBP curves, concept of overflash. Energy balance in a topping tower and calculations involve estimation of top, side, bottom draw tray temperatures. Calculation of side steam strippers.

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Vacuum distillation: Vacuum distillation tower, type of operations, Lube type Vacuum tower with pump back and pump around reflux heat removal. Lube or special vacuum distillation operation economic consideration in Vacuum Tower.

Fired Heater: Types of fired heaters, Horizontal Types, Vertical Types, Codes and standards Burner, Gas burner Oil burner combination burners. Preparing refractories for operation stacks emissions, Basic constructional features of furnace, Different furnace types.

Text Book:

1. R.N. Watkin, Petroleum Refinery Distillation, 2/e Gulf Publishing Co, Houstan, Texas, USA, 1981.

Reference Books:

1. B.K Bhaskar Rao, Modern Petroleum Refining Processes, 3/e, Oxford & IBH Publishing Co Pvt. Ltd., 1997.
2. Wayne C. Edmister, Applied Hydrocarbon Thermodynamics, 2/e, Gulf Publishing Co.,1988.
3. Van Winkle M., "Distillation", McGraw Hill, 1967
4. Sinnott R. K., "Coulson and Richardson's Chemical engineering", Vol. 6, Third Edition, Butter Worth-Heinemann, 1999.
5. Kern D. Q., "Process Heat Transfer", McGraw Hill, 1965.

7PCU3 Plant Design & Economics

Introduction: Process Design development, General design considerations, Cost and asset accounting,

Cash flow for industrial operations, factors effecting investment and production cost, capital investments, estimation of capital investments, cost indices, cost factors in capital investment.

Organizations for presenting capital investments, estimates by compartmentalization, estimation of total product of cost direction, production costs, fixed charges, plant overhead costs, financing.

Interest and investment cost, type interest, nominal and effective interest rates, continuous interest, present worth and discount annuities, cost due interest on investment, source of capital.

Taxes and insurances: type of taxes: federal income taxes, Insurance-types of insurance, self-insurance.

Depreciation: types of depreciation, services life, salvage value, present value, Methods for determining depreciation, single unit and group depreciation.

Profitability: alternative investments and replacements, profitability standards, discounted cash flow

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Capitalized cost, pay out period, alternative investments, analysis with small investments, increments and replacements.

Text Book:

1. Max S. Peters, Klaus D. Timmerhaus and Ronal E. West, Plant Design and Economics for Chemical Engineers, 5th ed. (2002), McGraw-Hill, New York

Reference Books:

1. Schwever , H.D., "Process Engineering Economics", McGraw- Hill.
2. Chilton, "Chemical Engineering Cost Estimation", McGraw-Hill.
3. Bauman, H.C., "Fundamentals of Cost Engineering in the Chemical Industry", Reinhold Book Corporation, New York.
4. Jelen, F.C., "Cost and Optimization Engineering", Mc Graw-Hill, New York.

7PCU4 Pipeline Engineering

Objective and scope of pipeline as a means of fluid transportation with special reference to crude oil/gas/refined products.

Design of Pipeline: Factors influencing oil, gas and refined products as pipeline design. Hydraulic surge and water hammer; specific heat of liquids; river crossing; pipe size and station spacing etc.

Theory and different formulae of the flow of fluids in oil/gas pipelines; basic equations for the flow of fluids through pipes; different flow equations for laminar and turbulent flow of compressible and incompressible fluids.

Introduction to the flow of Non- Newtonian fluids through pipes; multiphase flow and loop pipelines.

Construction of Pipelines; materials; project specifications; general equipment specifications (Pipes, valves and fittings); Installation of expansion loops and thermodymetric tapping plant.

Pigging: pigging technology, pig launcher and receiver, intelligent pigging, types of pigs.

Offshore Pipeline: design and control of Sag and Over bend; description of stinger and riser. Articulated stinger, construction of offshore pipeline; method of underwater welding. Prevention of hydrates, wax & scales. Crude conditioning and use of additives to improve flow conditions.

Corrosion protection and control; design of cathodic protection system, pipeline automation. City distribution network of oil/gas. Lease and custody transfer.

Text Book:

1. Piping design handbook: Macetta. John, M dekar1992

Reference Books:

1. Pipline & risers : Young Boi ,Elsevier Ocean Engineering Book series 2001Volume 3

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2. Pipe Line Corrosion, Cathodic Protection: Parker M E and Peattie E G , Elsevier USA 2001

7PCU5.1 Fertilizer Technology

NITROGENOUS FERTILISERS

Macro and micro nutrients, Fertilizers Grades, Various fertilizers and their demand and production in India. Biofertilizer Methods of production of nitrogenous fertilizers: ammonium sulphate, ammonium nitrate, Urea, calcium ammonium nitrate; ammonium chloride. Characteristics, specifications, storage and handling of nitrogenous fertilizers.

PHOSPHATIC FERTILISERS

Raw materials; phosphate rock, sulphur; pyrites etc. its application, Processes for the production of sulphuric and phosphoric acids. Phosphates fertilizers - ground rock phosphate; bone meal-single superphosphate, triple superphosphate, triple superphosphate. Thermal phosphates and their methods of production, characteristics and specifications.

POTASSIC FERTILISERS

Methods of production of potassium chloride and its application. Potassium schoenite their characteristics and specifications.

COMPLEX AND NPK FERTILISERS

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

MISCELLANEOUS FERTILISERS

Mixed fertilizers and granulated mixtures; bio fertilizers, nutrients. Secondary nutrients and micro nutrients; fluid fertilizers, controlled release fertilizers, controlled release fertilizers.

Text Books

1. 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.
2. Slack, A.V. and James, G.R., "Fertilizers Science and Technology Series", Marcel Dekker Inc. New York, 1983.
3. Rao, M.G. and Marshall Sittig, "Out lines of Chemical Technology", East-West Press, 1996.
4. Pandey G.N. and Shukla, B.D. "A Text Book of Chemical Technology, Vol I, Vikas. Publishing House, New Delhi.

7PCU5.2 Modern Separation Techniques

BASICS OF SEPARATION PROCESS: Review of Conventional Processes, Recent advances in Separation Techniques based on size, surface properties, ionic properties and other special characteristics of substances.

Processconcept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid.

MEMBRANE SEPARATIONS: Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fiber Membrane Reactors and their relative merits, commercial.

Pilot Plant and Laboratory Membrane permeators involving Dialysis, Reverse Osmosis, Nanofiltration, Ultra filtration and Micro filtration, Ceramic- Hybrid process and Biological Membranes.

SEPARATION BY ADSORPTION: Types and choice of Adsorbents, Adsorption Techniques, Dehumidification Techniques, Affinity.

Chromatography and Immuno Chromatography, Recent Trends in Adsorption.

INORGANIC SEPARATIONS: Controlling factors, Applications, Types of Equipment employed for Electrophoresis.

Dielectrophoresis, Ion Exchange Chromatography and Eletrodialysis, EDR, Bipolar Membranes.

OTHER TECHNIQUES: Separation involving Lyophilisation, Pervaporation and Permeation Techniques for solids,liquids and gases, zone melting. Adductive Crystallization, other Separation Processes, Supercritical fluid Extraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques.

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

7PCU5.3 Process Plant Utilities

STEAM AND STEAM GENERATION

Properties of Steam, problems based on Steam, Types of Steam Generator such as Solid Fuel Fired Boiler.

Ritesh Patidar

Waste Gas Fired Boiler and Fluidized Bed Boiler. Scaling and Trouble Shooting. Steam Traps and Accessories.

REFRIGERATION

Refrigeration Cycles, Methods of Refrigeration used in Industry and Different Types of Refrigerants. Chlorofluro Carbons and Brins, Refrigerating Effects and Liquefaction Processes.

COMPRESSED AIR

Classification of Compressor, Reciprocating Compressor, Single Stage and Two Stage Compressor, Velocity Diagram for Centrifugal Compressor, Silp Factor, Impeller Blade Shape. Properties of Air –Water Vapors and use of Humidity Chart. Equipments used for Humidification, Dehumidification and Cooling Towers.

WASTE WATER TREATMENT: Hard and Soft water, Requisites of Industrial Water and its uses. Water treatment processes (theory and application): aeration, solids separation, settling operations, coagulation, softening, Chemical Softening and Demineralization. Resins used for Water Softening and Reverse Osmosis. Effects of impure Boiler Feed Water. Treatment of waste water from refineries, exploration and productions.

Text Book:

1. Eckenfelder, W. W, Jr. "Industrial Water Pollution Control" McGraw-Hill: New York, 1966

Reference Books:

1. P. L. Ballaney, "Thermal Engineering", Khanna Publisher New Delhi, 1986.
2. Perry R. H. Green D. W. "Perry's chemical Engineer's Handbook", McGraw Hill, New York, 2007.
2. P. N. Ananthanarayan, "Basic Refrigeration & Air conditioning", Tata McGraw Hill, New Delhi, 2007

Practical and Sessional

7PCU7 Process Dynamics & Control Lab.

List of Experiment

1. To determine the time constant of a given thermometer and thermocouple
2. To study the open loop, three mode PID and two mode PD control
3. To study the working principal and calibration procedure of capacitance type level transmitter.
4. To obtain the step response of a single tank liquid level system to a step change in input flow and compare it with the theoretical response.
5. To study the inherent characteristics of control valve.

6. To study the theoretical time constant and damping coefficient of the manometer.
7. To study the interacting and non-interacting mode of system.
8. To study the behavior of a PID controller.

7PCU8 Pipeline Design Sessional

1. Introduction to Piping and Interaction & Interface for Piping Engineers.
2. Piping Elements and Thickness Calculation.
3. Basics of Piping Drawings.
4. Equipment & Piping Plans.
5. Piping Considerations for Pumps, Compressors, Blower and Static Equipment.
6. Pipe Racks & Sleeper Selections & Location.
7. Colour Coding of Pipelines.
8. Surface Preparation &Painting In Piping.
9. Codes & Standard.
10. Valves & Specification.

7PCU9 Report Writing

7PCU10 Practical Training

Objective of Industrial Training

The objective of undertaking industrial training is to provide work experience so that student's engineering knowledge is enhanced and employment prospects are improved. The student should take this course as a window to the real World and should try to learn as much as possible from real life experiences by involving and interacting with industry staff. Industrial training also provides an opportunity to students to select an engineering problem and possibly an industry guide for their Major Project in final semester.

7PCU12 Discipline & Extra Curricular Activity

Anil K. Mathur

8PCU1 Process Modeling & Simulation

The role of analysis: Chemical engineering problems, basic concepts of analysis; the analysis process, simple example of estimating an order, source of the model equations. Conservation equations, constitutive equations, control volumes, dimensional analysis, system of units, dimensional consistency in mathematical descriptions, dimensional analysis and Constitutive relationships, final observations.

Non-Reacting Liquid Systems: Introduction, equation of continuity, simple mass balance, application of the model equations, component mass balances.

Model behavior: Steady state behavior, un-steady state behavior, density assumption, numerical integration methods of ordinary differential equation.

Reacting Liquid Systems: Introduction, basic model equations for a tank-type reactor, reaction rate, batch reactor, pseudo first-order reactions, reversible reactions, multiple reactions. Consecutive reactions, parallel reactions, complex reactions, constant density assumption, order and stoichiometry.

Treatment of experimental data: Introduction, criteria for Best Fit, Best Slope-I, Best straight line. Fitting a quadratic, simulation examples of gravity fluid flow, heat and mass transfer. Dynamic modelling of simple processes, sequential, simultaneous modular and equation oriented approaches.

Computer programming of various iterative convergence methods such as Newton- Ralphson, false position, Muller methods.

Text Book:

1. Russell TWF; Introduction to Chemical Engineering Analysis - John Wiley & Sons

Reference Books:

1. Luyben W.L; Process Modelling, Simulation and Control for Chemical Engineers; TMH
2. Jana; Chemical Process Modelling and Computer Simulation; PHI Learning

8PCU2 Natural Gas Engineering

Properties and Measurement of Natural Gas: Introduction to Natural Gas, origin of natural gas, other sources of gaseous fluids. Phase behaviour fundamentals, qualitative and quantitative phase behaviour, vapour liquid equilibrium. Equation of state, critical pressure and temperature determination. Gas compressibility, viscosity and thermal conductivity, formation volume factor.

Gas Reservoir Performance: Fundamentals of gas flow in conduits, fundamentals of fluid flow in porous media, inflow performance curves, outflow performance.

(Ritesh Patidar)

Gas flow measurement: Fundamentals, Methods of measurements, Orifice meters equation, turbine meters.

Flow of Gas in Production Tubing: Introduction, gas flow fundamentals, vertical and inclined single phase flow of gas.
Calculating flow and static bottom hole pressure, gas flow through restrictions. Temperatures profiling in flowing gas systems.

Natural gas Processing: Gas liquid separations, dehydration processes, absorption and adsorption by gas permeation.
Desulfurization processes, solid bed sweetening process, physical and chemical absorption processes, Acid gas removal. Integrating natural gas processing
Gas Compression: Introduction, types of compressors, Selection, Thermodynamics of compressors, Design fundamentals for reciprocating, centrifugal and rotary compressors (single and multistage)

Gas Gathering and Transport: Gas gathering system, steady state flow in simple pipeline system, steady state and non-steady state flow in pipelines, solution for transient flow. Installation, operation and troubleshooting of natural gas pipelines.

Text Book:

1. Alireza Bahadori Natural Gas Processing, Gulf Professional Publishing
2. Kumar Sanjay, "Gas Production Engineering", Gulf Publishing Company, TX, USA, 1987.

Reference Books:

1. Ikoku, Chi, "Natural Gas Production Engineering", John Wiley and Sons, 1984.
2. Beggs, D, H, Gas Production Operations. Edition Technip. 1984
3. "Gas Processes Suppliers Handbook", USA, 1980
4. Lee, J, Wattenbarger, R. A., "Gas Reservoir Engineering", Society of Petroleum Engineers, TX, USA, 1996

8PCU3.1 Oil & Gas Processing Plant Design

Oil Processing:

Two-Phase Oil and Gas Separation: Factors Affecting Separation, Separators, Vessel Internals, Separator Sizing.

Oil and Water Separation: Theory, Separators, Emulsion, Separator Sizing.

Crude Oil Treating Systems: Desalting, salts, Emulsion Treating Theory, Emulsifiers & Demulsifiers, coalescence, coalescing media, Gravity Separation, Treating Equipment, Equipment Sizing and Theory, Design Procedure.

Ritesh Palidar

Gas Processing:

Condensate Stabilization: Multistage Separation, Condensate Stabilizer Design, Trays and Packing, LTX Stabilization.

Heat Exchanger Design: Process heat duty, Sensible heat of natural gas, water, heat transfer from fire-tube. Heat exchangers types, fluid placement, sizing, number of tubes.

Natural Gas Sweetening: Acid gases, Toxicity, Pipeline grade natural gas specification. Solid-bed Process. Adsorbent selection. Amine and other absorptive process details.

Natural Gas Dehydration: (a) Glycol Process: Process Description, Choice of Glycol, Design Considerations, System Sizing. (b) Solid bed process: Process Description, Design Considerations.
Hydrate formation & inhibition. Stabilizer design, Hydrocarbon recovery, Lean oil absorption design & operation, Regeneration and cooling. (VAP)

Text Book:

1. Arnold, Ken, Surface Production Operations: Vol – 1 & 2, Gulf Publishing Co, 1989.

Reference Books:

1. Production operations, T. O. Allen and A. P. Roberts, SPE – Vol - I 4-th edition.
2. Gas Production Engineering – S. Kumar-Gulf publishing Co., 1987.

8PCU3.2 Industrial Engineering Management

Basic functions of Management: Planning, organizing, staffing, directing and controlling. Introduction to Industrial Engineering techniques.

Productivity: definition, measurement. Work study and its role in improving productivity of an organization. Types of production systems. Introduction to production planning and control. Concepts of Human Resource

Management: Selection, Training & Development.

Finance Management: Capital Budgeting Techniques. Pay-back period, ARR, NPV, IRR, PI; Sources of capital. Cost concepts and Break-even analysis.

Project Management: Introduction, Network construction & identification of critical activities in CPM & PERT.

Text Book:

1. Varshney, R.L. and Maheswari, K.L. 2006. Managerial Economics, 19th Edn., Sultan Chand & Sons., New Delhi.

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Dean, FA & UD

Reference Books:

1. Koontz, H. and Weihrich, H. 2007. Essentials of management, 7th Edn., Tata McGraw Hill, New Delhi.
2. Prasad, L.M. 2006. Organisational behaviour, 4th Edn., Sultan Chand & Sons, New Delhi.
3. Luthans, F. 2005. Organisational behaviour, 10th Edn., Mc-Graw Hill International Edn., Singapore.
4. Keat, P.G. and Young, P.K.Y. 2004. Managerial Economic, pears education Inc.

8PCU3.3 Optimization of Chemical Processes

INTRODUCTION AND CLASSIFICATION

Basic concept of optimization, Mathematical formulation of optimization problems; applications of optimization in chemical engineering. Classification of Optimization Problems - single variable problems, Multivariable problems without constraints, Multivariable problems with constraints, Maximization and minimization problems.

SINGLE VARIABLE OPTIMIZATION

Necessary and sufficient conditions for optimum; interpolation method quadratic. Region elimination methods-internal halving, Fibonacci.

MULTIVARIABLE OPTIMIZATION

Optimization of Functions One Dimensional Search: Analytical Methods: classification, stationary points, direct substitution, constrained variation, penalty function, Lagrangian Multiplier, Kuhn-Tucker theorem. Numerical methods general principles of numerical search, direction of search, final stage in search, direct search, pattern search.

OTHER OPTIMIZATION METHODS

Introduction to geometric, dynamic and integer programming and genetic algorithms. Application of Geometric Programming: chemical engineering problems with degree of difficulty equal to zero or one with constraints.

APPLICATIONS OF OPTIMIZATION

Optimization of staged and discrete processes. Optimal shell-tube heat exchanger design. Optimal pipe diameter.

Text Book:

1. Rao, S. S., Engineering Optimization - Theory and Practice, Third Edition, John Wiley & Sons, New York, 1996.

2. Edgar, T.F., Himmelblau, D.M., "Optimisation of Chemical Processes ", McGraw-Hill Book Co., New York, 1985.

Reference Books:

1. Reklaitis, G.V., Ravindran, A., Ragsdell, K.M. "Engineering Optimizations: Methods and Applications", John Wiley & Sons, New York, 2006.
2. Optimization: Theory and Practice by MC Joshi and K M Moudgalya, Narosa Publishing. ISBN: 81-7319-424-6.

Practical and Sessional

8PCU7 Process Modeling & Simulation Lab.

1. Simulation of gravity flow tank by Euler Method
2. Simulation of gravity flow tank by Range Kutta Method
3. Simulation of three CSTR in series by Range Kutta method
4. Simulation of three CSTR in series by Euler method
5. Simulation of three CSTR in series with feedback -loop by Euler method
6. Modelling a batch reactor-verification of 1st and 2nd order rate kinetics.
7. Counter current double pipe heat exchanger modeling-data analysis by iterative methods
8. Simulation of a distillation column-binary systems, equi-molal overflow, constant relative, volatility.

8PCU8 **Compressive Viva**

8PCU9 **Seminar**

8PCU10 **Project**

8PCU12 **Discipline & Extra Curricular activity**