Sunrise University
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B TECH CHEMICAL ENGINEERING SYLLABUS

Semester -I

Code	Subject	Cr	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MS1	MS2	END TERM	IA	Total
Theory											
101	Engineering Mathematics-I	3	3	1	0	3	10	10	60	20	100
102	Engineering Physics	3	3	1	0	3	10	10	60	20	100
103	Communication Skills	3	3	1	0	3	10	10	60	20	100
104	Programming For Problem Solving	3	4	1	0	3	10	10	60	20	100
105	Basic Electrical Engineering	3	3	1	0	3	10	10	60	20	100
Practicals & Sessionals											
Code	Subject	Cr	Hrs. /Week			Exam Hrs.	IA (60%)		EA (40%)	Total	
			L	T	P		MP1 30%	MP2 30%			
106	Engineering Physics Lab	2	0	0	2	2	30	30	40	100	
106	Language Lab	2	0	0	2	2	30	30	40	100	
108	Computer Programming Lab	2	0	0	2	2	30	30	40	100	
109	Basic Electrical Lab	2	0	0	2	2	30	30	40	100	
110	Computer Aided Engg.Graphics	2	0	0	3	3	30	30	40	100	
	Grand Total	**26**	**18**	**6**	**11**					**1000**	

Semester-II

Code	Subject	Cr	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MS1	MS2	END TERM	IA	Total
Theory											
201	Engineering Mathematics-II	3	3	1	0	3	10	10	60	20	100
202	Engineering Chemistry	3	3	1	0	3	10	10	60	20	100
203	Human Values	3	4	1	0	3	10	10	60	20	100
204	Basic Mechanical Engineering	3	3	1	0	3	10	10	60	20	100
205	Basic Civil Engineering	2	2	1	0	3	10	10	60	20	100
Practicals & Sessionals											
Code	Subject	Cr	Hrs. /Week			Exam Hrs.	IA (60%)		EA (40%)	Total	
			L	T	P		MP1 30%	MP2 30%			
206	Engineering Chemistry Lab	2	0	0	2	2	30	30	40	100	
206	Human Values Activities	2	0	0	2	2	30	30	40	100	
208	Manufacturing Practice Workshop	2	0	0	2	2	30	30	40	100	
209	Basic Civil Engineering Lab	2	0	0	3	3	30	30	40	100	
210	Computer Aided Machine Drawing	2	0	0	2	2	30	30	40	100	
	Grand Total	**26**	**18**	**06**	**11**					**1000**	

Semester -III

Code	Subject	Credit	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MT1	MT2	End Term	TA	Total
Theory subjects											
3BTCH01	Mathematics-III	3	3	0	0	3	10	10	60	20	100
3BTCH02	Applied Chemistry	3	3	1	0	3	10	10	60	20	100
3BTCH03	Object Oriented Programming in C++	3	3	1	0	3	10	10	60	20	100
3BTCH04	Chemical Process Calculations	3	3	1	0	3	10	10	60	20	100
3BTCH05	Fluid Flow Operation	3	3	1	0	3	10	10	60	20	100
3BTCH06	**Elective-I (Any One)**	3	3	0	0	3	10	10	60	20	100
3BTCH06.1(CP)	Introduction to Computers and Operating Systems										
3BTCH06.2(ME)	Power Plant Engineering										
3BTCH06.3(EC)	Applied Electronics										

Practical laboratory courses

Code	Subject	Credit	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MP1	MP2	End Term	Viva	Total
3BTCH07	Applied Chemistry Lab.	2	0	0	2	3	30	30	30	10	100
3BTCH08	Object Oriented Programming in C++ Lab.	2	0	0	2	3	30	30	30	10	100
3BTCH09	Social Science & Economics	2	0	0	2	3	30	30	30	10	100
3BTCH10	Group Discussion & Seminar	2	0	0	2	3	30	30	30	10	100
	Grand Total	**26**	**18**	**4**	**8**						**1000**

Semester -IV

Code	Subject	Credit	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MT1	MT2	End Term	TA	Total
Theory subjects											
4BTCH01	Material Science & Technology	3	3	0	0	3	10	10	60	20	100
4BTCH02	Fluid-Particle Mechanics	3	3	1	0	3	10	10	60	20	100
4BTCH03	Environment Engineering	3	3	0	0	3	10	10	60	20	100
4BTCH04	Chemical Engineering Thermodynamics – I	3	3	1	0	3	10	10	60	20	100
4BTCH05	Heat Transfer Operation	3	3	1	0	3	10	10	60	20	100
4BTCH06	**Elective- II (Any One)**	3	3	1	0	3	10	10	60	20	100
4BTCH06.1(MA)	Mathematics-IV										
4BTCH06.1(HU)	Introduction to Economic Analysis										
4BTCH06.1(ME)	Non-Conventional Energy Sources										

Practical laboratory courses

Code	Subject	Credit	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MP1	MP2	End Term	Viva	Total
4BTCH06	Fluid-Particle Mechanics Lab.	2	0	0	2	3	30	30	30	10	100
4BTCH08	Environment Engineering Lab.	2	0	0	2	3	30	30	30	10	100
4BTCH09	Heat Transfer Operation Lab.	2	0	0	2	3	30	30	30	10	100
4BTCH10	Laboratory Techniques in Biotechnology	2	0	0	2	3	30	30	30	10	100
	Grand Total	**26**	**18**	**4**	**8**						**1000**

Semester -V

Code	Subject	Credit	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MT1	MT2	End Term	TA	Total
Theory subjects											
5BTCH01	Process Instrumentation	3	3	1	0	3	10	10	60	20	100
5BTCH02	Inorganic Chemical Technology	3	3	1	0	3	10	10	60	20	100
5BTCH03	Mass Transfer Operation –I	3	3	1	0	3	10	10	60	20	100
5BTCH04	Numerical Methods in Chemical Engineering	3	3	0	0	3	10	10	60	20	100
5BTCH05	Chemical Engineering Thermodynamics-II	3	3	1	0	3	10	10	60	20	100
5BTCH06	**Elective – III (Any One)**	3	3	1	0	3	10	10	60	20	100
5BTCH06.1	Analytical Techniques										
5BTCH06.2	Fertilizer Technology										
5BTCH06.3	Energy Resources & Utilization										
Practical laboratory courses											
Code	**Subject**	**Credit**	**Hrs. /Week**			**Exam Hrs.**	**Maximum Marks**				
			L	**T**	**P**		**MP1**	**MP2**	**End Term**	**Viva**	**Total**
5BTCH06	Environmental Instrumention Lab.	2	0	0	2	3	30	30	30	10	100
5BTCH08	Process Instrumentation lab	2	0	0	2	3	30	30	30	10	100
5BTCH09	Numerical Methods in Chemical Engineering Lab.	2	0	0	2	3	30	30	30	10	100
5BTCH10	Mass Transfer-I lab.	2	0	0	2	3	30	30	30	10	100
	Grand Total	**26**	**18**	**4**	**8**						**1000**

Semester -VI

Code	Subject	Credit	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MT1	MT2	End Term	TA	Total
Theory subjects											
6BTCH01	Chemical Reaction Engineering-I	3	3	1	0	3	10	10	60	20	100
6BTCH02	Mass Transfer Operation -II	3	3	1	0	3	10	10	60	20	100
6BTCH03	Process Dynamics & Control	3	3	1	0	3	10	10	60	20	100
6BTCH04	Organic Chemical Technology	3	3	0	0	3	10	10	60	20	100
6BTCH05	Petroleum Refining	3	3	1	0	3	10	10	60	20	100
6BTCH06	**Elective – IV (Any One)**	3	3	0	0	3	10	10	60	20	100
6BTCH06.1	Introduction to Oil/Fat Technology										
6BTCH06.2	Rubber Science & Technology										
6BTCH06.3	Introduction toPulp & Paper Technology										
Practical laboratory courses											
Code	**Subject**	**Credit**	**Hrs. /Week**			**Exam Hrs.**	**Maximum Marks**				
			L	**T**	**P**		**MP1**	**MP2**	**End Term**	**Viva**	**Total**
6BTCH06	Chemical Technology (Organic & Inorganic) Lab.	2	0	0	2	3	30	30	30	10	100
6BTCH08	Mass Transfer Operation -II lab.	2	0	0	2	3	30	30	30	10	100
6BTCH09	Process Dynamics & Control Lab.	2	0	0	2	3	30	30	30	10	100
6BTCH10	Petroleum Refining Lab.	2	0	0	2	3	30	30	30	10	100
	Grand Total	**26**	**18**	**4**	**8**						**1000**

Semester –VII

Code	Subject	Credit	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MT1	MT2	End Term	TA	Total
7BTCH01	Chemical Reaction Engg. II	3	3	1	0	3	10	10	60	20	100
7BTCH02	Transport Phenomena	3	3	1	0	3	10	10	60	20	100
7BTCH03	Process Equipment Design	3	3	1	0	3	10	10	60	20	100
7BTCH04	Optimization of Chemical Process	3	3	0	0	3	10	10	60	20	100
6BTCH05	Molecular Biology	3	3	0	0	3	10	10	60	20	100
7BTCH06	**Elective-V (Any One)**	3	3	0	0	3	10	10	60	20	100
7BTCH06.1	Bioprocess Engineering										
7BTCH06.2	Process Safety and Hazard Mgmt.										
7BTCH06.3	Sugar Technology										

Code	Subject	Credit	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MP1	MP2	End Term	Viva	Total
7BTCH05	Practical Training Seminar (Project Part-1)	2	0	0	2	3	30	30	30	10	100
7BTCH06	Chemical Reaction Engg. Lab	2	0	0	2	3	30	30	30	10	100
7BTCH06	Bioprocess Engineering	2	0	0	2	3	60	60	60	20	100
7BTCH08	Process Equipment Design	2	0	0	2	3	60	60	60	20	100
	Grand Total	**26**	**18**	**4**	**8**						**1000**

Semester -VIII

Code	Subject	Credit	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MT1	MT2	End Term	TA	Total
Theory subjects											
8BTCH01	Process Engineering & Plant Design	3	3	1	0	3	10	10	60	20	100
8BTCH02	Industrial Management	3	3	1	0	3	10	10	60	20	100
8BTCH03	Process Analysis & Simulation	3	3	1	0	3	10	10	60	20	100
8BTCH04	**Elective-VI (Any One)**	3	3	0	0	3	10	10	60	20	100
8BTCH08.1	Biochemical Technology										
8BTCH08.2	Catalysis Processes										
8BTCH08.3	Polymer Science & Technology										
Practical laboratory courses											

Code	Subject	Credit	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MP1	MP2	End Term	Viva	Total
8BTCH05	Process Engineering and Plant Design	3	0	0	2	3	30	30	30	10	100
8BTCH06	Computer Aided Design & Drawing	3	0	0	2	3	30	30	30	10	100
8BTCH07	Seminar	4	0	0	2	3	60	60	60	20	100
8BTCH08	Project	4	0	0	2	3	60	60	60	20	100
	Grand Total	**26**	**18**	**4**	**8**						**1000**

101 Engineering
Mathematics-I

SN	CONTENTS
1	**Calculus:** Improper integrals (Beta and Gamma functions) and their properties; Applications of definite integrals to evaluate surfa
2	**SequencesandSeries:** Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions.
3	**FourierSeries:** Periodic functions, Fourier series, Euler's formula, Change of intervals,Half range sine and cosine series, Parseval's th
4	**MultivariableCalculus(Differentiation):** Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxim Lagrange multipliers; Gradient, curl and divergence.
5	**MultivariableCalculus(Integration):** Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variabl and volumes, Centre of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), Simple applications parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

SN	CONTENTS	Hours
1	**WaveOptics:** Newton's Rings, Michelson's Interferometer, Fraunhofer Diffraction from a Single Slit. Diffraction grating: Construction, theory and spectrum, Resolving power and Rayleigh criterion for limit of resolution, Resolving power of diffraction grating, X-Ray diffraction and Bragg's Law.	9
2	**QuantumMechanics:** Introduction to quantum Mechanics, Wave-particle duality, Matter waves, Wave function and basic postulates, Time dependent and time independent Schrodinger's Wave Equation, Physical interpretation of wave function and its properties, Applications of the Schrodinger's Equation: Particle in one dimensional and three dimensional boxes.	6
3	**CoherenceandOpticalFibers:** Spatial and temporal coherence: Coherence length; Coherence time and 'Q' factor for light, Visibility as a measure of Coherence and spectral purity, Optical fiber as optical wave guide, Numerical aperture; Maximum angle of acceptance and applications of optical fiber.	4
4	**Laser:** Einstein's Theory of laser action; Einstein's coefficients; Properties of Laser beam, Amplification of light by population inversion, Components of laser, Construction and working of He-Ne and semiconductor lasers, Applications of Lasers in Science, engineering and medicine.	6
5	**MaterialScience&SemiconductorPhysics:** Bonding in solids: covalent and metallic bonding, Energy bands in solids: Classification of solids as Insulators, Semiconductors and Conductors, Intrinsic and extrinsic semiconductors, Fermi dirac distribution function and Fermi energy, Conductivity in semiconductors, Hall Effect: Theory, Hall Coefficient and applications.	6
6	**IntroductiontoElectromagnetism:** Divergence and curl of electrostatic field, Laplace's and Poisson's equations for electrostatic potential, Bio-Savart law, Divergence and curl of static magnetic field, Faraday's law, Displacement current and magnetic field arising from time dependent electric field, Maxwell's equations, Flow of energy and Poynting vector.	8
	TOTAL	**40**

03: Communication Skills

SN	CONTENTS	Hours
1	**Communication:** Meaning, Importance and Cycle of Communication. Media and Types of Communication. Verbal and Non-Verbal Communication. Barriers to communication. Formal and Informal Channels of Communication (Corporate Communication). Divisions of Human Communication and Methods to improve Interpersonal Communication. Qualities of good communication.	6
2	**Grammar:** Passive Voice. Reported Speech. Conditional Sentences. Modal Verbs. Linking Words (Conjunctions)	6
3	**Composition:** Job Application and Curriculum-Vitae Writing. Business Letter Writing. Paragraph Writing. Report Writing.	6
4	**ShortStories:** "Luncheon" by Somerset Maugham."How Much Land Does a Man Need?" by Count Leo Tolstoy. "The Night Train at Deoli" by Ruskin Bond.	6
5	**Poems:** "No Men are Foreign" by James Kirkup. "If" by Rudyard Kipling. "Where the Mind is without Fear" by Rabindranath Tagore.	65
	TOTAL	35

104: Programming for Problem Solving

SN	CONTENTS	Hours
1	**FundamentalsofComputer:** Stored program architecture of computers, Storage device- Primary memory, and Secondary storage, Random, Direct, Sequential access methods, Concepts of High-level, Assembly and Low-level languages, Representing algorithms through flowchart and pseudo code.	**12**
2	**Numbersystem:** Data representations, Concepts of radix and representation of numbers in radix r with special cases of r=2, 8, 10 and 16 with conversion from radix r1 to r2, r's and (r-1)'s complement, Binary addition, Binary subtraction, Representation of alphabets.	**12**
3	**CProgramming:** Problem specification, flow chart, data types, assignment statements, input output statements, developing simple C programs, If statement, for loops, while loops, do-while loops, switch statement, break statement, continue statement, development of C programs using above statements, Arrays, functions, parameter passing, recursion, Programming in C using these statements, Structures, files, pointers and multi file handling.	**12**
	TOTAL	**36**

105: Basic Electrical Engineering

SN	CONTENTS	Hours
1	**DCCircuits:** Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff current and voltage laws, Series-Parallel circuits, Node voltage method, Mesh current method, Superposition, Thevenin's, Norton's and Maximum power transfer theorems.	**8**
2	**ACCircuits:** Representation of sinusoidal waveforms, peak and r.m.s values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase AC circuits consisting of R, L, C, RL, RC and RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.	**8**
3	**Transformers:** Ideal and practical transformer, EMF equation, equivalent circuit, losses in transformers, regulation and efficiency.	**6**
4	**ElectricalMachines:** Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Starting and speed control of induction motor, single- phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited DC motor. Construction and working of synchronous generators.	**6**
5	**PowerConverters:** Semiconductor PN junction diode and transistor (BJT). Characteristics of SCR, power transistor and IGBT. Basic circuits of single phase rectifier with R load, Single phase Inverter, DC-DC converter.	**6**
6	**ElectricalInstallations:** Layout of LT switchgear: Switch fuse unit (SFU), MCB, ELCB, MCCB, Type of earthing. Power measurement, elementary calculations for energy consumption.	**6**
	TOTAL	**40**

106:EngineeringPhysicsLab

1 To determine the wave length of monochromatic light with the help of Michelson's interferometer.
2. To determine the wave length of sodium light by Newton's Ring.
3. To determine the wave length of prominent lines of mercury by plane diffraction grating with the help of spectrometer.
4. Determination of band gap using a P-N junction diode.
5. To determine the height of given object with the help of sextant.
6. To determine the dispersive power of material of a prism with the help of spectrometer.
6. To study the charge and discharge of a condenser and hence determine the same constant (both current and voltage graphs are to be plotted.
8. To determine the coherence length and coherence time of laser using He – Ne laser.
9. To measure the numerical aperture of an optical fibre.
10. To study the Hall Effect and determine the Hall Voltage and Hall coefficients.

106:LanguageLab

1. Phonetic Symbols and Transcriptions.
2. Extempore.
3. Group Discussion.
4. Dialogue Writing.
5. Listening comprehension.

108:ComputerProgrammingLab

1. To learn about the C Library, Preprocessor directive, Input-output statement.
2. Programs to learn data type, variables, If-else statement
3 Programs to understand nested if-else statement and switch statement
4. Programs to learn iterative statements like while and do-while loops
5. Programs to understand for loops for iterative statements
6. Programs to learn about array and string operations
6. Programs to understand sorting and searching using array
8. Programs to learn functions and recursive functions
9. Programs to understand Structure and Union operation
10 Programs to learn Pointer operations
11. Programs to understand File handling operations
12 Programs to input data through Command line argument

109:BasicElectricalEngineeringLab

1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
2. Transformers: Observation of the no-load current waveform on an oscilloscope. Loading of a transformer: measurement of primary and secondary voltages and currents, and power.
3. Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents).Phase-shifts between the primary and secondary side.
4. Demonstration of cut-out sections of machines: dc machine (commutator- brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
5. Torque Speed Characteristic of separately excited dc motor.
6. Demonstration of (a) dc-dc converters (b) dc-ac converters – PWM waveform
(c) the use of dc-ac converter for speed control of an induction motor and (d) Components of LT switchgear.

110: ComputerAidedEngineeringGraphics Lab

Introduction: Principles of drawing, lines, type of lines, usage of Drawing instruments, lettering, Conic sections including parabola, hyperbola, Rectangular Hyperbola (General method only); Scales-Plain, Diagonal and Vernier Scales.

ProjectionsofPoint&Lines: Position of Point, Notation System, Systematic Approach for projections of points, front view & Top view of point, Position of straight lines, line parallel to Both the RPs, Line perpendicular to either of the RPs, Line inclined to one RP and parallel to the other, Line inclined to Both the RPs, Traces of a line (One drawing sheet, one assignment in sketch book).

ProjectionofPlanes: Positions of planes, Terms used in projections of planes, plane parallel to RP, plane inclined to one RP and perpendicular to the other RP, plane perpendicular to Both the RPs, plane Inclined to Both the RPs, True shape of the plane, Distance of a point from plane, Angle between two planes.

ProjectionsofRegularSolids: frustum and truncated solids, those inclined to both the Planes-Auxiliary Views.

SectionofSolids: Theory of sectioning, section of prisms and cubes, section of pyramids and Tetrahedron section of Cylinders, section of cones, section of spheres (One drawing sheet, one assignment in sketch book)

OverviewofComputerGraphics: Covering theory of CAD software [such as: The menu System, Toolbars (standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.: Isometric Views of lines, Planes, Simple and compound Solids.

201: Engineering Mathematics-II

SN	CONTENTS	Hours
1	**Matrices:** Rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.	**10**
2	**Firstorderordinarydifferentialequations:** Linear and Bernoulli's equations, Exact equations, Equations not of first degree: equations solvable for *p*, equations solvable for *y*, equations solvable for *x* and Clairaut's type.	**6**
3	**Ordinarydifferentialequationsofhigherorders:** Linear Differential Equations of Higher order with constant coefficients, Simultaneous Linear Differential Equations, Second order linear differential equations with variable coefficients: Homogenous and Exact forms, one part of CF is known, Change of dependent and independent variables, method of variation of parameters, Cauchy-Euler equation; Power series solutions including Legendre differential equation and Bessel differential equations.	**12**
4	**PartialDifferentialEquations–Firstorder:** Order and Degree, Formation; Linear Partial differential equations of First order, Lagrange's Form, Non Linear Partial Differential equations of first order, Charpit's method, Standard forms.	**6**
5	**PartialDifferentialEquations–Higherorder:** Classification of Second order partial differential equations, Separation of variables method to simple problems in Cartesian coordinates including two dimensional Laplace, one dimensional Heat and one dimensional Wave equations.	**6**
	TOTAL	**40**

202 : Engineering Chemistry

SN	CONTENTS	Hours
1	**Water:** Common impurities, hardness, determination of hardness by complexometric (EDTA method), Degree of hardness, Units of hardness Municipal water supply: Requisite of drinking water, Purification of water; sedimentation, filtration, disinfection, breakpoint chlorination. Boiler troubles: Scale and Sludge formation, Internal treatment methods, Priming and Foaming, Boiler corrosion and Caustic embrittlement Water softening; Lime-Soda process, Zeolite (Permutit) process, Demineralization process.Numerical problems based on Hardness, EDTA, Lime-Soda and Zeolite process.	**10**
2	**OrganicFuels:** Solid fuels: Coal, Classification of Coal, Proximate and Ultimate analyses of coal and its significance, Gross and Net Calorific value, Determination of Calorific value of coal by Bomb Calorimeter. Metallurgical coke, Carbonization processes; Otto-Hoffmann by-product oven method. Liquid fuels : Advantages of liquid fuels, Mining, Refining and Composition of petroleum, Cracking, Synthetic petrol, Reforming, Knocking, Octane number, Anti-knocking agents, Cetane number Gaseous fuels; Advantages, manufacturing, composition and Calorific value of coal gas and oil gas, Determination of calorific value of gaseous fuels by Junker's calorimeter Numerical problems based on determination of calorific value (bomb calorimeter/Junkers calorimeter/Dulongs formula, proximate analysis & ultimate and combustion of fuel.	**10**
3	**Corrosionanditscontrol:** Definition and significance of corrosion, Mechanism of chemical (dry) and electrochemical (wet) corrosion, galvanic corrosion, concentration corrosion and pitting corrosion. Protection from corrosion; protective coatings-galvanization and tinning, cathodic protection, sacrificial anode and modifications in design.	**3**
4	**EngineeringMaterials:** Portland Cement; Definition, Manufacturing by Rotary kiln. Chemistry of setting and hardening of cement. Role of Gypsum. Glass: Definition, Manufacturing by tank furnace, significance of annealing, Types and properties of soft glass, hard glass, borosilicate glass, glass wool, safety glass Lubricants: Classification, Mechanism, Properties; Viscosity and viscosity index, flash and fire point, cloud and pour point.	**10**
5	**Organicreactionmechanismandintroductionofdrugs:** Organic reaction mechanism: Substitution; SN1, SN2, Elecrophilic aromatic substitution in benzene, free radical halogenations of alkanes, Elimination; elimination in alkyl halides, dehydration of alcohols, Addition: electrophilic and free radical addition in alkenes, nucleophilic addition in aldehyde and ketones, Rearrangement; Carbocation and free radical rearrangements Drugs : Introduction, Synthesis, properties and uses of Aspirin, Paracetamol	**6**
	TOTAL	**40**

203: Human Values

SN	CONTENTS	Hours
1	CourseIntroduction-Need,BasicGuidelines,ContentandProcessforValueEducation Understanding the need, basic guidelines, Self Exploration - its content and process; 'Natural Acceptance' and Experiential Validation, Continuous Happiness and Prosperity- Human Aspirations, Right understanding, Relationship and Physical Facilities,Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfill the above human aspirations: understanding and living in harmony at various levels	5
2	UnderstandingHarmonyintheHumanBeing-HarmonyinMyself Understanding human being as a co-existence of the sentient 'I' and the material 'Body' Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha Understanding the Body as an instrument of 'I',Understanding the characteristics and activities of 'I' and harmony in 'I' Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya.	5
3	UnderstandingHarmonyintheFamilyandSociety-HarmonyinHuman-HumanRelationship Understanding harmony in the Family, Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) , meaning of Vishwas; Difference between intention and competence, meaning of Samman, Difference between respect and differentiation; the other salient values in relationship, harmony in the society , Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals ,Visualizing a universal harmonious order in society- Undivided Society (AkhandSamaj), Universal Order (SarvabhaumVyawastha)- from family to world family.	5
4	UnderstandingHarmonyintheNatureandExistence-WholeexistenceasCoexistence Understanding the harmony in the Nature. Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature. Understanding Existence as Co-existence	5
5	ImplicationsoftheaboveHolisticUnderstandingofHarmonyonProfessionalEthics.Naturalacceptanceofhumanvalues Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in Professional Ethics: a) Ability to utilize the professional competence for augmenting universal human order, b) Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, technologies and management models. Strategy for transition from the present state to Universal Human Order: At the level of individual: as socially and ecologically responsible engineers, technologists and managers. Case studies related to values in professional life and individual life.	5
	TOTAL	**25**

204: Basic Mechanical Engineering

SN	CONTENTS	Hours
1	**Fundamentals:** Introduction to mechanical engineering, concepts of thermal engineering, mechanical machine design, industrial engineering and manufacturing technology. Steam Boilers classification and types of steam boilers and steam turbines. Introduction and Classification of power plants.	6
2	**PumpsandICEngines:** Applications and working of Reciprocating and Centrifugal pumps. Introduction, Classification of IC Engines, Main Components of IC Engines, Working of IC Engines and its components.	6
3	**RefrigerationandAirConditioning:** Introduction, classification and types of refrigeration systems and air-conditioning. Applications of refrigeration and Air-conditioning.	6
4	**TransmissionofPower:** Introduction and types of Belt and Rope Drives, Gears.	6
5	**PrimaryManufacturingProcesses:** Metal Casting Process: Introduction to Casting Process, Patterns, Molding, Furnaces. Metal Forming Processes: Introduction to Forging, Rolling, Extrusion, Drawing. Metal Joining Processes: Introduction to various types of Welding, Gas Cutting, Brazing, and Soldering.	6
6	**EngineeringMaterialsandHeatTreatmentofSteel:** Introduction to various engineering materials and their properties.	5
TOTAL		**40**

SN	CONTENTS	Hours
1	**Introductiontoobjective,scopeandoutcomethesubject**	
2	**Introduction:** Scope and Specialization of Civil Engineering, Role of civil Engineer in Society, Impact of infrastructural development on economy of country.	8
3	**Surveying:** Object, Principles & Types of Surveying; Site Plans, Plans& Maps; Scales & Unit of different Measurements. Linear Measurements: Instruments used. Linear Measurement by Tape, Ranging out Survey Lines and overcoming Obstructions; Measurements on sloping ground; Tape corrections, conventional symbols. Angular Measurements: Instruments used; Introduction to Compass Surveying,Bearings and Longitude & Latitude of a Line, Introduction to total station. Levelling: Instrument used, Object of levelling, Methods of levelling in brief, Contour maps.	8
4	**Buildings:** Selection of site for Buildings, Layout of Building Plan, Types of buildings, Plinth area, carpet area, floor space index, Introduction to building byelaws, concept of sun light and ventilation. Components of Buildings & their functions, Basic concept of R.C.C., Introduction to types of foundation.	8
5	**Transportation:** Introduction to Transportation Engineering; Traffic and Road Safety: Types and Characteristics of Various Modes of Transportation; Various Road Traffic Signs, Causes of Accidents and Road Safety Measures.	8
6	**EnvironmentalEngineering:** Environmental Pollution, Environmental Acts and Regulations,Functional Concepts of Ecology, Basics of Species, Biodiversity,Ecosystem, Hydrological Cycle;Chemical Cycles: Carbon, Nitrogen& Phosphorus; Energy Flow in Eco-systemsWater Pollution: Water Quality standards, Introduction to Treatment& Disposal of Waste Water. Reuse and Saving of Water, Rain Water Harvesting.Solid Waste Management: Classification of Solid Waste, Collection, Transportation and Disposal of Solid. Recycling of Solid Waste: Energy Recovery,Sanitary Land fill, On-Site Sanitation. Air& Noise Pollution: Primary and Secondary air pollutants, Harmful effects of Air Pollution, Control of Air Pollution. . Noise Pollution, Harmful Effects of noise pollution, control of noise pollution, Global warming& Climate Change, Ozone depletion, Green House effect	8
	TOTAL	**40**

205: Basic Civil Engineering

206: Engineering Chemistry Lab

1. Determination the hardness of water by EDTA method
2. Determination of residual chlorine in water
3. Determination of dissolved oxygen in water
4. Determination of the strength of Ferrous Ammonium sulphate solution with the help of K2Cr2O6 solution by using diphenyl amine indicator
5. Determination of the strength of CuSO4 solution iodometrically by using hypo solution
6. Determination of the strength of NaOH and Na2CO3 in a given alkali mixture
6. Proximate analysis of Coal
8. Determination of the flash & fire point and cloud & pour point of lubricating oil
9. Determination of the kinematic viscosity of lubricating oil by Redwood viscometer no. 1 at different temperature
10. Synthesis of Aspirin/ Paracetamol

206: Human Values Activities Lab

PS 1:
Introduce yourself in detail. What are the goals in your life? How do you set your goals in your life? How do you differentiate between right and wrong? What have been your salient achievements and shortcomings in your life? Observe and analyze them.

PS 2:
Now-a-days, there is a lot of talk about many technogenic maladies such as energy and material resource depletion, environmental pollution, global warming, ozone depletion, deforestation, soil degradation, etc. - all these seem to be manmade problems, threatening the survival of life Earth - What is the root cause of these maladies & what is the way out in opinion?
On the other hand, there is rapidly growing danger because of nuclear proliferation, arms race, terrorism, breakdown of relationships, generation gap, depression & suicidal attempts etc. - what do you think, is the root cause of these threats to human happiness and peace - what could be the way out in your opinion?

PS 3:
1. Observe that each of us has the faculty of 'Natural Acceptance', based on which one can verify what is right or not right for him. (As such we are not properly trained to listen to our 'Natural Acceptance' and may a time it is also clouded by our strong per-conditioning and sensory attractions).
Explore the following:
(i) What is Naturally Acceptable' to you in relationship the feeling of respect or disrespect for yourself and for others?
(ii) What is 'naturally Acceptable' to you - to nurture or to exploit others? Is your living in accordance with your natural acceptance or different from it?
2. Out of the three basic requirements for fulfillment of your aspirations - right understanding, relationship and physical facilities - observe how the problems in your family are related to each. Also observe how much time & effort you devote for each in your daily routine.

PS 4:

list down all your important desires. Observe whether the desire is related to Self (I) or the Body. If it appears to be related to both, visualize which part of it is related to Self (I) and which part is related to Body.

PS 5:

1. a. Observe that any physical facility you use, follows the given sequence with time: Necessary and tasteful - unnecessary but still tasteful - unnecessary and tasteless - intolerable

b. In contrast, observe that any feeling in you is either naturally acceptable or not acceptable at all. If not acceptable, you want it continuously and if not acceptable, you do not want it any moment!

2. List down all your important activities. Observe whether the activity is of 'I' or of

PS6:

1. Chalk out some programs towards ensuring your harmony with the body - in terms of nurturing, protection and right utilization of the body.

2. Find out the plants and shrubs growing in and around your campus, which can be useful in curing common diseases.

PS6:

Form small groups in the class and make them carry out a dialogue focusing on the following eight questions related to 'TRUST';

1a. Do I want to make myself happy? 2a. Do I want to make the other happy?

3a. Does the other want to make himself/herself happy? 4a. Does the other want to make me happy?

What is the answer?

Intention (Natural Acceptance)

1b. Am I able to always make myself happy? 2b. Am I able to always make the other happy?

3b. Is the other able to always make himself/herself happy? What is the answer?

Let each student answer the questions for himself and everyone else. Discuss the difference between intention and competence. Observe whether you evaluate yourself and others on the basis of intention/competence.

PS8:

1. Observe, on how many occasions, you are able to respect your related ones (by doing the right evaluation) and on how many occasions you are disrespecting by way of under-evaluation, over-evaluation or otherwise evaluation.

2. Also, observe whether your feeling of respect is based on treating the other as you would treat yourself or on differentiations based on body, physical facilities or belieds.

PS9:

1. Write a narration in the form of a story, poem, skit or essay to clarify a salient Human Value to the children.

2. Recollect and narrate an incident in your life where you were able to exhibit willful adherence to balues in a difficult situation.

PS10:

List down some common units (things) of Nature which you come across in your daily life and classify them in the four orders of Nature. Analysis and explain the aspect of mutual fulfillment of each unit with other orders.

PS11:

Make a chart to show the whole existence as co-existence. With the help of this chart try to identify the role and the scope of some of the courses of your study. Also indicate the areas which are being either over-emphasized or ignored in the present context.

PS12:

Identify any two important problems being faced by the society today and analyze the root cause of these problems. Can these be solved on the basic of natural acceptance of human values. If so, how should one proceed in this direction from

PS 13:

1. Suggest ways in which you can use your knowledge of Science/Technology/Management etc. for moving towards a universal human order.
2. Propose a broad outline for humanistic Constitution at the level of Nation.

PS 14:

The course is going to be over now. It is time to evaluate what difference in your thinking it has made. Summarize the core massage of this course grasped by you. How has this affected you in terms of;

a. Thought
b. Behavior
c. Work and
d. Relization

What practical steps are you able to visualize for the transition of the society from its present state.

Project:

Every student required to take-up a social project e.g. educating children in needy/weaker section, services in hospitals, NGO's and other such work i.e. social work at villages adopted by respective institute/ college.

208: Manufacturing Practices Workshop

Carpentry Shop

1. T – Lap joint
2. Bridle joint

Foundry Shop

3. Mould of any pattern
4. Casting of any simple pattern

Welding Shop

5. Lap joint by gas welding
6. Butt joint by arc welding
6. Lap joint by arc welding
8. Demonstration of brazing, soldering & gas cutting

Machine Shop Practice

9. Job on lathe with one step turning and chamfering operations

Fitting and Sheet Metal Shop

10. Finishing of two sides of a square piece by filing
11. Making mechanical joint and soldering of joint on sheet metal
12. To cut a square notch using hacksaw and to drill a hole and tapping

209: Basic Civil Engineering Lab

1. Linear Measurement by Tape:

a) Ranging and Fixing of Survey Station along straight line and across obstacles.

b) Laying perpendicular offset along the survey line

2. Compass Survey: Measurement of bearing of linesusing Surveyor's and Prismaticcompass

3. Levelling: Using Tilting/ Dumpy/ Automatic Level

a) To determine the reduced levels in closed circuit.

b) To carry out profile levelling and plot longitudinal and cross sections for road by Height ofInstrument and Rise & Fall Method.

4. To study and take measurements using various electronic surveying instruments likeEDM, Total Station etc.

5. To determine pH, hardness and turbidity of the given sample of water.

6. To study various water supply Fittings.

6. To determine the pH and total solids of the given sample of sewage.

8. To study various Sanitary Fittings.

210:Computer Aided Machine Drawing Lab

Introduction: Principles of drawing, conventional representation of machine components andmaterials, lines, types of lines, dimensioning types, rules of dimensioning.

Conversion of pictorial views into orthographic views: (1 drawing sheet) Introduction toorthographic projection, concept of first angle and third angle projection, drawing of simple machine elements in first angle projection, missing view problems covering Principles ofOrthographic Projections.

Sectional views of mechanical components: (1 drawing sheet) Introduction, cutting plane line, type of sectional views-full section, half section, partial or broken section, revolvedsection, removed section, offset section, sectioning conventions-spokes, web rib, shaft, pipes,different types of holes, conventions of section lines for different metals and materials.

Fasteners and other mechanical components: (Free hand sketch) Temporary and permanent fasteners, thread nomenclature and forms, thread series, designation, representation of threads, bolted joints, locking arrangement of nuts, screws, washers, foundation bolts etc., keys,types of keys, cotter and knuckle joints. Riveted joints, rivets and riveting, type of rivets, types of riveted joints etc. Bearing: Ball, roller, needle, foot step bearing. Coupling: Protected type,
flange, and pin type flexible coupling. Other components: Welded joints, belts and pulleys, pipesand pipe joints, valves etc.

Overview of Computer Graphics: (2 drawing sheets) Covering theory of CAD software suchas: The menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension),Drawing Area (Background, Crosshai
objects.: Isometric Views of Lines, Planes, Simple and compound Solids

3BTCH1 (MA)- MATHEMATICS-III

3L+1T MM: 100 Ex. Hrs.: 3

UNIT-I

Differential Equations & Fourier Series : Ordinary differential equations of second order with variable coefficients; Method of variation of parameters; Power series methods; Partial differential equations of first order Lagrange's method, standard forms, Fourier series and Harmonic analysis

UNIT-II

Legendre's function of first and second kinds; simple recurrence relations; Rodrigues' formula; orthogonal property, and Bessel's differential equation, Bessel functions of first and second kind, simple recurrence relations, orthogonal property of Bessel function.

UNIT –IV

Laplace Transforms with its simple properties; applications to the solution of ordinary differential equations, method of separation of variables, applications to the solution of wave equations in one dimension, Laplace's equation in two dimensions, diffusion equation in one dimension.

UNIT-V

Numerical Analysis: Finite differences- Forward, Backward, and Central differences, Newton's forward and backward difference interpolation formulae, Stirling's formula. Numerical differentiation, Numerical Integration – Trapezoidal rule, Simpson's one-third and three-eighth rule. Introduction to numerical solution of ordinary differential equations.

Tensor Analysis: Definition of a tensor, Transformation of co-ordinates. Contravariant and co-variant vectors, addition and multiplication of tensors, contraction of tensors, inner product, fundamental tensor, Christoffel symbols, co-variant differentiation.

Text/ Reference Books

1. Grewal, B.S., "*Higher Engineering Mathematics*", Khanna Publishers, New Delhi.
2. Gaur, Y.N. and Koul, C.L., "*Higher Engineering Mathematics*", Book1 & 2, Jaipur Publishing House, Jaipur.
3. Sastry, S.S., "*Introductory Methods of Numerical Analysis*", Prentice-Hall of India, 1988.

3BTCH2(CY) - APPLIED CHEMISTRY

3L MM: 100 Ex. Hrs.: 3

UNIT-I

Electrochemistry: Specific, equivalent and molecular conductance, their determination, theories of electrolytic conductance, Debye-Huckle theory of strong electrolytes, galvanic cells, reference electrodes and their potentials. Standard cell, standard electrode potential, determination of dissociation constants of acids and bases, solubility product, hydrolysis constant, hydrogen ion concentration, complex formation, activity of electrolytes etc., theory of acid-base indicators, electrometric titrations.

UNIT –II

Photochemistry: Photochemical Reactions, Laws of Photochemistry.
Reactions and their Mechanism: Types of mechanism, types of reactions and method of determination of mechanism.

UNIT-III

Chemical Bonding: Basic concepts of bonding. Types of bonding, covalent bonding, multiple bonding, inductive and field effects and bond energy. Aromaticity and Huckle's rule of electrons, Hyperconjugation and Tautomerism, Bonding weaker than covalent, resonance and field effects.

UNIT-IV

Aromatic Chemistry: Structure of benzene resonance and orbital picture, Orientation anddirective influence of substituents.
Heterocyclic Compounds: Heterocyclic compounds containing one heteroatom, pyrole,thiophene, furan, pyridine. Their aromatic character.

UNIT-V

Carbohydrates: Introduction, definition and classification, structure of glucose and fructose.
Stereochemistry: A brief account of stereochemistry, optical activity and chirality, configuration and strain.

Text/Reference Books

1. Jerry March, "*Organic Chemistry*," John Wiley, New York.
2. Finar, I. L.,"*Organic Chemistry*," ELBS, New Delhi.
3. Morrison and Boyd, "*Organic Chemistry*," MacMillan.
4. Glasstone, S., "*A Textbook of Physical Chemistry*," MacMillan.
5. Bahl and Tuli, "*Essentials of Physical Chemistry*," S. Chand and Co.

3BTCH3(CP) - OBJECT ORIENTED PROGRAMMING IN C++

3L MM: 100 Ex. Hrs.: 3

Characteristics of object-oriented languages.

UNIT-I

C++ Programming Basics: C++ Program structure, variables, input/ output with *cout* and *cin*, arithmetic operators.

Loops and Decisions: *for*, *while*, *do* loops; *if* and *if…else* statements, *switch* statement; *break, continue, go to* statements.

UNIT –II

Structures: Structure specifiers and definitions, accessing structure members; nested structures; structures as objects and data types; enumerated data types.

Functions: Function definitions and declarations; arguments and return values; reference arguments; overloaded arguments; default arguments; storage classes

UNIT-III

Objects and Classes: Definitions of objects and classes; member functions and data; constructors and destructors.

UNIT-IV

Arrays: Array definitions; accessing array elements; arrays of objects; strings.

Operator overloading: Overloading unary operators; overloading binary operators; data conversion.

Inheritance: Base and derived class; class hierarchies; public and private inheritance; multiple inheritance.

UNIT-V

Pointers: Addresses and pointers; pointers and arrays; pointers and function arguments; pointers and strings; memory management with *new* and *delete*; pointers and objects; pointers to pointers.

Files and streams: Stream class hierarchy; reading and writing objects; file pointers; redirection; printer output.

Text/Reference Books

1. Lafore, R., "*Object Oriented Programming in Turbo C++*," Galgotia Publications, New Delhi, 2000.
2. Balaguruswami, E., "*Object Oriented Programming with C++*," Tata McGraw-Hill, New Delhi, 1995.
3. Venugopal and Rajkumar, "*Mastering C++*", Tata McGraw-Hill, 1997.
4. Keogh, J., "*Introduction to Programming with C++*", Prentice Hall, 1996.

3BTCH4(CH) – CHEMICAL PROCESS CALCULATIONS

3L+1T MM: 100 Ex. Hrs.: 3

UNIT-I

Introduction to Chemical Engineering Calculations definition and strichiometry: Units and dimensions, the mole unit, conventions in methods of analysis and measurement, basis, temperature, pressure, the chemical equation and chemical formulae.

UNIT –II

Gases, Vapours, Liquids and Solids: Ideal gas law and its related calculations, real gas relationships, vapour pressure and liquids, saturation, partial saturation and humidity, introduction to vapour-liquid equilibria for multicomponent systems, material balances involving condensation and vaporization.

UNIT-III

UNIT-IV Material Balances: Material balance of physical processes with and without chemical reaction, including recycle, purge and bypass.

UNIT-V Energy Balances: Concept and Units, calculation of enthalpy changes, general balance with and without reactions, heats of solution and mixing.

Unsteady-state material and energy balances. Solids, liquids and gaseous fuels, some industrial examples of the above, simple estimation of physical properties (transport, thermodynamic) of fluids and mixtures.

Text/Reference Books

1. Himmelblau, D. M., "*Basic Principles and Calculations in Chemical Engineering*," 6th ed., Prentice-Hall of India.
2. Bhatt and Vora, "*Stoichiometry*," 3rd ed., Tata McGraw-Hill, New Delhi.
3. Hougen, Watson and Ragatz, "*Chemical Process Principles*," Vol. 1, Asia Publishing House, New Delhi.
4. Saha, S. N., "*Fundamentals of Chemical Engineering*," Dhanpat Rai Publishing Co., New Delhi, 2000.

3BTCH5(CH) – FLUID FLOW OPERATIONS

3L+1T MM: 100 Ex. Hrs.: 3

UNIT-I

Continuity equation for compressible and incompressible fluids. Bernoulli's equation, Euler's equation, introduction to Navier-Stokes equation

UNIT –II

Types of flows, steady and unsteady, laminar and turbulent flows; Relationship between shear stress and pressure gradient, Hagen-Poiseuille equation. Prandtl's mixing length theory and eddy diffusivity losses in pipes and fittings, Darcy-Weisbach equation for frictional head loss, Moody diagram. Flow through packed and fluidized beds.

UNIT-III

UNIT-IV

Velocity Profile and boundary layer calculations for turbulent flow

UNIT-V

Pumps and compressors for handling different fluids, types, cavitation, priming NPSH and characteristics of centrifugal pumps. Valves, pipe fittings and their standards. Power requirement for flow. Pipe layout and economical pipe diameter.

Flow measuring devices such as orifice meter, venturimeter, rotameter, pitot tube comparison of centrifugal and reappricating pumps, anemometer, etc.
Vacuum producing devices.
Introduction to Newtonian and non-Newtonian fluids flow and their behaviours

Text/Reference Books

1. Streeter, V. L. and Wylie, "*Fluid Mechanics*," 8th ed., McGraw-Hill, New York, 1985.
2. Gupta, S. K., "*Momentum Transfer Operations*," Tata McGraw-Hill.
3. Coulson, J. M. and Richardson, J. F., "*Chemical Engineering*," Vol. 1, Asian books, New Delhi.
4. McCabe, W.L., Smith, J.C., and Harriott, P., "*Unit Operations of Chemical Engineering*", 6th ed., McGraw Hill.

ELECTIVE-I

3BTCH6.1 (CP) - INTRODUCTION TO COMPUTERS AND OPERATING SYSTEMS

3L MM: 100 Ex. Hrs.: 3

UNIT-I

Introduction: Data Types, Fixed point representation and floating point representation, Binary and error detecting codes.

Basic Computer Organization and Design: Central Processing Unit, Arithmetic Logic Unit, Stack organization, Instruction Formats and addressing modes.

UNIT –II

Arithmetic Algorithms: Arithmetic with signed 2's complement numbers. Multiplication and Division algorithms, Booth's multiplication algorithm. Floating point arithmetic operations, decimal arithmetic operations and their hardware implementation.

UNIT-III

I/O Architecture: Peripheral devices, data transfer schemes (Programmed and DMA transfer), I/O processor. Multiprocessor system organization: Multiport memory, crossbar switch, Introduction to crossbar switch, introduction to timeshared common bus and dual bus. Data communication processor.

UNIT-IV

Memory and Storage: Processor vs. memory speed, memory hierarchy, cache memory, associative memory, Virtual memory mapping: different mapping schemes, random access, sequential access and direct access storage devices.

UNIT-V

Introduction to System Software: Elements of an Assembler. Basic idea of compiler and interpreters, Loaders and Linkers.

Introduction to Operating Systems: Classification of operating systems. Elements of an operating system. Basic idea of file system in DOS, Windows and UNIX operating systems.

Text/Reference Books

1. Mano, M. M., "*Computer System Architecture*," 2nd ed., Prentice Hall of India, New Delhi.
2. Dhamdhere, D. M., "Introduction to System Software," Tata McGraw-Hill, New Delhi.

ELECTIVE-I

3BTCH6.2(ME) - POWER PLANT ENGINEERING

3L MM: 100 Ex. Hrs.: 3

UNIT-I

Coal Thermal Power Plants: Steam Generation: High pressure and supercritical boilers, circulation of water in high pressure boilers; natural and forced calculation; Advantages and disadvantages; Water walls; Directly & indirectly heated boilers, LaMantm Benson, Loeffler, Romezin boilers Draught System; Losses in air gas loop system; natural, forced induced and balanced draught systems.

UNIT –II

Fuel Storage and Handling: Coal handling for thermal power plants; Coal feeding and burning methods; pulverized fuel firing and FBC. Ash handling and Dust Collection; Ash handling systems; Dust collection: Disposal of ash and dust.

UNIT-III

Diesel and Gas Turbine Power Plants: General layout; elements of diesel power plants; fields of use; systems of diesel power plants; general layout of gas of gas turbine plants; plant components; different arrangements for plant components; Governing system, combined gas and stream power plants. Introduction to integrated coal gasification combined cycle power plants

UNIT-IV

Nuclear power plants: Nuclear materials and waste disposal; nuclear fuels, coolants, moderating and reflecting materials, cladding materials, shielding materials; Disposal of nuclear waste; General components of nuclear reactor, different types of nuclear reactors, their construction and working. Fuel enrichment; Safety and control.

UNIT-V

Cooling Towers: Necessity of cooling condenser water, water cooling methods; types of cooling towers, hyperbolic, atmospheric, induced draft and forced draft cooling towers; Indirect and direct dry type cooling systems; water distribution in cooling towers.

Comparison of Power Plants: Suitability for base load, peak load; gestation period; water requirement, cost of electricity; fuel handling and transport; environment implications; suitability for small power, bulk power, thermal efficiency; land requirementper unit power.

Text/Reference Books

1. Skrotzki, B. G. A. and Vopat, W. A., "*PowerStation Engineering and Economy*," Tata McGraw-Hill, New Delhi, 1990.
2. Nag, P.K., " *Power Plant Engineering: Steam and Nuclear*," Tata McGraw-Hill, New Delhi, 1998.

ELECTIVE - I

3BTCH6.3 (EC) – APPLIED ELECTRONICS

3L MM: 100 Ex. Hrs.: 3

UNIT-I

Transistor: Transistor as an amplifier: low frequency, single stage and multistage amplifier. **Regulated Power Supply:** Capacitor filters for single-phase rectifiers. Application of 3-pin voltage regulator Ics 78xx/79xx/317/337.

UNIT –II

OPAMP: Introduction to operational amplifiers. Applications of OPAMP: 1) Summing scaling, averaging, integrator and differentiator; 2) OPAMP as comparator 3) Instrumentation Amplifier and its applications.

UNIT-III

Digital Electronics: 1) Combinational circuits: multiplexers, demultiplexers, decoders, encoders. 2) Flipflops: S-R F/F, clocked S-R F/F, D F/F, J-K F/F, T F/F 3) Counters: Asynchronous (ripple) counter, Asynchronous UP/DOWN counter, Synchronous counter, Synchronous UP/DOWN counter. 4) Registers: Serial-in,

UNIT-IV serial-out; Parallel-in, serial-out; Serial-in, parallel out; Serial/parallel in, Serial/parallel out.

UNIT-V **D/A converters:** R/ 2R register ladder. D/A converter. A/D converters: successive approx. A/D converter

Microprocessor: Concept of microprocessor, software architecture of 8086, Addressing modes, Data transfer arithmetic logical, Jump/Call, String instructions, Writing simple assembly language programmes, Technical details of serial and parallel ports of IBM compatible PC.

Text/Reference Books

1. Millman, Halkias, "*Basic Electronics*", Tata McGraw-Hill.
2. Coughlin and Driscoll, "*Operational Amplifiers and Linear Integrated Circuits*", Prentice Hall of India.
3. Bray B.B., "*8086 – 486 Intel Microprocessor*," Prentice Hall of India.
4. Hall, D., "*8086 Microprocessor*", Tata McGraw-Hill

4BTCH1(CH) - MATERIAL SCIENCE AND TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit- I

Introduction to Materials

Engineering materials, their classification, characteristics and basic principles for their selection. Structure of atom, and types of bonds. Crystal structure. Defects in crystal structure and their influence on properties of a material.

Unit- II

Metals and Their Alloys

Phase equilibrium diagram for Iron-carbon and Copper-zinc system. Ferrous and non-ferrous alloys. Mild steels, special steels, stainless steels, brasses, bronzes, aluminum alloys, and titanium alloys. Methods for fabrications- Rolling, forging, extrusion and joining.

Unit- III

Polymers

Types of plastics, structure properties, correlations of important plastics, polymerisation processes and additives. Fibre-reinforced plastics, rubbers & elastomers and applications.

Unit- IV

Ceramics and Glass

Structure – properties, correlations, oxide and non-oxide ceramics, vitreous and borosilicate glasses, glass-ceramics and enamels. Major electrical, optical and mechanical properties of ceramics and glasses. Enamelling and glass lining.

Unit- V

Corrosion and its Control

Types of corrosion, chemical and electrochemical reactions, methods of corrosion prevention. Corrosion-resistant materials.

Text/Reference Books

1. James, F. Shackelford, "*Introduction to Materials Science*", Macmillan Pub. Co., NY, 1990
2. Jestrazebaski, D.Z., " *Properties of Engineering Materials"*, 3rd ed., Toppen Co. Ltd.
3. Smith, W. F., "*Foundations of Materials Science and Engineering*," 2nd ed., McGraw-Hill, 1993.
4. Raghavan, V., "*Materials Science and Engineering*," PHI, New Delhi.
5. Van Vlack, L. H., "*Materials Science and Engineering*," Addison Wesley.

4BTCH2(CH)– FLUID-PARTICLE MECHANICS

3L+1T MM: 100 Ex. Hrs.: 3

Unit- I

Size Reduction: Principles of crushing and grinding, Determination of mean particle size and size distribution, Laws of crushing and grinding, Energy required for size reduction, crushing and grinding equipments, closed and open circuit grinding.

Agglomeration: Principles and applications. Techniques of agglomeration and methods of testing.

Unit- II

Screen Analysis and Size separation: Capacity and types of screens, mesh number and size distribution, different types of screening, effectiveness of screens, Particle size analysis, separation efficiency and screening equipments.

Unit- III

Filtration: Theory of Filtration, equations for compressible and incompressible cakes, Constant volume and Constant Pressure Filtration, Plate and frame filter press, Rotary drum and vacuum filter. Fiber and fabric filters, centrifuges, cyclone separators and electrostatic precipitator.

Unit- IV

Fluidization: Fluidization of solids and its applications, Design of Fluidized beds, Hydraulic and Pneumatic transport of solids.

Unit- V

Mixing: Mixing of liquids and solids types of mixers, Power requirement in mixing.

Storage and Handling of Materials: Sizing of hoppers and bins, Mechanical and pneumatic conveying systems like belt conveyors, bucket elevators, flight conveyors etc.

Text/Reference Books

1. McCabe, W.L., Smith, J.C., and Harriott, P., "*Unit Operations of Chemical Engineering*", 6th ed., McGraw Hill.
2. Brown, G. G., et al, "*Unit Operations*," CBS Publications, Delhi.
3. Coulson, J. H. and Richardson, J. F., "*Chemical Engineering*," Vol. 2, Asian Books Private Ltd., New Delhi.
4. Perry, R. H., et al, "*Chemical Engineers' Handbook*," 7th ed., McGraw-Hill.
5. Foust, A.S., et al., "*Unit Operations*", 2nd ed., John Wiley.
6. Bhattacharya, "*Unit Operations*", Vol. 1., Khanna Publishers.

4BTCH3(CH) – ENVIRONMENT ENGINEERING

3L **MM: 100** **Ex. Hrs.: 3**

Unit – I

Atmosphere- Introduction, structure of the atmosphere, chemical and photochemical reaction in the atmosphere, primary air pollutants-sources. Carbon, Nitrogen & Sulfur Cycle.

Unit – II

Wastewater Treatment: Characterization of industrial wastewater, primary, secondary and tertiary treatment. Segregation, screening, equalization, coagulation, flocculation, precipitation, flotation, sedimentation, aerobic treatment, anaerobic treatment, absorption, ion exchange, membrane filtration, electrodialysis, sludge dewatering and disposal methods.

Unit – III

Air Pollution Control: Sources and classification of air pollutants, nature and characteristics of gaseous and particulate pollutants, from automobiles. Air pollution meteorology, plume and its behavior and atmospheric dispersion, control of particulate emission by **gravity settling chamber, cyclones , wet scrubbers, bag filters and electrostatic precipitators** (General Explanation). Control of gaseous emission by absorption, adsorption, chemical transformation and combustion.

Unit – IV

Solid Waste Management: solid waste, waste disposal methods, recycling of solid waste and its management. Hazardous and non-hazardous waste, methods of treatment and disposal, land filling, leachate treatment and incineration of solid wastes.

Unit – V

Environmentally Pollution Monitoring Legislation, standards for water and air, Effects of air pollutants on human health, vegetation and materials**,** Air pollution monitoring instruments

CO_x, NO_x, SO_x, Hydrocarbon and Ozone. Hydrocarbons particulates, sampling techniques. Global warming, Green house effect, depletion of ozone layer, human activity and meteorology

Text/Reference Books:

1. Dhameja, S.K., "*Environmental Engineering and Management*", S.K. Kataria & Sons, Delhi, 2002.
2. Masters, G.M., "*Introduction to Environmental Engineering and Science*", Prentice Hall of India, New Delhi, 2001.
3. Bhatia, S.C., "*Environmental Pollution and Control in Chemical Process Industries*", Khanna Publishers, Delhi, 2001.
4. Pandey G.N. and Karney, "*Environmental Engineering*" Tata McGraw Hill, Delhi.
5. Instrumentation by Khandpur. Metcalf & Eddy, Inc., "*Wastewater Engineering: Treatment and Reuse*", 4th ed., Tata McGraw Hill, New Delhi, 2003.
6. Modi, P.N. "*Sewage Treatment and disposal and Waste Water*

Engineering," Vol.II, Standard book house, Delhi, 2001.

4BTCH4 (CH) – CHEMICAL ENGINEERING

THERMODYNAM ICS-I

3L+1T **MM: 100** **Ex. Hrs.: 3**

Unit – I

Introduction; Definitions and Concepts: System, Surroundings, Property, Intensive and Extensive Energy, Work, Thermodynamic equilibrium, stability of equilibrium states. Zeroth Law of Thermodynamics, Perfect Gas scale.

Unit – II

First law of Thermodynamics and Its Applications, First law analysis of processes, Control mass and control volume analysis, Steady state and Transient state flow processes.

Unit – III

Thermodynamic properties of fluids, Pure substance, Concept of Phase, Ideal gas equation of state, Van der Waals' equation of state, two parameter corresponding states principle, Compressibility charts, Steam Tables and applications.

Unit – IV

Second law of Thermodynamics: Limitation of First Law, Kelvin-Planck and Clausius Statements, Reversible and Irreversible Processes, Carnot cycle, Entropy, Second Law analysis of a control volume, Heat Engine and Heat Pump.
Fundamental Thermodynamic Relations, Maxwell Relations, Clapeyron's Equation, Kirchoff's equation, Phase Rule.

Unit – V

Ideal gas mixture, Air-Water mixture, Humidity, Psychrometric chart and its applications. Power Cycles: Rankine cycle and its modifications, Otto cycle, Diesel cycle. RefrigerationCycles: Vapor Compression Refrigeration cycle, Absorption Refrigeration cycle.

Statistical Thermodynamics: Postulates, Macrostates and microstates, Partition Function, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Applications of Statistical Thermodynamics: Ideal gas, Maxwell speed distribution, Einstein & Debye Models of a solid.

Text/Reference Books:

1. Rao, Y. V. C., "*An Introduction to Thermodynamics*," John Wiley, 1993.
2. Van Wylen, G. J. and Sonntag, R. E., "*Fundamentals of Classical Thermodynamics*," 2nd ed., John Wiley, New Delhi.
3. Chemical Engg. Thermdynamics by Yannes & Smith.
4. An-thermodyanamic Engg. Approach by Yunus A. Cengel Michael A. Boles.

Engg- thermodyanamic–Gordon Rogers Yon Mayhew.

4BTCH5(CH) - HEAT TRANSFER OPERATION

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Introduction: Modes of heat transfer: conduction, convection, radiation.

Steady-State Conduction in One Dimension: Fourier's Law, thermal conductivity, steady-state conduction of heat through a single and composite solid, cylinder and sphere. Steady-state heat conduction in bodies with heat sources: plane wall, cylinder and sphere.

Heat Transfer Coefficient: Convective heat transfer and the concept of heat transfer coefficient, overall heat transfer coefficient, heat transfer from extended surfaces, thermal contact resistance, critical and optimum insulation thickness.

Unit – II

Forced Convection: Flow over a flat plate, thermal boundary layer, flow across a cylinder. Dimensional analysis: Buckingham Pi theorem, Dimensionless groups in heat transfer. Correlations for the heat transfer coefficient: Laminar flow through a circular pipe, turbulent flow, through a non-circular duct, flow over flat plate, flow across a cylinder, flow past a sphere, flow across a bank of tubes, heat transfer coefficient in a packed and fluidized bed.

Double-pipe heat exchanger in parallel and counter-current flow.

Free Convection: Introduction, heat transfer correlations for free convection: flat surface, cylinder, sphere, enclosure. Combined free and forced convection

Unit – III

Boiling and Condensation: Boiling phenomenon, nucleate boiling, Correlations for pool boiling heat transfer: Nucleate boiling, critical heat flux, stable film boiling. Forced convection boiling, condensation phenomena, film condensation on a vertical surface, turbulent film condensation, condensation outside a horizontal tube and tube bank. Condensation inside a horizontal tube, effect of non-condensable gases. Dropwise condensation.

Unit – IV

Radiation Heat Transfer: Basic concepts of radiation from a surface: black body radiation, Planck's Law, Wien's Displacement Law, Stefan-Boltzmann Law, Kirchoff's Law, Gray body. Radiation intensity of a black body, spectral emissive power of a black body over a hemisphere. Radiation heat exchange between surfaces – the view factor. Radiation exchange between black bodies and between diffuse gray surfaces.

Unit – V

Heat Exchangers: Construction of a shell-and-tube heat exchanger, fouling of a heat exchanger, LMTD, temperature distribution in multi-pass heat exchangers, individual heat transfer coefficients and their relations with overall H.T. coefficients. Types of shell-and-tube heat exchanger.

Evaporators: Types of evaporators: Natural-circulation evaporators, forced-circulation evaporators, falling-film evaporators, climbing-film evaporators, agitated thin-film evaporators and plate evaporators. Principles of evaporation and evaporators; Single and multiple effect evaporators. Capacity and economy, Boiling point rise, Enthalpy balance of a solution. Calculations of single effect and

multieffect evaporators. Methods of feeding to multieffect evaporators.
Unsteady-State Heat Conduction: Mathematical formulations and initial and boundary conditions. Analytical solution, numerical solution.

Text/Reference Books:

1. Dutta, B. K., "*Heat Transfer: Principles and Applications*," PHI, New Delhi, 2001.
2. Holman, J. P., "*Heat Tansfer*," 8th ed., McGraw-Hill, New York.
3. A.J. Chapman, "*Heat Transfer*," Maxwell Macmillan, 1984.
4. Kern D.Q., "*Process Heat Transfer*", Tata McGraw Hill, 1950.
5. Hewitt, G. F., Shires, G.L. and Bott, T. R., "*Process Heat Transfer*", CRC Press, 1994.
6. Rao, Y. V. C., "*Heat Transfer*". New Age International , Delhi

ELECTIVE-II

4BTCH6.1(MA) – MATHEMATICS-IV

3L MM: 100 Ex. Hrs.: 3

Unit – I

Complex Variables: Analytic functions, Cauchy-Riemann equations, Elementary conformal mapping with simple applications, Line integral in complex domain, Cauchy's theorem, Cauchy's integral formula, Taylor's series, Laurent's series, Poles, Residues, evaluation of simple definite real integrals using the theorem of residues. Simple contour integration.

Unit – II

Introduction to Statistics: Probability distribution: Bimodal, Poisson, Uniform, Normal, Correlation and Regression, Linear regression, Confidence limits, types of errors, testing of hypothesis based on normal, Chi-square test, F-test, Z-test, Student's T-test. Comparison of means and variances.

Unit – III

Optimisation Techniques: Basic concepts of optimization: continuity of functions, Unimodal versus Multimodal functions, Concave and Convex functions.

Unit – IV

Unconstrained single variable optimisation: Newton, Quasi-Newton, Secant method, Dichotomous search, Fibonacci method, Golden Section method.

Unit – V

Introduction to Dynamic programming: Deterministic Dynamic programming, Probabilistic Dynamic programming.

Introduction to Integer programming: The Branch and Bound algorithm for Binary layer programming, the Branch and Scan algorithm for mixed integer programming.

Text/Reference Books:

1. Gaur, Y. N., and Kaul, C. L., "*Higher Engineering Mathematics*," Book 2, Jaipur Publishing House, Jaipur.
2. Gupta, S.P., "*Mathematical Statistics*".
3. Kapoor, J.N. and Saxena, "*Mathematical Theory of Statistics*," S. Chand & Co., New Delhi
4. Rao, S.S., "*Optimisation Techniques*," John Wiley, New Delhi
5. Kambo, N.S., "*Optimisation Techniques*".

ELECTIVE-II

4BTCH6.2(HU) - INTRODUCTION TO ECONOMIC ANALYSIS

3L MM: 100 Ex. Hrs.: 3

Unit – I

Scope and Methods of economic analysis. Theory of consumer behaviour - cardinal and ordinal utility approaches. Theory of production - the law of variable proportions and returnto scale.

Unit – II

Theory of cost – short and long-run viewpoint. Theory of exchange - demand and supply. Equilibrium of firm and industry – monopolistic competition and oligopoly.

Unit – III

General theory of distribution.

Unit – IV

General equilibrium of exchange and production. Concepts, significance of difficulties in the measurement of National income.

Unit – V

Classical theory of income determination and simple multiplier analysis. Types of economic systems and their characteristics – capitalism, socialism and mixed economy.

Economic role of the government, ways of interference and regulations by the government. The concept of economic development - structural change, measurement and ingredients of economic development. Leontief's input-output analysis.

Text/Reference Books:

1. Barda, C. S., "*Managerial Economics*," National Publishing House, Jaipur, 2000.
2. Peterson and Lewis, "*Managerial Economics*," Prentice-Hall.
3. Gupta, G. S., "*Managerial Economics*," Tata McGraw-Hill, New Delhi, 1990.
4. Hogendorn, J. S., "*Economic Development*," HarperCollins Publishers, 1987.

ELECTIVE-II

4BTCH6.3(ME) - NON-CONVENTIONAL ENERGY SOURCE S

3L MM: 100 Ex. Hrs.: 3

Unit – I

Introduction: Energy scene of supply and demand in India and the world, energy consumption in various sectors, potential of non-conventional energy resources. Detailed study of the following sources with particular reference to India.

Solar Energy: Solar radiation and its measurement, limitations in the applications of Solar Energy, Solar collectors – types, and constructional details. Solar water heating, applications of Solar Energy for heating, drying, space cooling, water desalination, solar concentrators, photovoltaic power generation using silicon cells.

Unit – II

Bio-Fuels: Importance, combustion, pyrolysis and other thermo chemical processes for biomass utilization. Alcoholic fermentation, anaerobic digestion for biogas production.

Unit – III

Wind Power: Principle of energy from wind, windmill construction and operational details and electricity generation and mechanical power production.

Tidal Power: Its meaning, causes of tides and their energy potential, enhancement of tides, power generation from tides and problems. Principles of ocean thermal energy conversion (OTEC) analysis and sizing of heat exchangers for OTEC.

Unit – IV

Unit – V

Geothermal Energy: Geo technical wells and other resources dry rock and hot aquifer analysis , harnessing geothermal energy resources.

Energy Storage and Distribution: Importance, biochemical, chemical, thermal, electric storage. Fuel cells, distribution of energy.

Text/Reference Books:

1. Rai,G.D,Non-conventional Energy Sources, Khanna Publishers, Delhi.
2. Twiddle, J. Weir, T. "*Renewable Energy Resources*," Cambridge University Press, 1986.
3. Kreith, F. and Kreider, J. F., "*Principles of Solar Engineering*," McGraw Hill, 1978.
4. Duffie, J. A., Beckman, W. A., "*Solar Engineering of Thermal Processes*," John Wiley, 1980.
5. Veziroglu, N., "*Alternative Energy Sources*," Volume 5 & 6, McGraw-Hill, 1978.
6. Sarkar, S., "*Fuels and Combustion*," 2nd ed., Orient Longman, 1989.
7. Sukhatme, S. P., "*Solar Energy*," 2nd ed., Tata McGraw-Hill, 1996.

4 BTCH 10(CH) LABORATORY TECHNIQUES IN BIOTECHNOLOGY

3S MM: 75 Ex. Hrs.: 3

The student should be taught about basic principles and applications and should also carry outexperiments related to the following instruments / techniques:

1. pH meter, conductivitymeter spectrophotometer and TLC.
2. Media preparation and sterilization.
3. Isolation,purification,identification and preservation of common microorganisms.
4. Qualitative identification and quantitative estimation of biomolecules.
5. Isolation, Purification and assay of enzymes.
6. Study of growth curve and factors affecting growth.

Text/Reference Books

1) G. cappuccino and N. Sherman. Microbiology, A Laboratory Manual, 4th Edition.Addison-Wesley.
2) Rodney Boyer. Modern Experimental Biochemistry. 3rd. Pearson Education Asia.
3) Keith and Wilson, Practical Biochemical Principles and Techniques

5BTCH1 : PROCESS INSTRUMENTATION

2L MM: 100 Ex. Hrs.: 3

Unit – I

Introduction, general principles of measurement, its classification by physical characteristics, direct and inferential measurement.

Unit – II

Static and dynamic characteristics of instruments. Measurement of temperature, pH, pressure, vacuum, flow rate, liquid level, differential pressure

Unit – III

Viscosity, conductivity, nuclear radiation, humidity and gas composition, spectroscopy.

Unit – IV

Classification of sensors and transducers. Building blocks of an instrument, transducer, amplifier signal conditioner, signal isolation, transmission, display, data acquisition modules, interfaces, recording.

Unit – V

Control centre, instrumentation diagram, On line instrumentation in modern plants.

Text/Reference Books:

1. Nakra, "*Instrumentation, Measurement and Analysis*"; Tata McGraw Hill, New Delhi.
2. Patranabis, D., "*Principles of Industrial Instrumentation*" 2nd ed. Tata McGraw Hill, New Delhi.
3. Eckman, D.P., "*Industrial Instrumentation*" Wiley Eastern, 1978.
4. Liptak, B.G., "*Industrial Engineers' Handbook*" Vol.1 and 2, CRC Press, 1994.
5. Andrew, W.G., et al., "*Applied Instrumentation in the Process Industries*," Gulf Pub.1993.
6. Wightman, E.J., "*Instrumentation in Process Control*," Butterworth, 1972.
7. Doebelin, E., "*Measurement Systems: Applications and Design*," 4th ed., McGraw Hill, 1990

5BTCH2 : INORGANI C CHEMICAL TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Study of the following chemical industries/processes involving processes details, production trend, thermodynamic construction, waste regeneration/recycling and safety, environmental and energy conservation measures.

Unit – I

Salts Sodium compounds, soda ash, Caustic soda, Chlorine and potassium salts.

Unit – II

Hydrochloric acid, sulphur and sulfuric acid, Phosphoric acid and phosphates.

Unit – III

Nitrogenous Industries, Ammonia and Nitric acid, Nitrogenous Fertilizer, mixed fertilizers,N-P-K Fertilizers and micronoutrients.

Unit – IV

Cement, Ceramic and Glass industries, Industrial gases : Nitrogen, Oxygen, Hydrogen,Helium and Argon.

Unit – V

Inorganic chemicals namely Bromine, Iodine and Fluorine, Alumina and Aluminum chloride, Inorganic pigments.

Text/Reference Books:

1. Austin G.T.- *Shreeves Chemical Process Industries* – 5th Ed., McGraw Hill 1984
2. Dryden C.E., M.Gopala Rao- *Outlines Of Chemical Technology* – 3rd Ed. AffiliatedEast – West Press, New Delhi.
3. Pandey G.N. – *Chemical Technology Volum* E – I – Lion Press, Kanpur.

5BTCH3 : MASS TRANSFER OPERATION – I

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

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.

Unit – II

Concept of Mass transfer coefficient: Individual and film coefficients, overall mass transfer co-efficient and their inter relationships. Continuous contact and differential contact, mass transfer concepts of NTU and HTU, their inter relationship.

Unit – III

Interphase Mass Transfer : Equilibrium, diffusion between phases, material balances, stages and concept of operating line and tie line.

Equipment for gas liquid contact : Sparged vessel, mechanically agitated vessel, tray towers, venture scrubber, wetted wall towers, spray towers and packed towers, tray tower vs packed tower.

Unit – IV

Absorption : Absorption in continuous contact columns, Co-current, Counter current and cross current contacting of fluids, calculation of NTU and HTU, concept of HETP.

Unit – V

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

Drying: Equilibrium mechanism theory of drying, drying rate curve, Batch and continuous drying, working principle of different types of dryers such as tray driers, Drum dryers, sprayand tunnel dryers.

Text/Reference Books:

1 Treybal, R.E.; "*Mass Transfer Operation"*, McGraw-Hill, 1980.
2 King, C.J. "*Separation Processes*", McGraw – Hill, NY.
3 Smith, B.D., "*Design of Equilibrium stage Processes*", McGraw-Hill, NY
4 McCabe, W.L. Smith, J.C. and Harriot, P., "*Unit Operations of Chemical Engineering*", 6th ed, McGraw-Hill, NY.
5 Coulson, J.M. and Richardson, J.F., "*Chemical Engineering*", Vol. I and II, Asian Books Pvt., New Delhi.

5BTCH4 : NUMERICAL METHODS IN CHEMICAL ENGINEERING

2L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Linear Algebraic Equations : Introduction, Gauss-Elimination, Gauss-Siedel and LU Decomposition Methods, Thomas' algorithm.

Eigen Values and Eigen Vectors of Matrices: Introduction, Fadeev Leverrier's method, Power method, Householder's and Givens' method.

Unit – II

Nonlinear, Algebraic Equations: Single variable and multivariable successive substitution method, single variable and multivariable newton-Raphson technique, Polynomial rood finding methods

Unit – III

Ordinary differential Equations – Initial Value Problems: Explicit Adams – Bashforth technique, Implicit Adams-Moulton technique, Predictor-corrector technique, Runge-Kuttamethods, stability of algorithms.

Unit – IV

Ordinary differential equations – Boundary Value Problems: Finite difference technique, Orthogonal collocation (OC), Orthogonal collocation on finite Elements (OCFE), Galerkin Finite Element (GFE) technique, shooting techniques.

Unit – V

Partial differential Equations: Partial Differential Equations (PDE) Classification of PDE, Finite difference technique (Method of lines), Orthogonal collocation. Case Studies. Use ofspreadsheets in Chemical Engineering.

Text/Reference Books:

1. Gupta, S.K., "*Numerical Methods for Engineers*", New Age International Ltd. New Delhi, 1995.
2. Hanna, O.T. and Sandall, O.C., "*Computational Methods in Chemical Engineering*" Prentice-Hall, 1975

5BTCH5 : CHEMICAL ENGINEERING THERMODYNAM ICS-II

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Review of first law and second law of thermodynamics

Volumetric Properties of Pure Fluids : PVT behavior of pure substances virial equation an its applications, cubic equations of state, generalized correlations for gases and liquids.

Heat Effects: Sensible heat effect, heat effects accompanying phase changes of pure substances, standard heats of reaction, formation and combustion, effect of temperature on the standard heat of reaction.

Unit – II

Thermodynamic Properties of Fluids: Fundamental property relations, Maxwell's equations, Residual properties, clapeyron's Equation, Generalized correlations for thermodynamic properties of gases.

Unit – III

Multicomponent Systems : Chemical potential, ideal-gas mixture, ideal solution, Raoult's Law. Partial properties, fugacity and fugacity coefficient, generalized correlations for the fugacity coefficient, excess Gibbs' energy, activity coefficient.

Unit – IV

Phase Equilibria at low to moderate pressures: phase rule, phase behavior for vapor liquid systems, Margules equation, Van laar equation, Wilson equation, NRTL equatiojn. Dew point, bubble point and flash calculations.

Solution Thermodymics : Ideal solution, fundamental residual – property relation, fundamental excess – property relation. Evaluation of partial properties. Heat effects of mixing processes. Partially miscible systems.

Unit – V

Chemical Reaction Equilibria : Reaction coordinate, equilibrium criteria to chemical reactions, standard Gibbs' energy change and the equilibrium constant. Effect of temperature on the equilibrium constant, evaluation of equilibrium constants. Relations between equilibrium constants and compositions: gas-phase reactions, liquid- phase reactions, Calculation of equilibrium compositions for single- phase reactions. Multireactionequilibria.

Text/Reference Books:

1. Smith, J.M.; Van Ness, H.C. and Abbott, M.M., "*Introduction to Chemical Engineering Thermodynamics*", 6th Ed. McGraw – Hill, 2001
2. Rao, Y.V.C, "*Chemical Engineering Thermodynamics*" University Press, 1997

Elective – III

5BTCH6.1: ANALYTICAL TECHNIQUES

3L MM: 100 Ex. Hrs.: 3

Unit – I

Components of instruments for optical spectroscopy : Components and configuration of instruments for optical spectroscopy, radiation sources, sample contains, radiation detection, signal processor and vadouts.

An Introduction to absorption Spectroscopy : Terms employed in absorption spectroscopy, quantitative aspects of absorption measurements

Unit – II

Application of Ultraviolet and visible Spectroscopy: Absorption species, typical instruments, application of absorption measurements to qualitative and quantitative Measurement.

Infra Red Absorption Spectroscopy : Theory of infrared absorption, infrared instruments qualitative and quantitative application.

Unit – III

Raman Spectroscopy: Theory of Raman spectroscopy, instrumentation application of Raman spectroscopy

Nuclear Magnetic Resonance Spectroscopy : Theory of instrumentation of NMR, application of protein NMR to analysis of compounds.

Unit – IV

Mass Spectroscopy : Theory of Flame Spectroscopy, flame characteristics, atomizer for atomic spectroscopy atomic absorption spectroscopy.

Atomic Spectroscopy : Theory of Flame Spectroscopy, flame characteristics, atomizer for atomic spectroscopy, atomic absorption spectroscopy.

Unit – V

Polarography: Theory of polarogrphy, instrumentation and qualitative and quantitative application.

Gas Chromatorgraphy : Principle of gas liquid chromatography, instrumentation, application of gas liquid chromatography.

Text/Reference Books:

1. D. Holen and H.Peck, "*Analytical Biochemistry*" Longman, 1983.
2. . Wilson and J. Walker, "*Practical Biochemistry*" University Press, 2000

Elective – III

5BTCH6.2 : FERTILISER TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit – I

Introduction: Plant nutrients, different types of fertilizers and their production in India.

Unit – II

Nitrogenous Fertilizers: Different feed stocks, synthesis gas production by steamnaptha reforming and gas purification. Ammonia synthesis, Urea manufacturing processes. Manufacture of sulphuric acid and ammonium sulphate. Nitric acid and ammonium nitrate manufacture.

Unit – III

Phosphatic Fertilizers : Availability and grinding of rock phosphate, manufacturing processes for single and triple super-phosphate and phosphoric acid.

Unit – IV

Mixed fertilizers: Availability and manufacture of muriate of potash.

Mixed Fertilizers: Mono and di-ammonium phosphate, ure ammonium phosphates, NPK complex fertilizers, granulation techniques.

Unit – V

Engineering Problems: Fertilizers Storage and handling. Corrosion problems in fertilizersindustries. Fertilizer plant effluent treatment and disposal.

Text/Reference Books:

1. Slack A.V. "*Chemistry and Technology of Fertilizers*", Wiley linter science Publishers.
2. Waggaman W.H., "*Phosphoric Acid, Phosphates and Phosphatic Fertilizers*" Hafner Pub.
3. Austin G.T., "*Shreve's Chemical Processes Industries*", 5th Ed. McGraw Hill.
4. Rao M.G. and Sittig M., "*Dryden's Outlines of Chemical Technology*", Affiliated East West Press, Delhi.

Elective – III

5BTCH6.3 : ENERGY RESOURCE S AND UTILISATION

3L MM: 100 Ex. Hrs.: 3

Unit – I

Introduction: Synthetic fuels and their manufacture introduction and classification of fuels, Fundamentals, Units and their conversions, Properties of coal, oil shale, and Tar Sands.

Unit – II

Solid Fuels: Wood, Wood charcoal and Peat. Origin, Composition, Characteristics, and Significance of constituents of coal, Petrography of coal, washing of coal, storage of coal. Pulverised fuel/coal, Uses of coal, comparison of Solid, Liquid, and Gaseous fuels. Selection of coal, Mineral matters in coal ash, and clinker formation; Properties and testing of coal, Classification of coal, Carbonization of coal – coke making and byproducts recovery, Characteristics and distribution of Indian coals, Briqueting of Solid fuel/coal.

Unit – III

Liquid Fuels/Petroleum Refining : Origin, Composition, Classification, and constituents of petroleum: Indian crudes, Processing of Crude oil:Distillation, Cracking- Thermal and Catalytic, Reforming – Thermal and catalytic, Polymerisation, Alkylation, and Isomerisation, Purification of Petroleum products, Antiknock value and Requisites of good quality gasoline, diesel and fuel oil, Liquidfuels from coal by hydrogenation/ liquefaction, other liquid fuels- Benzol, shale oil, alcohol, and colloidal fuels, Storage and Handling of Liquid fuels/Fuel oils.

Unit – IV

Unit – V

Gaseous Fuels : Methane, Wood Gas, Gobar gas, Sewage gas, Gas from underground gasification of coal, Natural gas, LPG, Refinery gases, Producer gas, and Water gas.

Furnaces: Introduction, Waste heat recovery in furnaces, Classification of furnaces.
Nuclear Fuels and their Utilization : Introduction, nuclear fuel resources in India, Nuclearreactors – introduction, Classification of nuclear reactors, Types of nuclear reactors.

Text/Reference Books:

1. Gupta, O.P., "*Fuels, Furnaces Refractories*", Khanna Publishers, Delhi 2000
2. Probstein, R.F. and Hicks, R.E., "*Synthetic Fuels*," McGraw Hill, NY, 1985.
3. Sarkar, S., "*Fuels and Combustion*," 2nd ed., Orient Longman, Bombay, 1990

6BTCH1 : CHEMICAL REACTION ENGINEERING – I

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Introduction : Definition of reaction rates, variable affecting reaction rates, classification ofreactions, order, molecularity.

Unit – II

Kinetics of Homogenous Reactions: Concentration dependent term of a rate equation, temperature dependent term of a rate equation, searching for a mechanism.

Interpretation of Batch Reactor Data: Constant volume batch reactor, variable volume batch reactor, temperature and reaction rate.

Unit – III

Introduction to Reactor Design : Ideal reactors for single reaction: Ideal batch reactor, steady state mixed flow Reactor, steady state PFR, Holding time and space time for flow systems.

Design for single reactions: Size comparison, multiple reactor systems, recycle reactor, auto catalytic reactions.

Design for multiple reactions: Reactions in parallel, reactions in series, series – parallel reactions.

Unit – IV

Temperature and Pressure Effects on Reactions: Single reactions: Heat of reaction, equilibrium constants, graphical design procedure, optimum temperature progression, adiabatic operations. Multiple reactions: Product distribution and temperature.

Unit – V

Stability of Multiple Steady – States : Multiple steady-states of a CSTR with a first order reaction, Ignition – extinction curve.

Text/Reference Books:

1. Levenspiel, O., "*Chemical Reaction Engineering*" 3rd ed., John Wiley & Sons, Singapore 1999.
2. Fogler, H.S., "*Elements of Chemical Reaction Engineering*" 3rd ed., Prentice Hall of India, 2003.
3. Smith, J.M. "*Chemical Engineering Kinetics*", 3rd McGraw-Hill, 1981.
4. Dawande S.D. "*Principles of Chemical Reaction Engineering*," 2nd ed., Central Techno Publications, Nagpur, 2003.
5. Richardson, J.F. and peacock D.G., "*Coulson and Richardson's Chemical Engineering*," Vol.3, 3rd ed. Asian Books Pvt. Ltd. New Delhi 1998.

6BTCH 2 : MASS TRANSFER OPERATION –II

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Distillation : Vapor liquid Equilibria, Boiling point diagram, Relative volatility, flash and differential distillation for two component mixture, steam distillation, azeotropic distillation,extractive distillation.

Continuous and differential contact distillation: Rectification, reflux ratio and its importance, Minimum reflux, total and optimum reflux ration, material balance and Q-line equation, open steam, multiple feed and multiple product calculations, Enthalpy concentration diagram, panchon-Savarit and McCabe Theile method for calculation of number of plates. Approximate wquation; Fensky and underwood

Unit – II equation for minimum reflux and minimum number of plate calculation, Batch distillation.

Liquid – Liquid extraction : Liquid-Liquid equilibrium, packed and spray column,

Unit – III conjugate curve and tie line data, plait-point, ternary liquid-liquid extraction, co-current, counter current and parallel current system, selection of solvent for extraction.

Unit – IV

Leaching : Solid-liquid equilibrium, Equipment, principles of leaching, co-current andcounter current systems and calculation of number of stage required.

Unit – V **Humidification :** General theory, psychometric chart, fundamental concepts in humidification and dehumidification, drybulb and wet bulb temperature, adiabatic saturation temperature, measurement of humidity calculation of humidification operation, coolingtowers and related equipments.

Crystallization : Supersaturation, methods to achieve supersaturation, Factors governing nucleation and crystal growth rates, controlled-growth of crystals, super saturation curve, principle and design of batch and continuous type crystallizers, Inverted soliability, fractional crystallization.

Text/Reference Books:

1. Treybal, R.E; "*Mass Transfer Operation*", McGraw-Hill,1980.
2. King, C.J. "*Separation Process"*, McGraw-Hill, NY.
3. Smith, B.D., "Design of Equilibrium stage Processes", McGraw-Hill, NY.
4. McCabe, W.L., Smith, J.C. and Harriot, P., "Unit Operation of Chemical Engineering", 6thed, McGraw-Hill, NY.
5. Coulson, J.M. and Richardson, J.F., "Chemical Engineering", Vol. I and II, Asian Books Pvt., New Delhi.

6BTCH3 : PROCESS DYNAMICS AND CONTROL

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Introduction to process control and review of Laplace transforms

Linear Open-Loop Systems : First–order Systerms : Transfer Function, Transient response (step response, impulse response, sinusoidal response) examples of first – order systems, response of first order systems in series : non-interacting systems and interacting systems.

Unit – II Second – order systems: transfer function, step response, impulse response, k sinusoidal response, transportation lag.

Unit – III **Linear closed-loop Systems :** Control System: components of a control system, block diagram, negative feedback and positive feedback, servo problem and regulator problem.

Unit – IV **Controller and final control element:** Mechanism of control valve and controller, transfer functions of control valve and controllers (P, PI, PD, PID). Example of a chemical reactor control system.

Unit – V **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.

Stability : Concept of Stability, Stability criteria, Routh test for stability, Root Locus.

Frequency Response : Introduction to Frequency Response, Bode Diagrams for First andsecond order systems, Bode stability Criteria, Ziegler-Nichols and Cohen-coon TuningRules.

Text/Reference Books:

1. Coughanowr, D.R., "*Process Systems Analysis and control*" 2nd ed. McGraw-Hill, 1991.
2. Stephanopoulos, G., "*Chemical Process Control*" PHI, 1984.
3. Luyben, W.L. "*Process Modeling, Simulation and Control for Chemical Engineers*," McGraw Hill, 1973.

6BTCH4 : ORGANIC CHEMICAL TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Study of organic process industries/processes involving, Process details, production trend, thermodynamics consideration, flowsheets, engineering problems pertaining to material of construction, waste regeneration/ recycling and safety, environmental and energy conservation measures.

Unit – I

Pulp and paper industry, soaps, detergents, dyes and dyes intermediates.

Unit – II

Agro based alcohol industries, production of cane sugar, molasses, formation of alcohol, alcohol derivatives like acetic acid, acetic anhydride, vinyl acetate, ethylene glycol, pyridine.

Unit – III

Intermediates for petrochemical from petroleum based stocks, phenol, methanol, ethylene, proplene, aromatic benzene, toluene and xylene acrylonitrite, stylene, butadiene.

Unit – IV

Unit – V

Carbohydrates and sugar, insecticides and pesticides.

Man made fibers, rayon, polyester, polyamides and acrylics, cellulose and acetate.

Text/Reference Books:

1. Austin G.T.- *Shreeves Chemical Process Industries* – 5th Ed., McGraw Hill 1984.
2. Dryden C.E., M. Gopala Rao-*Outlines of Chemical Technology*-3rd Ed. Affiliated East-West Press, New Delhi.
3. Pandey G.N.-*Chemical Technology Volume*-I, Lion Press, Kanpur.

6BTCH5 : PETROLEUM REFINING

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Introduction: World Petroleum resources, petroleum industry in India, origin, exploration, drilling, composition and classification of petroleum crude, ASTM, TBP and FEV and production of petroleum crude, transportation and pretreatment of crude oil.

Unit – II

Unit – III

Distillation of crude oil Atmospheric and Vacuum distillation. Properties and specification of petroleum products-LPG, Gasoline, naphtha, kerosene, diesel oil, lubricating oil, wax etc Testing and uses of petroleum products. Safety and pollution considerations in refineries

Unit – IV

Conversion process: Thermal and catalytic in vapor, liquid and mixed phases, Hydro cracking, Thermal reforming, Polyforming and plat forming, Catalytic reforming

Unit – V

Conversion of petroleum gases into motor fuel with reference to Alkylation, Polymerization, Isomerisation, Hydrogenation, Production of aviation gasoline, motor fuel, kerosene, diesel oil and jet fuel**..**

Vacuum distillation: Design and operation of topping and vacuum distillation units. Tube still furnaces solvent extraction, uses of lubricating oils & waxes, Chemical & clay treatment of petroleum products, Desulphurization

Text/Reference Books:

1. Nelson, W.L., "Petroleum Refinery Engineering," 4th Ed., McGraw Hill, 1987
2. Garry, J.H. and Handwrek, G.E. "Petroleum Refining, Technology and Economics" 2nd Ed., Marcel-Dekker
3. Prasad, R., "Petroleum Refining Technology" Khanna Publishers, Delhi, 2000
4. Kobe, K.A., and Mcketta, J.J. "Advances in Petroleum Chemistry and Refining", Wiley Interscience
5. Gruse, W.A. and Steven, D.R. "Chemical Technology of Petreleum" McGraw Hill
6. Rao, M.G. and sitting, M. "Dryden's Outlines of Chemical Technology", East West Press, 1997

Elective -IV

6BTCH6.1 : INTRODUCTION TO OIL/FAT TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit – I Characteristics of Oilseed, Oils and fats

Unit – II Oil Milling and Solvent Extraction

Unit – III Oil Processing for Vanaspati and Refined Oil Specialty Fats

Unit – IV Packaging of Oils and fats

Unit – V Oil and Fats Derivatives

Health and Nutrition

Engineering Aspects

Text/Reference Books:

1. Swern, D. (ed.) "*Bailey's Industrial Oil and Fat Products*," 4th Ed. John Wiley and Sons, NY 1982
2. Hilditch, T.P., "*The Industrial Chemistry of Fats and Waxes*," 3rd ed. Bailliere, Tindall and Cox, London, 1949
3. Patterson, H.B.W. "*Handling and storage of Oilseeds, Oils Fats and Meat"* Elsevier Applied Science, Landon 1989

6BTCH6.2:
RUBBER

Elective-IV

SCIENCE AND TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit – I

Rubber Science : Classification of polymers – Thermoplastic, elastomers (rubber), thermosets, Description of elastomers- rubber vulcanizates, classification of rubbers, glass rubber transition behavior, Rubber physics-elastic behaviour.

Unit – II

Unit – III

Rubber Rheology: Flow behaviour of unvulcanized rubber compounds, measurement of plasticity, viscoelasticity and relaxation properties, Rheological models

Natural Rubber : Hevea Brasiliensis, Preservation and concentration of NR latex, Comparison of natural rubber and synthesis CIS 1,4 polyisoprene, Special features and uses of natural rubber

Unit – IV

Synthetic Rubber: Polymerization methods, addition polymerization and condensationpolymerization

Unit – V

Rubber Compounding : Introduction to rubber compounding bulcanization and its effects, vulcanization systems, vulcanizate physical properties and their significance, properties desired for different rubber compounds, compounding ingredients and formulations.

Rubber Processing : Mixing, extrusion, and molding techniques.
Manufacture of Rubber Products : Pneumatic tyres, lates products, rubber footwear and rubber moulded products
Rubber Characterization : Rubber Compound analysis and identification of rubber. Behavior in service.

Text/Reference Books:

1. Blow, C.M. and Hepburn, "*Rubber Technology and Manufacture*" 2nd ed. Butterworth, London, 1982.
2. Evans, C.M. "*Practical Rubber Compounding and processing*" Elsevier Applied Science Publisher, 1981.
3. "*Rubber Engineering*" by Indian Rubber Institute published by Tata McGraw-Hill, 1998

Elective –IV

TO PULP AND PAPER TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit – I

Introduction : Present status of pulp industries: Fivrous raw materials, Fibre Chemistry.
Raw Material Preparation : Debarking, chipping, chip screening, storage.

Unit – II

Pulping : Chemical, semi chemical, mechanical, chemimechanical and nonconventional.Secondary fibre pulping. Advances and recent trends in pulping.
Pulp Manufacture : Stock preparation, beating and refining, functional and control additives for papermaking, wet-end chemistry, polymer chemistry, retention sizing.

Unit – III

Bleaching : Objective of bleaching, bleachability measurement, bio-bleaching
Chemical Recovery : Composition and properties of black liquor, oxidation and desilication, concentration of black liquor and its incineration, causticizing and clarification sludge washing and burning.

Unit – IV

Paper Manufacture : Approach flow system, wire part, sheet forming process, sheet transfer mechanism, press part, theory of pressing, dryer part, paper drying process, calendering, cylinder mould machine, finishing, fibre recovery systems, recent developments in paper making. Coating and lamination.

Unit – V

Paper Properties : Physical (Optical, strength and resistance) Chemical and electrical properties, paper defects
Paper Grades : Types, composition, manufacturing techniques, properties and uses

Text/Reference Books:

1. Britt, K.W. (Ed.) "*Handbook of Pulp and paper Technology*" 2nd ed., CBS Publishers & Distributors, Delhi, 1984.
2. Casey, J.P. "*Pulp and paper Chemistry and Chemical Technology*" Vol.1, 3rd ed. Wiley Interscience.
3. Rydholm. S.A. "*Pulping Processes*" Wiley Interscience.
4. Libby, C.E. "*Pulp and paper Science and Technology*" Vol.1, McGraw-Hill.
5. Clark, JDA, "*Pulp Technology and Treatment for Paper*" 2nd ed. Miller Freeman.
6. McDonald, R.G., "*Pulp and Paper Manufacture*," Vol.1, 2nd ed. McGraw-Hill.
7. Biermann, C.J. "*Essentials of Pulpingand Paper Making*," Academic Press.
8. Saltman, D., "*Paper Basics*" Van Nostrand, 1978.

7BTCH1 – CHEMICAL REACTION ENGINEERING - II

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Catalysts : Description, method of preparation and manufacture; catalyst characterization – BET surface area, pore volume, pore size distribution.

Catalyst Reaction Kinetic Models : Physical and chemical absorption; determination of rate expressions using absorption, surface reaction and desorption as rate-controlling steps.

Unit – II

Determination of Global Rate of Reaction : Heterogeneous laboratory reactors; Determination of rate expressions from experimental data.

Unit – III

Effect of Intrapellet Diffusion on Reaction Rates in Isothermal Pellets : Concept of effectiveness factor, Thiele modulus, experimental determination of effectiveness factor- wesiz-Prater criteria, Non-Isothermal effectiveness factor; Prater number, maximum temperature rise in a pellet, multiple steady states in heterogeneous reactors.

Unit – IV

Non-catalytic Gas-Solid Reactions : Progressive conversion model, Shrinking core model; various controlling regimes, design of gas-solid reactors.

Unit – V

Gas-Liquid Reactions : Effect of diffusion on rate of reaction, enhancement factor.

Introduction to Design of Heterogeneous Reactors : One dimensional model for fixed-bed reactors, parametric sensitivity; design of fluidized bed reactors.

Text/Reference Books:

1. Levenspiel, O., "*Chemical Reaction Engineering*" 3rd Ed., John Wiley, 1999.
2. Smith, J.M., "*Chemical Engineering Kinetics*" 3rd Ed., Mc Graw-Hill, 1981.
3. Fogler, H.S., "*Elements of Chemical Reaction Engineering*" 3rd Ed.,Prentice-Hall of India, Delhi, 2003.
4. Carberry, J.J., "*Catalytic Reaction Engineering*" Mc Graw-Hill, 1976.
5. Dawande, S.D., "*Principles of Reaction Engineering*" Central Techno Pub., Nagpur, 2001.
6. Levenspiel, O., "*The Chemical Reactor Omnibook*" OSU Bookstores, Corvallis Oregon, 1996.

7BTCH2/7FT5/BT705 – TRANSPORT PHENOMENA

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Newton's law of viscosity, pressure and temperature dependence of viscosity, theory of viscosity of gases (low density), and liquids, convective momentum transport. Shell momentum balances, boundary conditions, selected applications.

Unit – II

The equation of change for isothermal system. Navier stokes equation. Use of equation of change to solve steady state flow problems. Comparisons of laminar and turbulent flows, time smoothed equations of change for incompressible fluids. The time smoothed velocity profile near a wall, turbulent flow in ducts and jets.

Unit – III

Fourier's law of heat conductions, temperature and pressure dependence of thermal conductivity. Thermal conductivity of gases, liquids, solids and composite solids.

Unit – IV

Shell energy balance, boundary conditions, heat conduction with an electrical heat source, nuclear heat source, viscous heat source, chemical heat source, composite walls and fins. Forced convection, and free convection.

Unit – V

Fick's law of diffusions, analogy with heat & mass transfer. Transport by molecular motion, shell mass balance and boundary conditions, temperature and pressure dependence of diffusivities, concentration profile for stagnant gas film, a heterogeneous chemical reactions, homogenous chemical reaction and porous catalyst.

Text/Reference Books:

1 Bird, R.B., Steward W.E. and Lightfoot, E.N., "Transport Phenomena" John Wiley.

2 Christie J. Geankophis, "Transport process and Unit operations". Prentice-Hall, India.

7BTCH3 – PROCESS EQUIPMENT DESIGN

3L MM: 100 Ex. Hrs.: 3

Unit – I

Heat Exchangers : Auxiliary calculations; Review of Kern method; Bell's method and HTRI method of Shell-and-tube heat exchanger design; Plate heat exchanger design; finned tube heat exchanger; Optimization of shell-and-tube exchanger.

Unit – II

Reboliers : Design of Kettle and thermosyphon reboilers.

Evaporators : Sizing of drum; central core pipe size and number of tubes for short and longtube evaporators.

Unit – III

Agitated Vessels : Design of mixing vessels, gas-spraying systems; impellers, propellers, anchors and helical ribbon-type agitators.

Unit – IV

Gas Liquid Contact Systems : Distillation column, Absorption tower, tray hydraulics of sieve and valve trays; Design of packed bed columns.

Unit – V

Design of Reactors: CSTR, Batch and packed bed.

Text/Reference Books:

1. Sinnott, R.K., "*Coulson and Richardson's Chemical Engineering*" Vol. 6, 3rd Ed., Butterworth Heinmann, New Delhi, 2002.
2. Kern, D.Q., "*Process Heat Transfer*" McGraw-Hill, 1950.
3. Evans, F.I., "*Equipment Design Handbook*" 2nd Ed., Vol.2, Gulf Publishing, 1980.
4. Smith,B.D., "*Design of Equilibrium Stage Process*" Mc Graw-Hill, 1963.
5. Dawande, S.D., "*Process Design of Equipments*," 2nd Ed., Central Techno Publications, Nagpur, 2000.

7BTCH4 – OPTIMIZATION OF CHEMICAL PROCESSES

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Formulation of the objective function.

Unconstrained single variable optimization: Newton, Quasi-Newton methods, polynomial approximation methods.

Unit – II

Unconstrained multivariable optimization: Direct search method, conjugate search method, steepest decent method, conjugate gradient method, Newton's method.

Unit – III

Linear Programming : Formulation of LP problem, graphical solution of LP problem,simplex method, duality in Linear Programming, Two-phase method.

Unit – IV

Non Linear programming with constraints : Necessary and sufficiency conditions for a local extremum, Quadratic programming, successive quadratic programming, Generalized reduced gradient (GRG) method.

Unit – V

Applications of optimization in Chemical Engineering.

Text/Reference Books:

1. Edgar, T.F., Himmelblau, D.M., Lasdon, L.S. "*Optimization of Chemical Process*" 2nd ed, McGraw-Hill, 2001.
2. Rao, S.S., "*Optimization Techniques*" Witey Eastern, New Delhi, 1985.
3. Gupta, S.K., "*Numerical Methods for Engineers*" New Age, 1995.
4. Beveridge, G.S. and Schechter, R.S., "*Optimization Theory and Practice*" McGraw-Hill, New York, 1970.
5. Rekllaitis, G.V. Ravindran, A. and Ragsdell, K.M., "*Engineering Optimization – Methods and Applications*" John Wiley, New York, 1983.

7BTCH5 – MOLECULAR BIOLOGY

3L+3P MM: 100 Ex. Hrs.: 3

Unit- I

Introduction: Living systems and their properties, Measure biological compounds, Physiological processes, Introduction to environment, Evolution, Ecology, Biogeography regions.

Unit – II

Biomolecules: Chemistry and function of the constituents of cells- water, Salts, Amino acids, Proteins and its synthesis, nucleic acids, Metabolism of carbohydrates, Lipids, Introduction to enzymes and their action, Hormones.

Unit – III

Cell biology: Prokaryotic and Eukaryotic cells, Organization of plant and animal cells, Organelles- structure, Chemical composition, function.

Unit – IV

Cellular processes and information transfer: Carbon and Nitrogen cycles in nature, Glycolysis, TCA cycle, Signal transduction, Receptor concept.

Unit – V

Genetics: Facts and theories of heredity, Elements of population genetics and species concept, Mendel's laws-segregation, independent assortment, Phenotype and Genotype, Mono- and di- hybrid crosses, Chromosomes, Gene concept, DNA–Protein interactions, Central Dogma-DNA Replication, RNA Transcription and its control, RNA Processing, Protein Translation, Translation mechanism of gene expression, Genetic code, Prokaryotic and Eukaryotic genomes, Introduction to the methods of introducing genes into the recipient cells- transformation, Transudation, Conjugation.

Text/Reference Books:

1. Jain S.K. “Fundamentals Molecular Biology” CBS Publisher, 2004
2. Srivastava “Molecular Biology and Biotechnology “CBS Publisher, 2007
3. Singh “Molecular Biology: A Complete Course” CBS Publisher, 2008

ELECTIVE V

7BTCH6.1 – BIOPROCESS ENGINEERING

3L MM: 100 Ex. Hrs.: 3

Unit – I

Introduction to Bioprocesses

Historical development of bioprocess technology, an overview of traditional and modern applications of biotechnology industry, outline of an integrated bioprocess and the various (upstream and down stream) unit operations involved in bioprocess, generalized process flow sheets.

Unit – II

Fermentation Process-I : General requirements of fermentation processes, Basic design and construction of fermentor and ancillaries, Main parameters to be monitored and controlled in fermentation process;

Fermentation Process-II : An overview of aerobic and anaerobic fermentation processes and their application in the biotechnology industry, solid-substrate, slurry fermentation and its applications, whole cell immobilization, behaviour of microbes

Unit – III in different reactors (air lift, fluidized, batch, continuous fed batch condition).

Media Design : Medium requirements for fermentation process, Carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation for optimal growth and product formation, examples of simple and complex media, design and usage of various commercial media for industrial fermentations.

Unit – IV **Sterilization :** Thermal death kinetics of microorganisms, batch and continuous heat. Sterilization of liquid media, filter sterilization of liquid media, Air, Design of sterilization equipment.

Metabolic Stoichiometry : Stoichiometry of Cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron

Unit – V balances, yield coefficients of biomass and product formation, maintenance coefficients.

Energetics : Energetic analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures thermodynamic efficiency of growth.

Kinetics of Microbial Growth and Product Formation : Phases of cell growth in batch cultures. Simple unstructured kinetic models for microbial growth, Monod Model, Growth of Filamentous organisms, Growth associated (Primary) and non growth associated (secondary) product formation Kinteics. Leudeking-Piret models, substrate and product inhibition on cell growth and product formation, introduction to Structured Models for growth and product formation.

Text/Reference Books:

1. Biochemical Engineering Fundamentals Balley and Ollis, McGraw Hill (2nd Ed.), 1986.
2. Bioprocess Engineering, Shule and Kargi, Prentice Hall, 1992.

3. Stanbury, P.F., Whitaker, A., & Hall, S.J., (1998), Principles of fermentation Technology, 2nd ed., Elsevier Science Publishers, BV, Amsterdam.

ELECTIVE V

7BTCH6.2 – PROCESS SAFETY AND HAZARD MANAGEMENT

3L MM: 100 Ex. Hrs.: 3

Unit – I

Origin of process hazards, laws codes, standards, case historics, properties of chemicals, health hazards of industrial substances.

Toxicology : Toxic materials and their properties, effect of dose and exposure time, relationship and predictive models for response, threshold value and its definitions, material safetydata sheets, industrial hygiene evaluation.

Unit – II

Fire & Explosion : Fire and explosion hazards, causes of fire and preventive methods. Flammability characteristics of chemical, fire and explosion hazards, rating of process plant. Propagation of fire and effect of environmental factors, ventilation, dispersion, purifying and sprinkling, safety and relief valves.

Unit – III

Other Energy Hazards : Electrical hazards, noise hazards, radiation hazard in process operations, hazards communication to employees, plant management and maintenance to reduce energy hazards.

Unit – IV

Risk Analysis : Component and plant reliability, event probability and failure, plant reliability, risk analysis, HAZOP AND HAZAN, event and consequence analysis (vapour cloud modeling) Designing for Safety, measurement and calculation of risk analysis.

Unit – V

Hazard Assessment : Failure distribution, failure data analysis, modeling for safety, safety training, emergency planning ad disaster management, case studies.

Text/Reference Books:

1. Crawl D.A. and Louvar J.A., "Chemical Process Safety fundamentals with applications", Prentice Hall of India, New Delhi
2. Wentz, C.A. "Safety Health and Environmental Protection" McGraw Hill, 2001
3. Smith, B.D. "Design of Equilibrium State Process" McGraw Hill
4. Van Winkle, "Distillation", McGraw Hill

ELECTIVE V

7BTCH6.3 – SUGAR TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit – I

Sugar Industry and sugar scenario in India and world. Raw materials such as Sugar cane andbeet root and their availability.

Unit – II

Raw materials and their preparation, continuous operations, cane processing, weighment, chopping, grading crushing, milling and imbibition. Seeparation of bagase and bagacillo.

Unit – III

Juice purification – screening filtration, chemical treatment, sulfitation, carbonization, precipitation and clarification. Working of filter press, vacuum filtration and dorrclarifier settler.

Unit – IV

Concentration of clarified juice in multi effect evaporation, triple and quadruple effect, and capacity, stream economy, Co-current and countercurrent flow of juice in the evaporators.

Unit – V

Operations of vacuum pan. Theory of sugar crystallization, strike- pans sugar crystallizers. Crystal drying, screening and grading.

Sugar Industry bye products – bagasse, press mud, molasses; mud wax captive power and their utilization.

Text/Reference Books:

1. Birch and Parket, "Sugar Sciences and Technology" App. Sci Pub.
2. Hong. P. "Principles of Sugar Technology" 3rd ed., Elsevier New York
3. Gopal Rao and Marshal Sitting, "Dryden Outlines of Chemical Technology," East-West Press, 3rd ed., New Delhi 1977
4. Austin, G.T., "Shreve's Chemical Process Industries," 5th Ed. McGraw Hill Book Co. Singapore.

8BTCH1 : PROCESS ENGINEERING AND PLANT DESIGN

4L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Process Design and Development : General design considerations: The hierarchy of chemical process design, the nature of process synthesis and analysis.

Unit – II

Developing a conceptual design and finding the best flowsheet : input information and batch versus continuous, input/output structure of the flowsheet; Recycle structure of the flowsheet; Separation system; Heat Exchanger Networks.

Unit – III

Plant Design : Process design Development and general design considerations.

Unit – IV

Process Economics : Economic feasibility of project using order-of-magnitude costestimates, plant and equipment cost estimation, product cost estimation.

Unit – V

Profitability Analysis : Rate of return, payback period, discount rate of return, net presentworth, internal rate of return, comparing investment alternatives.

Text/Reference Books:

1. Douglas, J.M. Conceptual Design of Chemical Process, McGraw- Hill, 1989
2. Peters, M.S. and Timmerhaus, K.D., "Plant Design and Economics for Chemical Engineers."4th ed., McGraw Hill, 1991.
3. Biegler, L., Grossmann, I.E. Westerberg. A.W. "Systematic Methods of Chemical Engineering and Process Design," Prentice Hall, 1997

8BTCH2 : INDUSTRIAL MANAGEMENT

3L MM: 100 Ex. Hrs.: 3

Unit – I

Business Forms and Organization : Form of Business: (i) Single proprietorship (ii) Partnership (iii) Joint Stock Company, Private Limited Companies and Public Limited Companies, forming Joint Stock Companies (a) Registration (b) Issue of Prospectus (c) Commencement Certificate (d) Co-operative society. Choice of business forms (e) State undertaking Organization.

Unit – II

Finances and Financial Statements : Introduction, needs of finance, Kinds of Capital, Sources of fixed capital, shares (i) Ordinary shares (ii) Preference shares, Borrow capital- surplus profits, Depreciation Allowance. Specialized Financial Institutions, sources of working capital, Management of working capital. Rates commentaries.

Unit – III

Personnel Management : Origin and Evolution. Meaning and Content, different definitions of personnel manager. Functions of personal manager; Recruitment, grievances, methods of settlement, Absenteeism, labour turnover, Employees morale and satisfaction. Welfare provisions. Retirement pensions, Gratuity, discharge and dismissals, merit rating.

Unit – IV

Production/Operations Management : Overview, Choice of technology; Forecasting, transportation, assignment, PERT/CPM, Total Quality Management (TQM), Just in Time (JIT).

Corporate Management : Board of Directors : Role and function. Top management: Role and skill.

Unit – V

Strategic Choices : Strategic alternatives, diversification, mergers and acquisitions.

Marketing : Marketing of services, understanding consumers, product management, pricingand promotional strategies, sales, distribution strategy and control.

8BTCH3 : ANALYSIS AND SIMULATION

4L+1T

MM: 100 Ex. Hrs.: 3

Unit – I

Introduction to modeling and simulation. Analysis of Models : Role of analysis, basic concepts of analysis, an analysis process, simple examples, source of model equations.

Unit – II

Unit – III Conservation equations of mass, energy and momentum, constitutive equations, control volume, dimensional analysis, stability analysis, sensitivity analysis.

Unit – IV Formulation of Process Models : Development of model equations for simple isothermal non-reacting and reacting liquid systems for both steady state and unsteady state conditions.

Unit – V Isothermal two phase systems and rate of mass transfer, equilibrium staged processes, non- isothermal systems. Modeling of distillation column, absorber, heat exchanger, heat transfer in a jacketed verssel.

Chemical Process Simulation : Introduction to simulation methodologies, process flowsheet simulators.

Text/Reference Books:

1. Russell, T.W.F. and Denn, M.M. "Introduction to Chemical Engineering Analysis." John wiley, NY 1972
2. Denn, M.M. "Process Modeling", NY, 1990
3. Holland, C.D., "Fundamentals of Modeling Separation Processes," Prentice Hall, 1975
4. Biegler, L., Grossmann, I.E. and Westerberg, A.W., "Systematic Method of Chemical Engineering and Process Design," Prentice Hall, 1975
5. Hussain, A., "Chemical Process Simulation," Wiley Eastern, N. Delhi, 1986
6. Walas, S.M., "Modeling with Differential Equations in Chemical Engineering" Butterworth 1991.

ELECTIVE - VI

8BTCH4.1 : BIOCHEMICAL TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit – I

Overview of industrial bioprocesses with emphasis on new material.

Unit – II

Microorganisms/enzyme, metabolic pathway, yield, bioprocess, chemical engineering operations and applications.

Unit – III

Solvents, enzymes, organic

Unit – IV

acids.Antibiotics, vitamins.

Unit – V

Pharmaceutical products.

Text/Reference Books:

1. Atkinson, B. andMavituna, F., "Biochemical Engineering and Biotechnology Handbook," Nature Press, Macmillan, 1983
2. Glazer, A.N. and Nikaido, H., "Microbial Biotechnology: Fundamentals of Applied Microbiology," WH Freeman & Co., New York, 1995
3. Reed, G. (Ed.), "Prescott & Dunn's Industrial Microbiology" 4th Ed., CBS Publishers & Distributors, New Delhi, 1999.

The above syllabus was not in the scheme,VIII semester. so kindly ether deleted from here or added in the scheme of

ELECTIVE - VI
8BTCH4.2 : MULTIPHASE FLOW

3L MM: 100 Ex. Hrs.: 3

Unit – I

Introduction to the flow of multiphase mixture : Gas or vapor-liquid, liquid-liquid, liquid-solid, gas-solid, solid-liquid-gas and gases carrying solids (pneumatic transport) stratification and disperson, Flow regimes and flow patterns.

Unit – II

Gas (vapor) and Liquid Flows : Horizontal flow, Vertical flow, pressure, momentum and energy relations, methods of evaluation pressure drop. Lockhard-Martinell, Chisholm correlations, critical flow, non-Newtonian flow.

Unit – III

Solid -Gas Flow : Effect of pipeline diameter, inclination, bends, valves and length. Liquid and its physico-chemical properties, rheology, corrosive nature, viscosity, Solid particle size, distribution phase, and density i.e. their factors effecting behavior in a fluid, concentration of particles and the flow rates of both solids and liquid.

Unit – IV

Solid –Gas Flow : Horizontal flow, Suspension mechanism, determination of voids, energy requirements for conveying, pressure drop and solid velocities in dilute phase flow, dense phase conveying, vertical transport.

Unit – V

Bubble and drop formation : Phase holdups, Interfacial areas, mixing and pressure drops, multiphase (Gas liquid solid) Operations.

Text/Reference Books:

1. Govier, G.W. and Aziz K., "The Flow of Complex Mixtures in Pipe," Krieger Publication Florida, 1982
2. Coulson JM and Richardson J.F. "Chemical Engineering," Vol-I, Butterworth-Heinmann, Oxford, 1999

ELECTIVE - VI

8BTCH4.3 : CATALYTIC PROCESSES

3L MM: 100 Ex. Hrs.: 3

Unit – I

Review of Heterogeneous Catalysis.

Unit – II

Transport Processes : Analysis of external transport processes in heterogeneous reactions in fixed ed, fluidized bed and slurry reactors, Intrapellet mass transfer, heat transfer, mass transfer with chemical reaction and simultaneous mass and heat transfer with chemical reaction.

Unit – III

Catalyst Selectivity : Effect of intrapellet diffusionon on selectivities in complex reactions, effect of external mass transfer on selectivities.

Unit – IV

Catalyst Deactivation : Modes of deactivation – poisoning, fouling and sintering. Determination of deactivation routes, combined effect of deactivation and diffusion on reaction rates, effect of deactivation on selectivity.

Unit – V

Reactor Design : Design calculation for ideal catalytic reactor operating at isothermal, adiabatic and non-adiabatic conditions. Deviations from ideal reactor performance. Design of industrial fixed-bed, fluidized bed and slurry reactors, Thermal stability of packed bed and fluidized bed reactors.

Text/Reference Books:

1. Smith, J.M., "Chemical Engineering Kinetics," 3rd ed., McGraw-Hill, 1981
2. Carberry, J.J., "Catalytic Reaction Engineering," McGraw-Hill, 1977.
3. Lee, H.H., "Heterogeneous Catalytic Reactors," Butterworth
4. Tarhan, M.O., "Catalytic Reactor Design," McGraw-Hill, NY 1983
5. Anderson, J.R. and Boudart, M., "Catalysis, Science and Technology," Vol.7., Springer Verlag. N.Y.
6. Thomas, J.M. and Thomas, W.J., "Introduction to the Principles of HeterogeneousCatalysis," Academic Press, 1967.

8BTCH4.4 : POLYMER SCIENCE AND TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit – I

Chemistry of Polymerization Reactions : Functionality, polymerization reactions, polycondensation, addition free radical and chain polymerization. Copolymerization, block and graft polymerizations, stereospecific polymerization.

Unit – II

Polymerization Kinetics : Kinetics of radical, chain and ionic polymerization and co-polymerization systems.

Unit – III

Molecular Weight Estimation : Average molecular weight: number average and weight average. Theoretical distributions, methods for the estimation of molecular weight.

Unit – IV

Polymerization Processes : Bulk, solution, emulsion and suspension polymerization. Thermoplastic composites, fibre reinforcement fillers, surface treatment reinforced thermoset composites – Resins, Fibres, additives, fabrication methods.

Unit – V

Rheology : Simple Rheological response, simple linear viscoelastic models – Maxwell,, Voigt, material response time, temperature dependence of viscosity, Rheological studies.

Text/Reference Books:

1. Rodringuez, "Principles of Polymer Systems", Tata McGraw Hill, 1970
2. Billmayer Jr. and Fred. W., "Textbook of Polymer Science", Wiley Tappers, 1965
3. David, J.W., "Polymer Science and Engineering", Prentice Hall, 1971
4. Schmidt, A.K. and Marlies, G.A., "High Polymers – Theory and Practice", McGrawHill, 1948
5. McKelvey, J.M., "Polymer Processing, "John Wiley, 1962
6. Manoriffs, R.W., "Man-made Fibres," Wiley Inter Science.

8BTCH8 : SEPARATION TECHNIQUES

3S MM: 100 Ex. Hrs.: 3

Unit – I

Introduction : Separation process in chemical and Biochemical industries, Categorization of separation process, equilibrium and rate governed processes. Introduction to various new separation techniques e.g. Membrane separation, Ion-exchange foam separation, supercritical extraction, liquid membrane, PSA & Freeze drying.

Unit – II

Membrane based separation technique (MBSTs) : Historical background, physical and chemical properties of membranes, Techniques of membrane preparation, membrane characterization, various types of membranes and modules.

Unit – III

Osmosis and osmotic pressure. Working principle, operation and design of reverse osmosis, ultrafiltration, microfiltration, electrodialysis and pervaporation. Gaseous separation by membrances.

Unit – IV

Ion Exchange : History, basic principle and mechanism of separation, Ion exchange resins, regeneration and exchange capacity. Exchange equilibrium, affinity, selectivity and kinetics of ion exchange. Design of ion exchange systems and their uses in removal of ionic impurities form effluents.

Unit – V

Introduction to foam separation, micellar separation, supercritical fluid extraction, liquid membrane permeation and chromatographic separation.

Text/Reference Books:

1. King, C.J., "Separation Processes", Tata McGraw-Hill
2. Sourirajan, S. and Matsura, T., "Reverse Osmosis and Ultra-filtration – Process Principles"NRC Publication, Ottawa, 1985
3. Porter, M.C., "Handbook of Industrial Membrane Technology" Noyes Publication, newJersey, 1990
4. Henry, J.d. and Li, N.N., "New Separation Techniques", AICHE Today Series, AICHE(1975)
5. Hatton, T.A., Scamehorn, J.F. and Harvell, J.H. "Surfactant Based Separation Processes",Vol. 23, Surfactant Science Series, Marcel Dekker Inc., New York 1989.