Dharmsinh Desai University
(Faculty of Technology)
Nadiad 387001 (Gujarat)

Structure & Syllabus
of
B.Tech (Chem) Degree Course (2014-2015)

SEMESTER – I (EC/IC/CE/CH/CL)

AF – 111 MATHEMATICS – I

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
3	1		60	40			100

1. Differential Calculus

applications of differential calculus to geometrical problems, equation of tangent & normal, angle between two curves, subtangent, subnormal, length of tangent & length of normal, pedal equation, radius of curvature of plane curves in cartesian, polar and parametric equations, radius of curvature at origin by Newton's method and by method of expansion

2. Successive Differentiation

Leibnitz's theorem, Maclaurin's theorem, Taylor's theorem, applications to obtain expansion of functions, indeterminate forms

3. Integral Calculus

curve tracing, applications for finding area, length of arc, volume and surface area of solids of revolution, centre of gravity

4. Reduction Formula for

$\int_0^{\frac{\pi}{2}} \sin^n x \, dx$ $\int_0^{\frac{\pi}{2}} \cos^n x \, dx$ $\int_0^{\frac{\pi}{2}} \sin^m x \cos^n x \, dx$ $\int_0^{\frac{\pi}{4}} \tan^n x \, dx$ $\int_0^{\frac{\pi}{4}} \cot^n x \, dx$ etc...

5. Beta and Gamma Functions

definition, properties, relation between beta and gamma functions, use in evaluation of definite integrals, error and elliptic functions

6. Ordinary Differential Equations

formulation of differential equations, general and particular solutions, equations of first order and first degree of the type: variable separable, homogeneous, non-homogeneous, linear equations, exact equation and those reducible to these forms, Clairut's form, application to geometrical and physical problems

Text Books

Engineering Mathematics - II by Shanti Narayan
S. Chand & Co. Pvt. Ltd., Delhi
Higher Engineering Mathematics by Dr. B. S. Garewal
Khanna Publishers, Delhi

Reference Books

Applied Mathematics by P. N. Wartiker & J. N. Wartiker
Engineering Mathematics - I by I. B. Prasad

AF-112 BASIC ELECTRICAL ENGINEERING

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
3	1	2	60	40	25	25	150

1. Fundamentals of Current Electricity and DC Circuits

introduction – definition, symbols and unit of quantities, multiple and sub-multiple units, computation of resistance at constant temperature, temperature dependence of resistance, computation of resistance at different temperatures, Ohm's law – statement, illustrations and limitations, unit work, power, and energy (electrical, thermal and mechanical), circuits – identifying the elements and the connected terminology, Kirchhoff's law – statement and illustrations, resistances in series and parallel and current division technique, method of solving a circuit by Kirchhof's laws

2. Magnetic Circuits

introduction, definition, magnetic circuit, leakage flux, fringing effect, comparison between magnetic and electric circuits

3. Electromagnetic Induction

introduction, magnetic effect of electric current, current carrying conductor in magnetic field, laws of electromagnetic induction, induce EMF, self inductance (L), mutual induction (M), coupling coefficient between two magnetically coupled circuits (K)

4. AC Fundamentals
introduction, generation of alternating EMF, waveform terminology, concept of 3 phase EMF generation, root mean square (RMS) to effective value, average value of AC, phasor representation of alternating quantities, analysis of AC circuit

5. Single Phase AC Circuits
introduction, I operator, complex algebra, representation of alternating quantities in rectangular and polar forms, R-L series circuit, R-C series circuit, R-L-C series circuit, admittance and its components, simple methods of solving parallel AC circuits, resonance

6. Electrical Machines
introduction, DC generator, DC motor, transformer, 3-phase motor, application of electrical machines

7. Passive Circuit Components
constructional details of resistors, capacitors & inductors.

Practical & Term Work
Experiments & demonstrations based on the syllabus

Text Book
Basic Electrical, Electronics and Computer Engineering by R. Muthusubramaniam, S. Salivahanan, K.A. Muraleedharan
Tata McGraw Hill Publications Co. Ltd., New Delhi

AX – 113 COMPUTER PROGRAMMING-I

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
2	1	2	60	40	25	25	150

1. Introduction to digital computer-Introduction to DOS-Overview of C-Constants, Variables and data types-Operators and Expressions-scanf() and printf() functions.

2. Decision making with if statement, if-else statement, nesting of if-else statement, else-if ladder-Switch statement.

3.Operator- goto statement-While ,do While-for statement-Jumping in loops-Break and continue statement-Arrays(one dimensional).

Practical & Term Work
The laboratory and term work will be based on above topics.

Text Book
Programming in ANCI C by E. Balagurusamy
2nd Edition, Tata McGraw-Hill Publishing Company Limited-New Delhi.

AF – 114 ENGINEERING MECHANICS

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
3	1	3	60	40	25	25	150

1. Statics
introduction, engineering & SI units, accuracy in engineering calculations, vectors – composition & resolution, concept of rigid bodies
Resultant of a force system
concurrent coplanar force system
non-concurrent coplanar force system
parallel
non parallel
simple cases of concurrent force system in space
concept of internal force, free body diagram, equilibrium of force systems listed above friction – friction on inclined plane, ladder friction, wedge fiction, screw friction, belt and rope drive, centre of gravity of – lines, plane figures volumes, bodies & Pappu's theorem, principle of virtual work & its applications, types of beams, types of supports, support reaction for statically determinate beams

2. Dynamics
rectilinear motion, circular motion, projectiles, relative velocity, instantaneous centre in plane motion, laws of motion, motion along inclined plane, principle of conservation of momentum, mass moment of inertia in rotational motion,

motion of connected bodies, impulse & momentum, impact, work, motion along smooth curve & super elevation

Term Work

1. Experiments based on theory
2. Problems based on theory

Text Book

1. Mechanics for Engineers – Static by F. P. Beer & E. R. Johnston Jr.
2. Mechanics for Engineers – Dynamic by F. P. Beer & E. R. Johnston Jr.
3. Engineering Mechanics: Static & Dynamic by A. K. Tayal

AF – 116 WORK SHOP – I

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
		3				50	50

1. Instruction

kinds of wood, types of carpentry tools, carpentry joints, plumbing tools, pipe fittings, tin smithy & soldering tools.

2. Demonstrations

operation of wood working machines

Term Work

Each candidate shall submit the following term work.

i. practice job in carpentry 1 job
ii. simple job in carpentry1 job
iii. simple carpentry joint 1 job
iv. tin smithy and soldering 1 job

SEMESTER – II (EC/IC/CE/CH/CL)

AF – 201 MATHEMATICS – II

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
3	1		60	40			100

1. Partial Differentiation & its Applications

partial derivatives, homogenous functions, Euler's theorem, total derivatives – differentiation of implicit functions, change of variables, errors and approximations, maxima & minima of functions of two variables, Lagrange's method of undetermined multipliers

2. Multiple Integrals & their Applications

double integrals – definition, evaluation change of order, double integrals in polar co-ordinates and area enclosed by plane curves, triple integrals, change of variables, volume of solids

3. Infinite Series

introduction, definitions - convergence, divergence and oscillation of series, P-test, comparison test, ratio test, root test, higher ratio test, Raabe's test, log test, alternating series, Leibnitz's rule

4. Complex Numbers

definition, elementary operations, Argand's diagram, De Moivre's theorem & its applications to expand $\sin n\theta$, $\cos n\theta$ in powers of $\sin\theta$ & $\cos\theta$ respectively, to expand $\sin^n\theta$, $\cos^n\theta$ & $\sin^m\theta \cos^m\theta$ in a series of Sine or Cosine of θ, hyperbolic functions, formulae of hyperbolic functions, inverse hyperbolic functions, logarithm of complex quantities, separation of real & imaginary parts, summation of series by C + iS method

5. Laplace Transforms

introduction, definition, transform of elementary functions, properties of Laplace Transforms, inverse Laplace Transforms, note on partial fractions, transforms of derivatives, transforms of integrals, multiplication & division by t, convolution theorem

Text Book
Higher Engineering Mathematics by Dr. B. S. Grewal
Khanna Publishers, Delhi

Reference Books
1. Applied Mathematics for Engineers and Physicists by Pipes & Harvill McGraw Hill – Kogakusha Ltd.
2. Applied Mathematics by P. N. Waritkar & J. N. Wartikar

AF – 202 BASIC ELECTRONICS

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
3	1	2	60	40	25	25	150

1. Diode Theory
semiconductor theory, conduction in crystals, doping source, the unbiased diode, forward bias, reverse bias, linear devices, the diode graph, load lines, diode approximations, D. C. resistance of a diode

2. Diode Circuits
the Sine wave, the transformer, the half wave rectifier, the full wave rectifier, the bridge rectifier, the capacitor input filter

3. Special Purpose Diodes
the zener diode, the zener regulator, optoelectric devices

4. Bipolar Transistor
some basic ideas, forward-reverse bias, the CE connection, transistor characteristics, DC load lines, the transistor switch

5. Transistor Biasing Circuits
base bias, emitter – feedback bias, collector – feedback, voltage divide bias, emitter bias, moving ground around, PNP circuits

6. CE Amplifiers
coupling & bypass capacitors, the superposition theorem for amplifiers, AC resistance of the emitter diode, AC beta, the grounded emitter amplifier, the AC mode of a CE stage

7. CC & CB Amplifiers
the CC amplifier, the AC model of an emitter follower, types of coupling, direct coupling

8. Class A & B Power Amplifier
the AC load line of a CE amplifier, AC load lines of other amplifiers, class A operation

9. OP-AMP Circuits
non-inverting voltage amplifiers, the inverting voltage amplifiers, the summing amplifier, comparators

10. Oscillators and Timers
theory of sinusoidal oscillation, the Wean-bridge oscillator

11. Thyristors
the ideal latch, the four layer diode, the silicon controlled rectifier

12. Frequency Domain
the Fourier series, the spectrum of a signal.

13. Frequency Mixing
nonlinearity, medium signal operation with one sine wave, medium signal operation with two sine waves

14. Amplitude Modulation
basic idea, percent modulation, AM spectrum, the envelope detector, the Superhetrodyne receiver

15. Digital IC
number system, Boolean algebra, logic gates

Practical & Term Work
The practical & term work shall be based on the above syllabus.

Text Books

1. Electronic Principles (Third Edition) by Albert Paul Malvino
   Tata McGraw Hill Publications Co. Ltd., New Delhi
2. Basic Electrical, Electronics and Computer Engineering by R. Muthusubramaniam, S. Salivahanan, K.A. Muraleedharan
   Tata McGraw Hill Publications Co. Ltd., New Delhi

AX – 213 COMPUTER PROGRAMMING-II

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
2	1	2	60	40	25	25	150

1. Arrays:

Introduction and Initialization of two-dimensional arrays, Multidimensional arrays.

2. Handling of Character Strings:

Introduction, Declaring and initializing string variables, Reading strings form terminal, Writing strings on screen, Arithmetic operations on characters, Putting strings together, Comparison of strings, String handling functions, Table of strings.

3. User Defined Functions:

Introduction, Need for user defined functions, A multi-function program, Forms of C functions, Return values and their types, Calling a function, Category of functions, No arguments and no return values, Arguments and no return values, Arguments and return values, Handling of non-integer functions, Nesting of functions, Recursion, Functions with arrays, The scope and life time of variables in functions, Ansi C functions.

4. Structures and Unions:

Introduction, Structure definition, Giving values to members, Structure initialization, Comparison of structure variables, Arrays of structures, Arrays within structures, Structures within structures, structures and functions, Unions, Size of structures, Bit-fields.

5. Pointers:
Introduction, Understanding pointers, Accessing the address of a variable, Declaring and initializing pointer, Pointer expressions, Pointer increments and scale factor, Pointer and arrays, Pointer and character strings, Pointer and functions, Pointer and structures.

6. File Management in C:
Introduction, Defining and opening a file, Closing a file, Input/Output operations on files, Error handling during I/O operations, Random access to files, Command line arguments.

7. Dynamic Memory Allocation and Linked Lists:
Introduction, Dynamic memory allocation, Concepts of linked lists, Advantages of linked lists, Types of linked lists, Pointers revisited, Basic list operations, Application of linked lists.

8. The Preprocessors:
Introduction, Macro substitution, File inclusion, Compiler control directives, ANSI additions.

Practical & Term Work
The laboratory and term work will be based on above topics.

Text Book
Programming in ANCI C by E. Balagurusamy
2nd Edition, Tata McGraw-Hill Publishing Company Limited-New Delhi.

AF – 204 MECHANICS OF SOLIDS

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
3	1	2	60	40	25	25	150

1. Simple Stresses and Strains
introduction, stress, strain, tensile stress, compressive stress, shear stress, elastic limit, Hooke's law, Poisson's ratio, modulus of elasticity, modulus of rigidity, bulk modulus, bars of varying sections, extension of tapering rods, bars

of uniform strength, temperature stresses, Hoop's stress, stress on oblique sections, stat of simple shear, relation between elastic constants

2. Mechanical Properties of Materials
ductility, brittleness, toughness, malleability, behaviour of ferrous and non-ferrous metals in tension & compression, shear and bending tests, standard test pieces, influence of various parameters on test results, true and nominal stress, modes of failure, characteristic stress-strain curves, strain hardening, hardness, different methods of measurement – Izod impact test, Charpy impact test & tension impact test, fatigue, creep, correlation between different mechanical properties, effect of temperature, Testing machines and special features, different types of extensometers & compressometers, measurement of strain by electrical resistance strain gauges

3. Bending Moment and Shear Force
bending moment, shear force in statically determinate beams subjected to uniformly distributed, concentrated & varying loads, relation between bending moment, shear force & rate of loading

4. Moment of Inertia
concept of moment of inertia, moment of inertia of plane areas, polar moment of inertia, radius of gyration of an area, parallel axis theorem, moment of inertia of composite areas, product of inertia, principle axes and principle moments of inertia

5. Stresses in Beams
theory of simple bending, bending stresses, moment of resistance, modulus of section, built up & composite sections, beams of uniform strength, distribution shear stress in different sections

6. Torsion
torsion of circular solid & hollow section shafts, shear stress, angle of twist, torsional moment of resistance, power transmitted by shaft, keys & couplings, combined bending & torsion, close coiled helical springs

7. Principle Stresses and Strains
compound stresses, principle planes & principle stresses, Mohr's circle of stress, principle strains, angle of obliquity of resultant stresses, principle stresses in beams, principle stresses in shafts subjected to bending, torsion & axial force

Term Work

1. Experiments based on theory
2. Problems based on theory

Text Book

1. Strength of Materials by Timoshenko Vol. 1 & 2
2. Strength of Materials by Popov
3. Mechanics of Structure by Junarkar S. B.
4. Strength of Materials by S. Ramamrutham

AF – 215 HEAT POWER

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
3	1	2	60	40	25	25	150

1. Properties of Steam

distinction between gas & vapour, sensible heat, latent heat, total heat & super heat of steam, conditions of steam, dryness fraction, methods of determination of dryness fraction, internal energy of steam, specific volume, critical pressure & temperature

2. Fuels

solid, liquid & gaseous fuels used for boilers and I.C. engines, combustion of fuel, air required, products of combustion of fuel, analysis of flue gases, calorific value of fuel & its determination

3. Boilers

classification of boilers, Cochran and Babcock & Wilcox boilers, boiler mountings and accessories, draught – natural & artificial

4. Properties of Gases

zeroth, first & second laws of thermodynamics, laws of perfect gases, Boyle's law, Charle's law, Regnault's law, Joule's law. Characteristic equation, gas constant, internal energy, specific heat at constant pressure & at constant volume, relation between specific heats, thermodynamic processes of perfect gases

5. I. C. Engine

prime-movers, classification of prime-movers with examples of each class, advantages of I. C. engines over E. C. engines, classification of I. C. engines, thermodynamics air cycles, - Carnot cycle, constant volume Otto cycle, constant pressure Joule cycle & Diesel cycle, air-standard efficiency, construction & working of two stroke & four stroke cycle engines, P-V diagram, determination of indicated power & brake power, mechanical fuel supply in I. C. engines, ignition systems of I. C. engines, cooling of I. C. engines, lubrication of I. C. engines, governing of I. C. engines

6. Solar Energy

introduction, solar energy systems.

Practical & Term Work

The practical & term work shall be based on the above syllabus.

Text Book

Elements of Heat Engines (SI Units) Vol. – I by R. C. Patel & C. J. Karamchandani
Acharya Book Dept, Baroda
OR
Elements of Heat Engines (SI Units) by N. C. Pandya & C. S. Shah
Charotar Publishing House, Anand.

Reference Book

1. Heat Engine by P. L. Ballaney
2. A Course in Thermodynamics & Heat Engines by Kothandaraman

AF – 206 WORK SHOP – II

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
		3				50	50

1. Instructions

introduction to fitting shop tools, taps, dies, drills, drilling machines, welding process, welding equipment for arc welding, forging tools, forging, bending, upsetting, drawing, adhesive bonding

2. Demonstrations

demonstration of general operation of drilling turning & shaping

Term Work

Each candidate shall submit the following term work

i. filing and fitting practice 1 job
ii. simple welding of joint 1 job
iii. forging practice 1 job
iv. wooden utility job with adhesive bonding 1 job
v. PCB making 1 job

SEMESTER – III (CH)

AF – 301 MATHEMATICS – III

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-		60	40			100

1. Fourier Series

Euler's formula, conditions for Fourier expansion, functions having points of discontinuity, change of interval, odd & even functions, expansion of odd & even periodic functions, half range series, practical harmonic analysis

2. Integral Transforms

definition, Fourier integral, Fourier sine & cosine integrals, complex form of Fourier integral, Fourier transform, Fourier sine & cosine transforms, finite Fourier sine & cosine transform, Fourier transform of the derivative of a function, inverse Laplace transform by method of residues, application of transforms to boundary value problems

3. Matrices

fundamental concepts, operations, associated matrices, matrix method of solution of simultaneous equations, rank of matrix, linear dependence of vectors, consistency of a system of linear equations, characteristic equation, Eigen vectors & Eigen roots, Cayley – Hamilton theorem, reduction of quadratic form to canonical form

4. Ordinary Differential Equations

linear differential equations – definition, rules for finding complementary function, rules for finding the particular integral , working procedure, Cauchy's & Legendre's linear equation, simultaneous linear equations with constant coefficients,application of linear differential equation to simple harmonic motion, oscillation of a spring, simple pendulum, oscillatory electrical circuits, electro-mechanical analogy, deflection of beam, whirling of shafts, application to simultaneous equations, series solution of differential equations of the second order with variable coefficients & special functions

5. Partial Differential Equations

introduction, formation, solution of a partial differential equation solvable by direct integration, linear equation of first order, non-linear equations of first order – Charpit's method, homogenous linear equations with constant coefficient, homogeneous linear equations with constant coefficients by finding complimentary function & particular integral, nonhomogeneous linear

equations with constant coefficients, solution of non-linear equation of second order by Monge's method, applications of partial differential equation- method of separation of variables, vibrating string problem, heat flow, etc.

6. Laplace Transforms

application to differential equations, simultaneous linear equation with constant coefficients

Text Book

Higher Engineering Mathematics by Dr. B. S. Grewal

Reference Book

1. A Text Book of Applied Mathematics by P. N. Wartikar & J. N. Wartikar
2. Mathematics for Engineering by Chandrika Prasad
3. A Text Book of Engineering Mathematics by Dr. K. N. Srivastva & G. K. Dhawan

CH – 302 GENERAL CHEMICAL TECHNOLOGY -I

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-		60	40			100

1. Water and water treatment

Industrial use of water, demineralisation, deionisation, RO system, water treatment , concept of water resources management

2. Fuels & Energy

Classification of fuel, Water gas, Producer Gas, Coke oven gas, coal & coal chemicals, coking of coal, various types of coal gasifiers, concept of energy conservation

3. Chlor-Alkali Industry

Manufacture of soda ash by solvay and modified solvay process, Electrolytic process for caustic soda, different types of cell, manufacturing of chlorine and hydrogen, hydrochloric acid, common salt by vacuum evaporation process

4. Cement & Glass Manufacturing

Lime stone beneficiation and Manufacturing of cement , types of cement, manufacturing of glass, types of glass

5. Sulphuric Acid Manufacturing

Manufacturing of elemental sulfer by Frasch process, Single and double Absorption process for manufacturing of sulfuric acid

6. Electrolytic Manufacturing of Aluminium & Magnesium

Purification of alumina from bauxite using Bayer process, Manufacturing of magnesium.

7. Pulp & Paper Manufacturing

Kraft process and sulfite process for manufacturing of pulp, chemical recovery system, types of paper, paper manufacturing process

8. Sugar & Starch Industry

Manufacturing of sugar, starch, and dextrin

9. Oils, Fats, Soaps & Detergents

Vegetable oil Extraction method using Mechanical and Solvent extraction process , hydrogenation of oil, cleaning mechanism of soaps and detergents, manufacturing of soaps and glycerin, manufacturing of detergents

10. Fertilizer Industry

Nitrogenous Fertilizers : Introduction to fertilizers, synthesis gas, Manufacturing of ammonia, Manufacturing of nitric acid, urea, ammonium nitrate & ammonium sulphate

Phosphatic Fertilizers : Production of elemental phosphorus, manufacture of phosphoric acid by wet process and electric furnace process, single & triple super phosphate, Ammonium phosphate
Mixed Fertilizers: compositions & constituents, granulation, controlled release fertilizers

Text book:

Shreve's Chemical Process Industries, 5th Ed. By, George F. Austin
McGraw Hill International Edition

Reference Books

Chemical Process Industries, 4th Ed. by R. Norris Shreve & J. A. Brink, Jr.
International Student's Edition

Pollution Control in Chemical Process Industries, 1st Ed. By S. P. Mahajan
Tata McGraw Hill Publications, New Delhi

Dryden's Outlines of Chemical Technology, 2nd Ed. By M. Gopala Rao &
Marshall Sitting, East West Press Pvt. Ltd., New Delhi
Tata McGraw Hill Publications, New Delhi

Dryden's Outlines of Chemical Technology, 2nd Ed. By M. Gopala Rao &
Marshall Sitting, East West Press Pvt. Ltd., New Delhi

CH – 305 THEORY OF MACHINES & MACHINE DESIGN

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (4 hrs.)	SES (1.5 hr.)	PR	TW	TOTAL
4	-	3	60	40		50	150

Theory of Machines (40% weightage)

1. Cam

types of cam, types of followers, nomenclature of cam mechanism, types of motions of follower – uniform velocity, simple harmonic, uniform equal acceleration & retardation, design of cam profile, applications of cam

2. Friction

screw friction, bearing friction in – journal bearing, flat pivot thrust bearing, collar pivot thrust bearing & conical pivot thrust bearing, friction clutches – plate or disc clutches & cone clutches, ball & roller bearing

3. Belt Drive

types of flat belt drive, velocity ratio of simple & compound belt drive, slip and creep of belt, length of belt, power transmitted by belt, ratio of driving tension for flat belt drive, centrifugal tension, condition for transmission of maximum power, V-belt drive, advantages & disadvantages of V-belt drive, ratio of driving tension for V-belt drive

4. Toothed Gearing

nomenclature & classification of toothed gears, types of gear trains – simple & compound, reverted & epicyclical spur gear trains

5. Brakes

types of brakes – simple block or shoe brake & band brake

Machine Design (60% weightage)

1. Design of Operational Joints

cotter joints, sleeve type cotter joint, gib & cotter joint, knuckle joints, pinned joints, threaded fasteners, design load for fasteners, turn buckle, bolt of uniform strength

2. Welded Connections
types of welded joints, weld symbols, strength & design of welds, direct loading, asymmetric loading, designation and representation, design procedure

3. Pressure Vessels & Pipes
classification of pressure vessels, stresses in thin cylinder due to internal pressure, circumferential stresses, longitudinal stresses, thin spherical shells, thick cylinders, thickness of cylinder heads & cover plates, design of pipes, pipe joints, design of circular flanged pipe joints, design of oval flanged pipe joints, design of square flanged pipe joints, standard pipe flanges, hydraulic pipe joint for high pressure

4. Shafts, Keys & Couplings
design of shafts on basis of strength & rigidity, shaft subjected - to torque, bending moment & combined bending moment & torque, types of keys, design of shank key, design of shear pins, design of shaft coupling, design of flange coupling, design of bush pin type flexible coupling

5. Levers
types of levers, design of levers – hand lever, foot lever, bell crank lever & lever of safety valve

6. Design of Springs
types of springs, materials, allowable working stress, design of closely coiled spring subjected to axial load

7. Belt & Pulley Drive
design of belt & pulley drive

8. Eccentric Loading
eccentric loading on rivets & bolts

9. Columns & Struts
types of end conditions of column, slenderness ratio, Euler's formula, Rankine's formula, design of simple column, design of piston rod & connecting rod

Practical & Term Work

The term work shall be based on the above syllabus which involves designing & preparation of detailed drawings.

Text Book

1. Theory of Machines by R. S. Khurmi & J. K. Gupta
2. Machine Design by R. S. Khurmi & J. K. Gupta

Reference Book

1. Theory of Machines by P. L. Ballaney
2. Theory of Machines by N. C. Pandya & C. S. Shah
3. Thenical Dynamics by L. B. Shah, R. C. Patel & B. M. Patel
4. Machine Design Vol. 1 by R. C. Patel, A. D. Pandya, H. J. Rajput & S. S. Shikh

CH – 311 INTRODUCTION TO CHEMICAL ENGINEERING

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	1	2	60	40	25	25	150

1. Introduction (5):
About the discipline of chemical engineering, concept of unit operations and unit processes, symbols as per Indian Standards, operations in batch, semi-batch and continuous mode, flow pattern in counter-current, co-current and cross-current fashion, systematic analysis to chemical process by flowsheet reading, drawing of PBD and PFD and overview of P&ID.

2. Overview Chemical Process Industry and Role of Chemical Engineer (3):
Satisfactory definition of CPI/GCT, important chemical process industries, its typical raw materials, products and end usages. role of chemical engineer in various aspects such as research, process development, process design & evaluation, plant design, construction (EPC firms), process supervision, plant technical service, product sales, general aspects of chemical engineering such as communication, human relations, professional activities & technical reading.

3. Useful Mathematical Methods (7):
Presentation & correlation of data, curve fitting using graphical method and method of least squares, graphical addition & subtraction (inverse lever arm rule), graphical and numerical methods for integration, differentiation and to find the root of an equation, trial & error solution, mean values, Lagrangian method of interpolation, dimensions, units and conversion of units, dimensional analysis by Buckingham method and Rayleigh's method.

4. Physical and Chemical Principles (7):
Process variables – temperature, pressure, density, composition & flow rate, physical states, phase equilibria, fundamentals of reaction rates, illustrative problems on the listed topics

5. Mass Balance (7):
Overall mass balance, material balance without chemical reactions and with chemical reactions, basic concept of by-pass, recycle, purge and differential mass balances.Concept of yield, conversion and selectivity.

6. Energy Balance (7):
Various forms of energy, flow process and non-flow process, state and path function, total energy balance, energy balance in non-flow systems, illustrative problems on the listed topics

Practical & Term Work

- Manual calculation of chemical engineering problems with application of appropriate mathematical method.
- Writing codes in C- Language to solve above listed problems.
- Validation of the same using MS Excel (graphical as well as numerical problems)

Text Books:

1. Introduction to Chemical Engineering by L. B. Andersen & L. A. Wenzel

McGraw – Hill Book Company, 1961.

2. Basic Principles & Calculations in Chemical Engineering by D.M.Himmelblau

Pretice Hall (India)

3. Introduction to Chemical Engineering by Salil K Ghosal, Siddhartha Datta, Shyamal K Sanyal, Tata McGraw - Hill Education, 2004.

Reference Books:

1. Introduction to Chemical Engineering by E. V. Thompson & W. H. Cekler McGraw – Hill Kogakusha Company Ltd.
2. Introduction to Chemical Engineering by Walter L Badger and Julius T Banchero, McGraw – Hill Book Company Ltd, 1955.

CH – 306 CHEMISTRY – I

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
3	-	3	60	40	25	25	150

1. Physical Properties & Chemical Constitution

additive & constitutive properties, molar volume, surface tension & parachor, viscosity, refractivity & molar refractivity, dipole moments, spectroscopy - the visible & invisible spectrum, spectrum analysis, different types of spectra

2. Phase Equilibria

definition, statement of phase rule,, application to one & two component system, distribution law, Henry's law, critical solution temperature, solvent extraction, phase rule & applications

3. Chemical Kinetics

rate of a reaction, rate constant, order & molecularity, first & second order reaction, determination of order of reaction, theories of reaction rates, effect of temperature

4. Photochemistry

Lambert & Bear's law, law of photochemistry, quantum yield, high & low quantum yield, method of determination of quantum efficiency, types of photochemical reaction, luminescence

5. Surface Chemistry and Colloids

absorption & adsorption, Freundlich adsorption isotherms, Langmuir adsorption isotherms, partition & adsorption, chromatography, classification of colloids, preparation of colloids, purification of colloids, properties of colloids, industrial application of colloidal chemistry, emulsions & gels, catalysis, types of catalysis, theory of catalysis

6. Thermodynamics

first & second law of thermodynamics, spontaneous process, entropy, efficiency of reversible cycle, free energy & maximum work, Clapeyron equation, Clausius – Clapeyron equation, Gibb's – Helmholtz equation, Van't hoff isotherm & iscochore, thermo chemistry – heat of reaction, heat of

combustion, heat of formation, heat of neutralisation, Hess's law of constant heat summation, heat of reaction at constant volume & at constant pressure

7. Acids & Bases

modern concept of acids & bases, hydrolysis, relative strength of acids &bases, theory of indicator

Practical & Term Work

Experiments based on theory are performed in the laboratory class

Text Book

1. Essentials of Physical Chemistry by B. S. Bhal & G. D. Tuli
   S. Chand & Co., New Delhi
2. Elements of physical Chemistry by S. Glassstone
   Macmillan & Co. Ltd., London

CH – 307 CHEMISTRY – II

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
3	-	3	60	40	25	25	150

1. Purification of Organic Compounds

by crystalisation, fractional crystalisation, sublimation & different types of distillation.

2. Detection & Estimation of Elements

detection of elements (C, H, N, S, P & halogens), estimation of elements (C, H, S, P & halogens) by combustion estimation of nitrogen by Dumas method & Kjeldahl's method, Carius method, chemical reactions involved in the methods of detection & determination of elements

3. Nomenclature of Organic Compounds

IUPAC nomenclature of organic compounds including heterocyclic & alicyclic compounds.

4. Stereochemistry

isomerism – structural & stereoisomerism, optical isomers of lactic acid & tartaric acid, geometrical isomerism

5. Organic Reactions
general nature of Organic reactions – substitution, addition, elimination, rearrangement, nucleophilic & electrophillic reactions with their mechanism

6. Aliphatic Compounds
general methods of preparation & important chemical properties, general methods of preparation & important chemical properties with their uses of the following compounds – chloroform, carbon tetrachloride, iodoform, ethanol, ethylene glycol, glycerine, formaldehyde, acetaldehyde, acetone, lactic acid, oxalic acid, citric acid, succinic acid, diethyl ether, acetoacetic ether, malonic ester

7. Organometallic Compounds
preparation & industrial uses of organolead compounds, organozinc compounds, organolithium compounds, organomagnesium compounds

8. Aromatic Compounds
general nature of aromatic reaction with their mechanism, halogenation, sulphonation, nitration, alkylation, acylation & addition reaction

9. Arylhalides
study of chlorobenzene, bromobenzene, benzylchloride, D.D.T & B.H.C

10. Amines & Amino Compounds
study of aniline, acetanilide, sulphanilic acid, aulphanilamide, diphenylamine, dimethylamine, distinguishing tests for different amines

11. Phenols & Aromatic Alcohols
preparation & important chemical properties of phenol, catechol, resorcinol, quinol & phloroglucinol

12. Aromatic Aldehydes & Ketones
study of benzaldehyde, salicylaldehyde, cinnamaldehyde, acetophenone & benzophenone

13. Aromatic Acids
study of benzoic acid, salicylic acid, pthalic acid, cinnamic acid

Note:

1. Study term include discussion of important methods of preparation & chemical properties with industrial & commercial uses.

Practical & Term Work
Practical – Laboratory experiments may be given relating to theory as:

i. Quantitative analysis of organic compounds
ii. Preparation of nitrobenzene, m-dinitrobenzene, acetanilide, sulphonic acid, saccharine, phenol & its derivatives, aniline, diazo derivatives, etc
iii. Purification of impure organic solids & liquids
iv. Measurement of melting & boiling points

Text Book

1. A Text Book of Organic chemistry by P. L. Soni
2. Advance Organic Chemistry by Fischer & Fischer
3. Advance Organic Chemistry by Robert & Cassero

SEMESTER – IV

AF – 401 MATHEMATICS – IV

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-		60	40			100

1. Functions of Complex Variables

analytic functions, Cauchy – Reimann equations, harmonic functions, orthogonal system, complex potential, determination of conjugate function, conformal transformation, some standard transformations – translation, magnification & rotation, inversion & reflection & bilinear tansformations, line integral, properties of complex integration, Cauchy's theorem, Cauchy's integral formula

2. Numerical Methods

solution of algebraic and transcendental equations by Newton – Raphson method, direct iteration method & false position method, solution of linear simultaneous equations by Gauss elimination method, Gauss – Jordan method & Gauss – Siedel, numerical methods to solve first order & first degree ordinary differential equations by Picard's method, Taylor's series method, modified Euler's method, Milne's method, Runge's method, Runge – Kutta method

3. Finite Differences & Difference Equations

finite diffrence, interpolation, Newton's forward, backward & central difference, Lagrange's formula, Stirling & Bessel's formula, numerical differentiation, numerical integration – trapezoidal rule, Simpson's rules, difference equations with constant coefficient, Z-transform

4. Vector Calculus

vector function of a single scalar variable, differentiation of vectors, simple applications to plane, motion, scalar & vector point functions, del applied to scalar point function (gradient), divergence of a vector point function, curl of a vector, second order expressions, line integrals, surface integrals, Gauss theorem, Stoke's theorem

5. Statistical Methods

binomial distribution, Poisson's distribution, normal distribution, calculation of errors, probable errors, standard error, coefficient of correlation, lines of regression

Text Book
Higher Engineering Mathematics by Dr. B. S. Grewal

Reference Book
1. A Text Book of Applied Mathematics by P. N. Wartikar & J. N. Wartikar
2. Mathematics for Engineering by Chandrika Prasad
3. A Text Book of Engineering Mathematics by Dr. K. N. Srivastva & G. K. Dhawan

CH – 404 CHEMISTRY – III

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
3	-	3	60	40	25	25	150

1. Inorganic
general metallurgy, chemistry of the following metals beryllium, lithium, thorium, tungsten, uranium, molybdenum, rare earth metals

2. Electrochemistry
r\theory of electrolytic dissociation, Arrhenius theory, buffer solution, buffer capacity, theory of ionic interaction, activity & activity coefficient, Debye – Huckel model of electrolytic solution.

3. Electrical Conductance
specific & equivalent conductance its measurement & applications, Kohlrausch's law, transport number & its determination, Debye – Onsager theory, thermodynamic expression for equilibrium electrode potential, classification of electrodes, types of electrochemical systems (electrochemical cells), Faraday's laws, current efficiency, types of over potential & hydrogen over voltage, instrumental analytical techniques – potentiometry, pH-metry, conductometry, voltametry, polarography, colorimetry, spectrophotometry,

flame photometry, nephelometry & turbidimetry, principles & applications of thermogravimetry, differential thermal analysis

Practical & Term Work

Experiments based on topics 2 & 3.

Text Book

1. Text book of Inorganic Chemistry by P. L. Soni
   S. Chand & Sons
2. Theoretical Electrochemistry by L. Antropov
   Mir Publishers
3. Instrumental Method of Analysis by Willard, Merritt & Dean
   EWP
4. Instrumental Method of Analysis by B. K. Sharma

CH – 415 CHEMISTRY – IV

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
3	-	3	60	40	25	25	150

1. Naphthalene & its Derivatives
nomenclature and isomerism of naphthalene & its derivatives, manufacture of naphthalene, chemical properties – orientation, derivatives of naphthalene, nitro, halo, sulphonic acid, naphthalamines, naphthols & naphthaquinones

2. Anthracene & its Derivatives
nomenclature & isomerism of anthracene & its derivatives, preparation of anthracene, properties of anthracene, uses of anthracene, structure of anthracene, derivatives of anthracene – anthraquinone, alizarin, phenanthrene

3. Aromatic Heterocyclic Compounds
introduction, furan, furfural, thiophene, pyrrole, pyridine

4. Carbohydrates
introduction, classification, glucose, constitution of glucose, reactions of glucose, mutarotation, fructose, constitution of fructose, reactions of fructose, some typical conversions in monosaccharides, disaccharides, sucrose, manufacturing of sucrose, properties & uses of sucrose, starch & cellulose

5. Proteins
introduction, composition of proteins, classification of proteins according to composition & functions, isolation of proteins, general characteristics of proteins, physical characteristics of proteins, analytical tests, properties & uses of proteins

6. Alkaloids
introduction, occurrence & extraction of alkaloids, general properties, determination of chemical constitution of alkaloids, Hofmann exhaustive methylation, some individual members – coniine, piperine & nicotine

7. Synthetic Drugs

introduction, chemotherapy, sulpha drugs – sulphappyridine, sulphathiazole, sulphadizine, sulphanilamide, mode of action of sulpha drugs, chemotherapy in malaria, antimalarial drugs, synthetic antimalarial drugs, aminoacridine, 4-aminoquinol, mode of action, derivatives of 8-aminoquinolines, antipyretics & analgesics, tranquillizers, sedatives, antidepressants, anaesthetics

8. Polymers

introduction, classification of polymers, types of polymerisation reactions, the process of addition polymerisation, free radical polymerisation, chain transfer agents, ionic polymerisation, thermoplastic & thermosetting plastics, plasticizers, classification of resins & plastics, synthetic & natural rubbers – polychloroprene, buna-S and buna-N

9. Colour & Dyes

colour sensation, dyes & dyeing, colour & constitution, chromophore – auxochrome theory, chromogen, valence bond theory of colour, classification of dyes, direct dies, mordant dyes, vat dyes, classification based on chemical structure, nitro & nitroso dyes, triphenyl dyes

10. Oils, Fats & Waxes

occurrence, classification of oils, chemical properties, soaps, detergents

Practical & Term Work

Experiments involving estimation of various inorganic & organic elements

Text Book

1. A Text Book of Organic Chemistry by P. L. Soni
   S. Chand & Co., New Delhi
2. Synthetic Organic Chemistry by O. P. Agarwal
3. Natural Products Vol. 1 by O. P. Agarwal

CH – 411 ENERGY TECHNOLOGY

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-		60	40			100

1. An Introduction to Energy Sources

energy sources (conventional & non-conventional), renewable energy resources, primary & secondary energy sources, energy chain, energy demand, national energy strategy & plan, energy management, energy audit & conservation

2. Definitions, Units & Measures

proximate & ultimate analysis, calorific values, rank of coal, coking & caking, gasification, basis for reporting results of analysis, units & conversion factors

3. Solid Fuels

wood & charcoal, peat, lignite, sub-bituminous & bituminous coals, semi-anthracite and anthracite coals, cannel & boghead coal, origin of coal, composition of coal, analysis & properties of coal, problems

4. Processing of Solid Fuels

coal preparation, washability curve, dry & wet washing methods of coal, washer efficiency, gasification & liquefaction of solid fuels, problems

5. Solar Energy

solar constant, solar radiation & related terms, measurement of solar radiation, solar energy collectors – flat plate collector, air collector, collectors with porous absorbers, concentrating collectors, applications & advantages of various collectors, selective absorber coatings, solar energy storage systems (thermal, electrical, chemical & mechanical), solar pond, applications of solar energy

6. Wind Energy

basic principles, power in wind, force on blades & turbines, wind energy conversion, site selection, basic components of wind energy conversion systems (WECS), classification of WECS, wind energy collectors, applications of wind energy

7. Energy from Biomass
introduction, energy plantation, biomass conversion technologies, photosynthesis, biogas generation, factors affecting biogas generation, classification of biogas plants & their comparisons, types of biogas plants (including those used in India), biogas from plant wastes, community plants & site selection, digester design considerations, design calculations, methods of maintaining & starting biogas plants, properties & utilisation of biogas, thermal gasification of biomass, pyrolysis, alternative liquid fuels

8. Geothermal Energy
geothermal resources, hydrothermal resources, liquid dominated systems, geopressured resources, petrothermal systems, magma resources, energy conservation & comparison with other resources, applications of geothermal energy

9. Energy from Oceans
OTEC, methods (open cycle & close cycle) energy from tides, components of tidal power plants, operation, methods of utilisation of tidal energy, storage, ocean waves, wave energy conversion devices

10. Fuel Cell
introduction, hydrogen – oxygen fuel cell, ion exchange membrane cell, fossil fuel cell, molten carbonate cell, advantages & disadvantages, conversion efficiency, polarisation, type of electrodes, applications of fuel cells

11. Hydrogen & Methanol
properties of Hydrogen, production of hydrogen, thermochemical methods, fossil fuel methods, solar methods, storage & transportation, safety & management

12. Magneto Hydro-Dynamic (MHD) Power Generation
principle, MHD system, open cycle system, closed cycle system, design problems & developments, advantages, materials for MHD generators, magnetic field & super conductivity

13. Nuclear Energy
fission, fusion, fuel for nuclear fission reactor (exploration, mining, milling, concentrating, refining, enrichment, fuel fabrication, fuel use, reprocessing, waste disposal), storage & transportation, fast & slow neutrons, multiplication factors & reactor control, uranium enrichment process, nuclear reactor power

plant, fast breeder reactor, boiling water reactor, pressurised heavy & light water reactor

Text Book

1. Energy Sources 2nd Ed. by G. D. Rai
   Khanna Publications, New Delhi
2. Fuels & combustion by Samir Sarkar
   Orient Longmans(1974)
3. Solar Energy by Sukatame
   Tata McGraw Hill, New Delhi
4. Energy Technology by Rao & Parulaker

CH – 414 GENERAL CHEMICAL TECHNOLOGY – II

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	3	60	40	25	25	150

1. Petroleum Refining

Origin, formation and composition of petroleum, Petroleum reservoirs in India and World, Evaluation of petroleum, thermal properties of petroleum fractions, Important products-properties and test methods, Dehydration and desalting of crudes, Distillation of petroleum, Fractions-impurities, Gasoline Treatment, Treatment of Kerosene, Treatment of Lubes, Wax and purification,Thermal and Catalytic cracking, Catalytic reforming, Naphtha cracking, Coking, Hydrogen processes, Alkylation

2. Petrochemical Industry

C_1 Chemicals: Manufacturing of methanol, formaldehyde and chloromethanes

C_2 Chemicals: Manufacturing of ethylene, ethylene oxide, ethylene dichloride , vinyl chloride, ethanolamines, Acetaldehyde and vinyl acetate

C_3 Chemicals: manufacturing of isopropanol, Acetone, Isopropyl benzene (Cumene), Acrylonitrile, Isoprene

C_4 Chemicals: Manufacturing of Butanol, Butadiene

BTXN chemicals: Manufacturing of phenol by cumene process and Raschig process, Styrene, Phthalic Anhydride, Maleic Anhydride, aniline, Dimethyl terephthalate

3. Polymer Industries

Polymerisation fundamentals, manufacture of phenol & urea formaldehyde resins, manufacture of PVC, polyethylene, polypropylene, etc, manufacture of synthetic rubber

4. Synthetic Fibre Industries

Nylon, polyester, acrylic, etc.

5. Fine Chemicals & Drugs

classification of drugs, manufacture of important drugs and pharmaceuticals – salicylic acid, methyl salicylate, penicillin , aspirin, & antibiotics

6. Dyes and its intermediates

Classification of dyes, azo dyes, reactive dyes, disperse dyes

7. Fermentation Industry

Importance of Biochemical Engineering in Chemical process industries, Fundamentals, micro organisms, strains, culture, ethanol, etc.

Practical & Term Work

Experiments to determine pour point, flash point, etc, estimation of ammonia, carbonate etc., in given compounds, estimation of casein present in milk etc.

Text Books

1. Modern Petroleum Refining processes, 3 rd Ed., B.K.Bhaskara Rao, Oxford Publishers, New Delhi
2. A text on petrochemicals, 4th Ed., B.K.Bhaskara Rao Khanna Publications, New Delhi
3. Shreve's Chemical Process Industries, 5th Ed. By, George F. Austin

CT – 415 YOGA & MEDITATION

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (1.5 hrs.)	SES (1 hr.)	PR	TW	TOTAL
1	-	1	50			50	100

Training in Yogic Asanas, Pranayams & Mudras

1. Basics

kapalbhati pranayam, anulom vilom pranayam, omkar pranayam, bhramari pranayam, body rotation, shavasan, suryanamaskar

2. Asanas for Meditation

padmasan, swastikas an, sidhbhasan, bhadrasan, vajrasan, sukhasan, mararasa, sevasan

3. Asanas to be Performed in Standing Position

trikonasan, parvatasan, utkatukasan

4. Asanas to be Performed while in Supine Position

sarvangasan, halasan, savasan, kosthavishramasan, matshendrasan, suptavajraasan

5. Asans to be Performed Lying in Prone Position

uttanapadasan, uttanadhadasan, sarpasan, bhujasan, salabhasan, dhanurasan, makarasan

6. Asanas to be Performed in Sitting Position

pavanmuktasan, hastapadasan, vajrasan, ardhamatshyendrasan, shishiasan, saptamudrasan, gomukhasan

7. Yoga Mudras (Seven Types)

8. Pranayam (Seven Types)

9. Rajyog Meditation – Theory & Practice

the true concept of yoga, science of consciousness & dynamics of mind, philosophical basis of yoga, concept of god & true secularism, principles of spiritual science, stages of yoga, practical meditation & yoga practice

10. Moral, Ethical & Spiritual Dimensions in Development of Inner Personality
the concept of holistic health & its various dimensions, addictions, cures & remedies to get rid of addiction, stress management & relaxation technique, how to get rid of examination fear, world religions, scriptures & the common extracts from them.

Term Work
Practice of asanas, pranayam & meditation

SEMESTER – V (CH)

CH – 501 FLUID FLOW OPERATIONS

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	3	60	40	25	25	150

1. Fluid Properties & Dimensional Analysis

definition of a fluid, types of fluids, perfect or ideal fluid, properties of fluids – viscosity, density, specific volume, specific weigh, specific gravity, pressure, bulk modulus of elasticity, vapour pressure & surface tension, systems of unit, dimensional analysis & its applications to fluid flow problems

2. Fluid Statics & its Applications

pressure concept & types of pressure, hydrostatic equilibrium & its applications – barometric equation, hydrostatic equilibrium in a centrifugal field, design of continuous gravity decanter & continuous centrifugal decanters, pressure measuring devices – static pressure & its measurement, types of manometers – open U tube & open gauge type, the differential U tube, closed U tube, mercury barometer, tube size estimation of manometers, multiplying gauges, change of manometric fluids, inclined U tube, draft gauge & two fluid U tube, mechanical pressure gauges – bourdon tube gauge, diaphragm gauge, pressure signal transmission – the differential pressure cell

3. Fluid Flow Phenomena

types of flow – potential flow, steady flow, one dimensional flow, laminar flow & turbulent flow, Reynolds number, transition from laminar to turbulent flow, Reynolds number for non-Newtonian fluids, nature of turbulence, eddy viscosity & eddy diffusivity of momentum, flow in boundary layers, laminar & turbulent flow in boundary layer, calculation of boundary layer thickness & friction factor in streamline portion of boundary layer, turbulent portion of boundary layer, laminar sub layer portion of boundary layer, boundary layer formation in straight tubes, transition length for laminar & turbulent flow, boundary layer separation & wake formation

4. Basic Equations of Fluid Flow

continuity equation, average velocity, mass velocity, momentum balance, momentum correction factor, momentum balance in potential flow – Bernoulli

equation without friction, mechanical energy equation, kinetic energy & its correction factor, Bernoulli equation with friction & pump work.

5. Friction in Pipes & Channels
shear stress distribution in fluid, resistance to flow in pipes, friction factor charts, calculation of pressure drop along a pipe, roughness of pipe surface, velocity distribution for streamline flow for pipes of circular cross section, volumetric flow rates & average velocity calculations, kinetic energy of fluid, flow between tow parallel plates, flow through an annulus, velocity distribution for turbulent flow – flow in non circular ducts, flow through curved pipes, miscellaneous friction loses for incompressible fluids – sudden enlargement, sudden contraction, pipe fittings & flow over banks of tubes, flow in open channels – uniform flow

6. Flow of Compressible Fluids & Two Phase Flow
continuity equation, total energy balance, mechanical energy balance, velocity of sound, ideal gas equations, acoustic velocity & Mach number of ideal gas, stagnation temperature, process of incompressible flow – flow through variable area conduits (i.e. converging – diverging nozzle), equations for isentropic flow, change in gas properties during flow, velocity in nozzle, effect of cross section area in nozzle flow, adiabatic frictional flow – friction parameter, equation for adiabatic frictional flow, property equations, maximum conduit length & mass velocity, isothermal frictional flow, heat transfer in isothermal, two phase flow – flow pattern, hold up, pressure, momentum & energy relations & erosion

7. Flow Past Immersed Bodies
drag, drag coefficient, stagnation point, stagnation pressure, friction in flow through beds of solids, motion of particles through fluids – mechanics of particle motion, types of settling, fluidisation, conditions for fluidisation, minimum fluidisation velocity & types of fluidisation

8. Fluid Flow Measurement
pitot tube, orifice meter, nozzle, venturimeter, pressure recovery in orifice type meter, variable area meters- rota meter, notches & weirs, other methods of measuring flow rates – hot wire anemometer, magnetic meter, quantity meter & liquid meters

9. Pumping of Fluids
pumping equipment for liquids – reciprocating pumps, positive displacement rotary pumps, centrifugal pumps, use of compressed air for pumping air lift

pumps, pumping equipment for gases – reciprocating compressor, rotary blowers & compressors, centrifugal blowers & compressors including turbo compressor, vacuum producing equipment, power required for compression of gases – clearance volume, multistage compressors, compressor efficiencies, power required for pumping through pipelines, types of turbines

10. Agitation & Mixing of Liquids

agitation of liquids – purpose of agitation, agitation equipment, impellers, flow patterns in agitated vessels, standard turbine design, circulation velocities & power consumption in agitated vessels, blending & mixing – mixing of miscible liquids, suspension of solid particles, blending of miscible liquids, motionless mixers, mixer selection, scale up of agitator design, dispersion operations – characteristics of dispersed phase, mean diameter, gas dispersion – bubble diameter, gas dispersion in agitated vessels, gas handling capacity & loading of turbine impellers, power input to turbine dispensers, dispersion of liquids in liquids

Practical & Term Work

1. Experiments based on metering devices such as venturimeter, orifice meter, pitot tube, rotameter & notched weirs
2. Experiments based on characteristics of pumps, blowers, compressors, vacuum jet ejectors, etc.
3. Experiments based on measurement of pressure drop like flow through various pipes, flow through packed beds, flow through pipe fittings & valves, etc.
4. Experiments based on practical applications of theory like Bernoulli's theorem, Ergun equation, Reynold's experiment, etc.

Text Book

1. Unit Operation of Chemical Engineering by Warren L. McCabe, Julian C. Smith & Peter Harriott 4th Ed,
   McGraw Hill Publications
2. Chemical Engineering Vol. 1 3rd Ed. by J. M. Coulson & J. F. Richardson
   Pergamon International, 1984, Great Britain

Reference Book

1. Fluid Mechanics by Victor L. Streeter, E. Benjamin Wylie, 7th Ed.
   McGraw Hill Publications
2. Fluid Dynamics & Heat Transfer by J. G. Knudson & Donald L. Kala
   McGraw Hill Publications
3. Perry's Chemical Engineer's Handbook by Robert H. Perry, Don W. Green
   McGraw Hill Publications

CH – 502 MECHANICAL OPERATIONS

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	3	60	40	25	25	150

1. Solids
characteristics of solids, particles, types of standard screen series

2. Size Reduction & Enlargement
principle of communition, types of crushers, grinders & disintegrators for coarse, intermediate & fine gringing, energy & power requirement, laws of crushers & work index, close & open circuit grinding, feed control, mill discharge, removal & supply of heat in wet grinding, size enlargement by agglomeration, briquetting, compacting, granulation, tabletting etc.

3. Screening & Other Separation Methods
types of screens, screen analysis, estimation of particle sizes, surface area & particle population based on screen analysis, comparison of ideal & actual screens, capacity & effectiveness of screens, principle of elutriation, floatation, jigging, electrostatic & magnetic separation processes

4. Sedimentation
settling velocities in free & hindered settling, flocculation, rate of sedimentation, types of thickener & thickener area calculation, batch & continuous settling chambers, sorting classifiers, centrifugal settling process, cyclone, principle of centrifugal sedimentation

5. Fluidisation
mechanism, dense phase fluidisation & boiling beds, minimum porosity of bed & bed height, minimum fluidisation velocity & pressure drop in fluidised beds, applications of batch & continuous fluidisation

6. Filtration
types of filters, filter media, filter aids, batch & continuous filtration equipments – filter press, leaf filter, cartridge filter, rotary drum filter, theories of filtration, washing of cake, principle of centrifugal filtration, suspended basket centrifuge, etc.

7. Mixing & Agitation

fundamentals of mixing & agitation, characteristics of mixing equipments, agitation of liquids, types of impellers, power consumption in agitated vessels in liquid – liquid, liquid – solid & solid – liquid mixing, mixing of pastes & paste masses, pony mixers, beater mixer, mixing of dry powder, ribbon blender, tumbler mixer, etc.

8. Conveying

mechanical & pneumatic conveying, elevators, etc. storage of solids, liquids & gases

Practical & Term Work

Experiments based on screening, screen efficiency, sedimentation, filtration, fluidisation, etc.

Text Book

1. Unit Operations in Chemical Engineering by Warren L. McCabe, Julian C. Smith & Peter Harriot 4th Ed.
   McGraw Hill Publications
2. Introduction to Chemical Engineering by Badger & Banchero
   McGraw Hill Publications
3. Chemical Engineering Vol. 2 by J. M. Coulson & J. F. Richardson
   Pergamon International, 1984, Great Britain
4. Unit Operations by Brown & Associates
   John Wiley & Sons

CH – 503 CHEMICAL ENGINEERING THERMODYNAMICS – I

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-		60	40			100

1. Introduction

conservation of energy & first law of thermodynamics, application to steady state flow process, enthalpy, internal energy, equilibrium state, phase rule, irreversible & reversible processes, heat capacity & specific heat

2. Properties of Pure Substances

PVT behaviour of pure substance, ideal & non-ideal gases, different equations of state for real gases like Viral equation, Vander wall's equation, Redlich – Kwong equation, etc., calculation of constants in terms of P, V, & T conditions to be satisfied, corresponding states theory, Pitzer's modification to law of corresponding states

3. Heat Effects

heat capacity of gases as a function of temperature, heat capacities of gases, liquids & solids, concept of C, heat of vaporisation, heat of fusion, heat of sublimation, heat of formation, heat of combustion, calculation of heat of formation from heat of combustion, calculation heat of reaction from heat of formation, etc.

4. Second Law of Thermodynamics

second law of thermodynamics, thermodynamics temperature scale, ideal gas temperature scale, concept of entropy, change & irreversibility, introduction to third law of thermodynamics

5. Thermodynamic Properties of Fluids

network of thermodynamic equations, mathematical relations among thermodynamic functions, Maxwell's relations, interrelation between H, S, U, G, C_P, C_V, etc. in terms of PVT relations, thermodynamic properties of single phase & two phase systems, types of thermodynamic diagrams, generalised correlation of thermodynamic properties

6. Thermodynamics of Flow Processes

fundamental equations & relationships for flow in pipes, maximum velocity in pipe flow, throttling process, flow through nozzles, single stage multistage compressors

7. Refrigeration & Liquefaction

Carnot refrigeration cycle, air refrigeration cycle, vapour compression cycle, absorption refrigeration, choice of refrigerant, heat pump, liquefaction processes

Text Book

1. Introduction to Chemical Engineering Thermodynamics 4th Ed. by J. M. Smith & H. C. Van Ness
   McGraw Hill Book Company
2. Chemical Engineering Thermodynamics by B. F. Dodge
   McGraw Hill Book Company

CH – 504 MASS TRANSFER – I

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-		60	40			100

1. Introduction to Mass Transfer Operations (MTO)
classification, methods of conducting MTO

2. Molecular Diffusion in Fluids
steady state molecular diffusion in fluids (both liquids & gases), diffusivity of liquids & gases

3. Mass Transfer Coefficients
MT coefficients in laminar flow & turbulent flow, theories of MT, heat, mass & momentum transfer in laminar & turbulent flow & their analogies, simultaneous heat & mass transfer

4. Diffusion in Solids
Fick's law, unsteady state diffusion, types of solid diffusion

5. Inter Phase Mass Transfer
equilibrium, diffusion between phases, local & overall diffusion, various processes & material balance for each of them

6. Equipments for Gas – Liquid Operations
gas dispersion, liquid dispersion equipments

7. Distillation
VLE data, flash distillation, simple distillation, continuous rectification, McCabe Thiele & Ponchon Sovarit methods, distillation in packed columns & vacuum distillation

Text Book

1. Mass Transfer Operations 3rd Ed. by R. E. Treybal
   McGraw Hill Publications
2. Unit Operations in Chemical Engineering by Warren L. McCabe, Julian C. Smith & Peter Harriot 4th Ed.
   McGraw Hill Publications

CH – 505 HEAT TRANSFER

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	3	60	40	25	25	150

1. Introduction
modes of heat transfer & basic equations, classification of heat flow processes, Fourier's law, steady state heat conduction through composite wall, cylinder & sphere, stead & unsteady state processes, partial differential equation for one dimensional heat flow, flow of heat through solid slab

2. Convection
heat transfer by convection, fluid with & without phase change, free & forced convection, laminar & turbulent flow, heat transfer inside & outside tubes, concepts of thermal boundary layer, individual and overall heat transfer coefficients, LMTD, fouling factor, transfer units, laminar flow over flat plate, heat transfer in turbulent flow, Re, Pr & other dimensionless numbers, dimensional analysis, empirical correlations, heat transfer in packed & fluidised beds

3. Natural Convection
Gr, analogies, heat transfer to molten metals

4. Boiling
definition, phenomena of boiling, regimes of boiling, heat transfer to boiling liquids

5. Condensation
definition, film type & drop wise condensation, condensation on horizontal & vertical tubes

6. Evaporation
definition, basic principles, single effect evaporators, boiling point elevation, multi effect evaporation, forward & backward feed systems, different types of evaporators

7. Heat Exchangers

basic types of heat exchangers, performance, design parameter of heat exchangers, parallel, counter current & cross flow heat exchangers, shell & tube type heat exchanges, double pipe heat exchanger

8. Radiation

definition, emission of radiation, laws of radiation, black body, radiation between surfaces, radiation shield, radiation through gases

9. Extended Surfaces

different types of fins, fin efficiency, applications of extended surfaces

Practical & Term Work

Experiments to measure heat transfer coefficients, boiling, heat transfer in agitated vessel, condensation, radiation, etc.

Text Book

1. Unit Operations in Chemical Engineering by Warren L. McCabe, Julian C. Smith & Peter Harriot 4th Ed.
   McGraw Hill Publications
2. Chemical Engineering Vol. 1 by J. M. Coulson & J. F. Richardson
   Pergamon International, 1984, Great Britain
3. Heat Transfer by Holman J. P.
   McGraw Hill Publications

Reference Books

1. Heat Transfer – Basic Approach by Ozisic M. N.
   Tata McGraw Hill
2. Heat Transfer by Gebhart B.
   Tata McGraw Hill
3. Engineering Heat Transfer by Wiley
   John Wiley & Sons

CH – 511 CHEMICAL PROCESS CALCULATIONS

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-		60	40			100

1. Dimensions & Units

dimensions & system of units, fundamental & derived units, dimensional consistency, dimensional equations & empirical equations, different ways of expressing units of quantities & physical constants

2. Basic Chemical Calculations

composition of gaseous mixtures, liquid mixtures, solutions, ideal gas law & its application, Dalton's & Amaget's Law, Henry's law, solubility & distribution coefficient, humidity & saturation

3. Material Balance without Chemical Reaction

process flow sheet, material balance with & without recycle, bypass, purge stream, material balance around equipments related to unit operations like absorber, stripper, distillation tower, extractors, dryers, evaporators, crystallisers, humidification & dehumidification towers, material balance of unsteady state operations like mixing

4. Material Balance with Chemical Reaction

concept of limiting & excess reactants, percent conversion, yield, etc., material balance involving reactions with special reference to fertilizers, electrochemical industries, petrochemicals, dyestuffs

5. Energy Balance

heat capacity of gases & gaseous mixtures, heat capacity of liquids & solids, sensible heat change in liquids & gases, enthalpy changes during phase change transformation, enthalpy changes accompanied by chemical reactions, thermo chemistry of mixing process, dissolution of solids

6. Fuels & Combustion

types of fuels, calorific value of fuels, problems on combustion of coal, liquid fuels, gaseous fuels, sulphur & sulphur pyrites, etc., proximate & ultimate analysis

Text Book

Stoichiometry 3rd Ed. By B. I. Bhatt & S. M. Vora
Tata McGraw Hill Company

Reference Book

1. Chemical Process Principles by Hougen, Watson & Ragatz
   Asia Publishing House
2. Industrial Stoichiometry 2nd Ed. by W. K. Lewis, A. H. Radaxh & H. C. Lewis
   McGraw Hill Kogakusha Co.
3. Stoichiometry for Chemical Engineers by E. Williams & C. Johnson
4. Basic Principles & Calculations in Chemical Engineering by D.M.Himmelblau
   Pretice Hall

CT –515 PERSONALITY DEVELOPMENT

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (2 hrs.)	SES (1 hr.)	PR	TW	TOTAL
2	-	-	50				50

The course comprises of the following areas:

1. Introduction: The Contemporary Need of the Developed Personality at all Levels of Life.

2. Health, Hygiene and High-Spirits.

3. Proper Use of Language and Communication Skills.

4. HRD, Inter-Actions and Facing People.

5. Goal Setting and Time Management.

6. Leadership and Team Spirit.

7. Motivating Morale and Will to Work.

8. Effective Concentration and Memory.

9. Ways to Plan and Organise Work.

10. Mannerism, Self-Bearing and Reflexes.

11. Importance of Values and Virtues.

12. Effective Self-Presentation and Facing Interviews.

SEMESTER – VI (CH)

CH – 601 CHEMICAL REACTION ENGINERING – I

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	3	60	40	25	25	150

1. Introduction

thermodynamics, chemical kinetics, classification of reactions, variables affecting the rate of reaction, definition of reaction rate

2. Kinetics of Homogeneous Reactions

concentration dependent term of a rate equation, single & multiple reactions, elementary & non elementary reactions, kinetic view of equilibrium for elementary reactions, molecularity & order of reaction, rate constant,

representation of a rate constant, kinetic models for non elementary reactions, temperature dependence of rate equation, Arrhenius theory, collision theory & transition state theory, comparisons of the theories

3. Interpretation of Batch Reactor Data
constant volume batch reactor, integral method & differential method of analysis of data, variable volume batch reactor, integral method of analysis, differential method of analysis

4. Introduction to Reactor Design
material and energy balances

5. Single Ideal Reactors
ideal batch reactor, space time & space velocity, steady state mixed flow reactor, steady state plug flow reactor, holding time & space time for flow systems

6. Design for Single Reactions
size comparison of single reactors, batch reactor, mixed reactor versus plug flow reactors, first & second order reactions, variation of reaction rates for second order reactions, general graphical comparison, multiple reactor system, plug flow reactors in series and/or in parallel, equal sized mixed reactors in series, mixed flow reactors of different sizes, ractors of different types in series, recycle reactor

Practical & Term Work
Experiment pertaining to determination of order of reaction using integral & differential methods of analysis, effect of temperature on rate of reaction, study of pilot scale reactor

Text Book
Chemical Reaction Engineering 2nd Ed. by Octave Levenspiel
John Wiley & Sons

Reference Book
1. Chemical Engineering Kinetics 3rd Ed. by J. M. Smith
   McGraw Hill Publishing
2. Reaction Kinetics for Chemical Engineers by S. M. Nalas
   McGraw Hill Publishing

CH – 602 CHEMICAL SYSTEM MODELLING

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-		60	40			100

1. Introduction
physical modelling, mathematical modelling, principles of similarity in physical modelling, definitions of independent variables, dependent variables & boundary conditions

2. Mathematical Modelling of Chemical Systems
single stage, 2 stage & N stage extraction of steady state mass transfer process, unsteady state formulation of single stage extraction, steady state heat conduction through hollow cylindrical pipe using various boundary conditions, unsteady state process of steam heating of liquid, heat transfer through extended surfaces (triangle & rectangle), steady state counter current cooling of tanks, unsteady state heat loss through maturing tank, diffusion with chemical reaction in a tubular reactor, gas pre-heater, heat loss through circular flanges

3. Laplace Transforms
thermometer system, mixing tank, fixed bed reactor formulation

4. Partial Differential Equations & Finite Difference
unsteady state continuity equation, unsteady state heat conduction, unsteady state mass transfer (Fick's second law), gas absorption accompanied by chemical reaction (mathematical model formulation), finite difference – solvent extraction in N stage process, gas absorption in N stages (Kremser – Brown), N stirred tanks reactors in series, etc.

5. Numerical Methods
Simpson's rules, Gauss's method, trapezoidal rule, solving differential equations by Taylor's series method, modified Euler's method, Runge – Kutta Method

6. Treatment o Experimental Results
errors, method of averages, linear least squares method

7. Optimisation
simplex method, method of steepest descent, method of Lagrange's multiplier

8. Introduction to Computers

analog & digital computers, linear computers involving summer, integrators, potentiometer, multiplication, examples of solving the differential equations

Text Book

1. Mathematical Methods in Chemical Engineering by V. G. Jensen & G. V. Jeffreys
   Academic Press, New York
2. Applied Mathematics in Chemical Engineering 2nd Ed. by H. S. Mickley, T. S. Sherwood & C. E. Reed
   Tata McGraw Hill Publishing Co. Ltd., New Delhi
3. Cybernetic Methods in Chemistry & Chemical Engineering by V. Kafarov
   Mir Publishers

CH – 603 CHEMICAL ENGINEERING THERMODYNAMICS – II

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-		60	40			100

1. Thermodynamic Properties of Fluids

partial molar properties, chemical potential, ideal & non-ideal solution, fugacity & fugacity coefficient, evaluation of fugacity coefficient – for a pure component, for a mixture of gases & for liquids, effect of temperature & pressure on fugacity & fugacity coefficient of a pure component as well as a gaseous mixture, Lewis – Randall rule & Henry's law, excess properties, activity & activity coefficient

2. Phase Equilibrium

criterion of phase equilibrium, phase rule, Duhem's theorem, vapour – liquid equilibrium calculations, phase diagrams for miscible systems, phase diagrams for immiscible systems, phase diagrams for partially miscible systems, testing of vapour – liquid equilibrium data, Gibb's – Duhem equation, Van Laar equation, Margule's equation, evaluation of constants in these equations, Redlich – Kister equation, P-x,y & T-x,y & x-y diagrams, vapour – liquid equilibrium of ideal & non-ideal solutions, Raoult's law & Henry's law, positive & negative deviations from Raoult's law

3. Chemical Equilibrium

criteria for chemical equilibrium, equilibrium conversion (x), equilibrium constant (k), effect of temperature & pressure on k, evaluation of equilibrium constants by various methods, evaluation of equilibrium conversion for gas phase reactions, liquid phase reaction, heterogeneous reactions etc., phase rule for chemically reacting systems

4. Introduction to Statistical Thermodynamics

different thermodynamic distributions like Boltzmann distribution, Bose – Einstein distribution, Fermi – Dirac distribution, corrected Boltzmann statistics, partition function, evaluation of properties for monoatomic gases using partition function, group contribution methods

Text Book

1. Introduction to Chemical Engineering Thermodynamics 4^{th} Ed. by J. M. Smith & H. C. Van Ness
   McGraw Hill Book Company
2. Chemical Engineering Thermodynamics by B. F. Dodge
   McGraw Hill Book Company
3. Fundamentals of Statistical Thermodynamics by Sonntag & Van Wylen

CH – 604 MASS TRANSFER – II

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	3	60	40	25	25	150

1. Absorption
equilibrium, material balance for single component transfer, multistage & packed tower operation

2. Humidification
equilibrium, vapour – gas mixture, gas liquid contact operations, adiabatic & non-adiabatic operations

3. Liquid Extraction
equilibrium, stage wise contact, single stage type contactor, continuous contact extractor

4. Adsorption & Ion-exchange
equilibrium, stage wise operation, continuous contact operation

5. Drying
equilibria, batch drying, mechanism of batch drying, continuous drying

6. Leeching
equilibrium, steady state & unsteady state operations, methods of calculations

7. Crystalisation
equilibrium, operations, equipments

8. Introduction to Recent Separation Techniques using Mass Transfer
thermal diffusion, reverse osmosis, membrane processes, etc.

Practical & Term Work
Experiments on diffusion in liquids, diffusion through solids, distillation, leeching, liquid – liquid extraction, crystallisation, drying, adsorption, humidification, etc.

Text Book

1. Mass Transfer Operations 3rd Ed. by R. E. Treybal

McGraw Hill Publications
2. Unit Operations in Chemical Engineering by Warren L. McCabe, Julian C. Smith & Peter Harriot 4th Ed.
McGraw Hill Publications

CH – 605 INSTRUMENTATION & PROCESS CONTROL

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	3	60	40	25	25	150

1. Process Control

introduction, steady state & unsteady state design equation for an agitated heated tank, introduction to P, PI & PID controls, dynamics of first order systems subjected to various disturbance like step, ramp, impulse & sinusoidal, examples of the above systems viz. liquid level tanks, mixing process, thermometer, etc., response of the first order system in series, dynamics of the second order systems subjected to various disturbances like step, impulse & sinusoidal, transportation lag, linear closed loop system – servo & regulator problem, closed loop transfer function, block diagram for various simple systems, transient response of a control system, stability of control system, Routh test criterion, frequency analysis for simple order systems, Bode diagrams, advanced controls like feed forward, cascade & ratio control, controller & control element, control values

2. Instrumentation

measuring instruments for temperature, pressure, level & flow

Practical & Term Work

Experiments to study the response of first order systems and second order system to various inputs

Text Book

1. Process System Analysis & Control by D. R. Coughanowr McGraw Hill Publishing Co.
2. Instrumentation by Eckman

Reference Book

Introduction to Control Systems by Stephenopolis

CH – 609 ENVIRONMENTAL ENGINEERING

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-		60	40			100

1. Introduction
types of pollution & their impact on the environment

Air Pollution
2. Sources & Effects
definition, ways of expressing concentration, classification & properties of air pollutants, emission sources – classification according to source types, major emissions from global sources & emission source in India, behaviour & fate of air pollutants, effect of air pollution on – human health, vegetation & materials, air pollution laws & standards

3. Meteorological Aspects of Air Pollution
pollutant dispersion, temperature lapse rate & stability, wind velocity & turbulence, plume behaviour, dispersion of air pollutants – atmospheric dispersion model & the Gaussian plume model, estimation of plume rise

4. Air Pollution Sampling & Measurement
ambient air sampling & stack sampling, analysis of air pollutants

5. Air Pollution Control Methods & Equipment
source correction methods, particulate emission control methods & gaseous emission control methods

6. Control of Specific Gaseous Pollutants
control of sulphur oxides, nitrogen oxides, carbon monoxide & hydrocarbon emissions

Water Pollution
7. Origin of Waste Water (W. W) & W. W. Flow Rates

8. W. W. Characteristics
W. W. composition & physical, chemical & biological characteristics of W. W.

9. W. W. Sampling
methods of sampling, methods of analysis & water quality standards

10. W. W. Treatment
objectives & classification of W. W. treatment methods

11. Physical Unit Operation & their Design
screening, communition, grit chambers, flow equalisation, mixing, flocculation, sedimentation, floatation & filtration.

12. Chemical Unit Processes
chemical precipitation, gas transfer, adsorption, disinfection with chlorine & ozone, dechlorination

13. Biological Unit Processes
fundamentals of microbiology, bacterial growth & biological oxidation, kinetics of growth, aerobic suspended growth, treatment processes, activated sludge process & its design, aerobic aerated lagoons, aerobic digestion, aerobic stabilisation ponds, aerobic attached growth treatment processes – trickling filters & its design, rotating biological contactors, anaerobic suspended growth, treatment processes – anaerobic digestion, anaerobic attached growth treatment process – anaerobic filter & anaerobic ponds, combined aerobic/anoxic or anaerobic treatment processes – facultative lagoons (ponds), sludge treatment & disposal

14. Solid Waste Management
sources & classification, methods of collection & disposal

15. Noise Pollution
sources of noise pollution & their control methods

16. Environmental Legislation
water and air act, hazardous waste handling & management act, environmental impact assessment, environmental audit

Text Book

Environmental Pollution Control Engineering by C. S. Rao
Wiley Eastern Ltd.
Waste Water Engineering – Treatment, Disposal & Reuse by Metcalf & Eddy Inc.

Tata McGraw Hill Publications

Reference Book

1. Introduction to Environmental Engineering by Mackenzie L. Davis & David A. Cornwell
   McGraw Hill International Publications
2. Environmental Engineering by Raw, Peavy & Tchobanoglous
3. Chemistry for Environmental Engineering 3rd Ed. by Sawyer & McCarty
   McGraw Hill Publications

SEMESTER – VII (CH)

CH – 701 CHEMICAL REACTION ENGINEERING – II

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	3	60	40	25	25	150

1. Residence Time Distribution of Fluid in Vessels

E, the age distribution of fluid leaving vessel, experimental methods, the F curve, the C curve, relation among E, F & C curves & mean time for closed vessel, useful mathematical tools, the mean & variance ways of using age distribution information, linear & non-linear systems with flow models, finding RTD by experiment, conversion directly from tracer information, model for non-ideal flow dispersion model, fitting the dispersion model for small extents of dispersion & large extent of dispersion, chemical reaction & dispersion, tanks in series model

2. Introduction to Design for Heterogeneous Reacting Systems

rate equation for heterogeneous reactions, combining linear & non-linear rate expressions, the concept of rate controlling step, linearisation of a non-linear rate equation, contacting patterns for two phase systems

3. Fluid Particle Reactions

unreacted core model for spherical particles of unchanging size, diffusion through gas film, ash layer & chemical reaction control, rate of reaction for shrinking spherical particles (chemical reaction & gas diffusion control), determination of the rate controlling step, application to design, mixture of particles of unchanging size & uniform gas composition, application to fluidised bed with entrainment of solid fines

4. Fluid – Fluid Reaction

kinetic regimes for mass transfer & reaction, detailed treatment for all the cases, film conversion parameter M, kinetic regime from experiment, slurry reaction kinetics, design of towers for fast & slow reactions

5. Solid Catalysed Reactions

effectiveness factor for first order reaction, experimental methods for finding rates

Practical & Term Work

Experiments to determine RTD & conversion form RTD for various geometries under laminar & turbulent flows, heterogeneous reaction system, application of tank in series & dispersion models, RTD in a pilot scale batch reactor

Text Book

Chemical Reaction Engineering 2nd Ed. by Octave Levenspiel
John Wiley & Sons

Reference Book

1. Chemical Engineering Kinetics 3rd Ed. by J. M. Smith
   McGraw Hill Publishing
2. Reaction Kinetics for Chemical Engineers by S. M. Walas
   McGraw Hill Publishing

CH – 702 TRANSPORT PHENOMENA

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	3	60	40	25	25	150

1. Transport by Molecular Motion

review of momentum, energy & mass transport by molecular motion

2. Transport in Laminar One Dimensional Flow

i. Momentum Transport: shell momentum balances, velocity profiles in cases like adjacent flow of two liquids
ii. Energy Transport: shell energy balances, temperature profiles, heat conduction with an electrical heat source, heat conduction viscous heat source & heat conduction chemical heat source
iii. Mass Transport: concentration distribution in solids & laminar flow, shell mass balances, diffusion with heterogeneous chemical reaction, diffusion in falling liquid film

3. Transport in Arbitrary Continuum

i. Momentum Transport: equation of change for isothermal system, equation of continuity & motion in rectangular, cylindrical & spherical co-ordinates
ii. Energy Transport: non-isothermal systems, equation of energy of motion for forced & free convection in non-isothermal flow
iii. Mass Transport: equation of continuity for binary mixtures, equation of change for multi-component systems, mass flux in terms of transport properties, use of equation of change

4. Transport with Two Independent Variables

a. Momentum Transport: unsteady state viscous flow, two dimensional viscous flow, boundary layer momentum transport
b. Energy Transport: heat conduction in viscous flow, boundary layer energy transport
c. Mass Transport: unsteady diffusion, diffusion in viscous flow, two dimensional diffusion in solids, boundary layer theory

5. Transport in Turbulent Flow

i. Momentum Transport: time smoothing of equation of change for incompressible fluid & review of logarithmic law of viscosity
ii. Energy Transport: temperature fluctuations & time smoothing of temperature & energy equation, semi-empirical equations for turbulent energy flux
iii. Mass Transport: time smoothing of equation of change, turbulent concentration profiles

6. Transport between Two Phases

i. Momentum transport: friction factors for flow in tubes, flow rate & pressure drop relations, friction factor for packed beds
ii. Energy Transport: non-isothermal system, heat transfer coefficients, dimensionless correlations for forced & free convection in tubes & around submerged objects, heat transfer coefficient for forced convection through packed bed
iii. Mass Transport: mass transport coefficient, correlations for binary systems in one phase & at low mass transfer rates, definition & correlation for binary mass transfer coefficients in two phases at low mass transfer rates, transfer coefficients for high mass transfer rates, boundary layer theory

7. Transport in Layer Flow System

microscopic mass balance & mechanical energy balances, estimation of friction losses, macroscopic energy balance in non-isothermal systems, use of balances to solve steady state & unsteady state problems

Note:

While teaching the above topics more stress is to be given on the following unit operations;

1. Transport Phenomena in liquid extraction
2. Transport Phenomena in gas absorption
3. Transport Phenomena in distillation

Practical & Term Work

Experiments on based on the above mentioned topics

Text Book

1. Transport Phenomena by R. B. Bird, W. E. Stewart & F. W. Lightfoot
   John Wiley & Sons
2. Momentum Transfer Operations by S. K. Gupta
   Tata McGraw Hill Corp,

Reference Book

Transport Phenomenon in Liquid Extraction by G. S. Laddha & T. E. Degaleesan
McGraw Hill Publishing

Absorption & Extraction by T. K. Sherwood & R. L. Pigford
McGraw Hill Publishing

Multi-component Distillation by D. D. Holland

Prentice Hall, India

CH –703 PROCESS EQUIPMENT DESIGN & DRAWING

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	3	60	40	25	25	150

1. Introdution
basic considerations in mechanical design of process equipments, selection of type of vessel, method of fabrication, economic consideration

2. Vessel Design
criteria in vessel design, excessive elastic deformation, plastic instability, brittle rupture, creep

3. Vessels Under Internal Pressure
design of pressure vessels under internal pressure, construction features – pressure vessel codes, design of shell, types of heads for pressure vessel, design of thickness of heads

4. Vessels under External Pressure
use of stiffeners, design of shell, analytical & graphical methods, design of circumferential stiffeners, design of covers, pipes, tubing under external pressure

5. Reaction vessels
various jackets, half coiled jacket design & combined stress calculation, channel jackets

6. Storage Vessels
design of storage vessel, storage of non-volatile & volatile liquids, storage of gases, types & constructional features of storage vessels, rectangular tank design, design of cylindrical storage tank, bottom design, roof design, shell design

7. Design of Tall Columns
design of tall distillation or fractionation columns, plate (tray type) & packed tower calculations, construction & features in column stress & determination of shell thickness, design & construction features of column internal such as trays, packing, bubble caps, distribution, etc.

8. High Pressure Vessel
types, design of high pressure vessel, auto clave, construction features, materials for high pressure shell design, types of vessel closures

9. Design of Heat Exchanger
types & design of shell & tube heat exchanger, tube sheet, channels, shell joints, baffles, tie rods, expansion provision, etc, mechanical & thermal design

10. Supports for Vessels
types – bracket or leg support, skirt support & saddle support, design calculations

11. Other Process Equipments
design & constructional features of evaporators, crystallisers, dryers & filters

12. Safety
process hazards, safety measures in equipment design, analysis of hazard, pressure relief devices, other safety devices

Practical & Term Work
Designing of equipment and preparation of fabrication drawings for the same

Text Book

1. Process Equipment Design by M. V. Joshi
   McMillan Co., India
2. Process Equipment Design & Drawing by L. E. Brownel & E. H. Young
   Wiley Eastern Ltd., New Delhi

CH – 704 CHEMICAL ENGINEERING PLANT DESIGN & ECONOMICS

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-		60	40			100

1. Introduction
basic considerations in chemical engineering plant design, identification – preliminary techno-economic feasibility

2. Process Design Aspects
selection of process, factors affecting selection, importance of laboratory development, pilot plant, scale-up methods, safety factors, type of flow diagrams

3. Selection of Process Equipments
standard vs. special equipment, material of construction for process equipments, selection criteria, specifications sheet

4. Process Auxiliary
piping design, layout, supports for piping, insulation, pipe fittings, types of valves, selection of valves, process control & instrumentation, control system design

5. Process Utilities
process water, boiler feed water, water treatment, waste treatment & disposal, steam, oil heating system, chilling plant, compressed air & vacuum

6. Plant Location & Layout
factors affecting location, factors in planning layout, principles of layout, use of scale models

7. Cost Estimation
factors involved in project cost estimation, total capital investment, fixed capital investment, fixed capital & working capital, type & methods for estimation of total cost, investment, estimation of cost of equipment & cost of production

8. Estimation of Total Product Costs

factors involved in total cost of production, factors affecting investment & production costs

9. Depreciation
types & methods of determining depreciation, evaluation of depreciation methods

10. Profitability, Alternative Investment & Replacement
methods for profitability evaluation, practical factors in alternative investment & replacement studies

11. Economic Considerations in Process & Equipment Design
inventory control, scheduling project using CPM/PERT methods, project management

12. Optimum Design

general production rates in plant operation, optimum conditions, optimum production rates in plant operation, optimum conditions in cyclic operations

Text Book

Plant Design & Economics for Chemical Engineers by M. S. Peters & K. D. Timmerhaus 2nd Ed.
McGraw Hill Publication

Chemical Engineering Plant Design by F. C. Vilbrant & C. E. Dryden
McGraw Hill Publication

CH – 709 CHEMICAL ENGINEERING MATERIALS & SAFETY

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-		60	40			100

1. Basic Concepts of Material Science (4):
Introduction to Material science, Classes of engineering materials.
Mechanical properties: Isotropy and anisotropy, Stress and strain relation, Hooke's law, Modulus of material, Poisson's ratio.
Fundamental Properties: Elasticity, Plasticity, Strength, Stiffness, Resilience, ductility, Malleability, Toughness, Hardness etc.
Deformation of metals elastic & plastic deformations, failure of metals, creep, fracture & fatigue with illustrative examples.

2. Ferrous andNon-ferrous Material (5):
Ferrous metals: Cast iron and its types, Steel , stainless steel, Classification of steel, manufacturing process of steel, alloy steels and its classification, effect of alloying elements on mechanical properties of steel
Non ferrous metals: Aluminium& its alloys, titanium, zirconium, copper & its alloys, lead & its alloys, Zinc and its alloys, Nickel & its alloys.
Effects of acids & alkali on metals & alloys, Heat treatment to metals – Annealing, Normalising,Quenching, Tempering, Case hardening- carburising, cyaniding, nitriding, Surface hardening.

3. Inorganic, Organic & Other Materials (4):
Glass, vitreous, silicon, concrete & ceramic materials, high polymers, rubbers, wood, graphite, insulating & cementing materials

4. Corrosion and its prevention (4):
Mechanism of corrosion, dry & wet corrosion, other forms of corrosion, Passivity, factors influencing corrosion, atmospheric corrosion, Control & prevention of corrosion – cathodic& anodic control, inhibitors & other protective measures.

Protective coatings, metallic coating & metal cladding, physico-chemical principles involved, chemical conversion coating, organic coating, enamels, ceramic protective materials

5. Introduction to Process Safety(5):
Define: safety, hazard, risk, accident, incident, likelihood, consequence, loss prevention, domino effect, first aid, incident rate, lost workdays, occupational injury and illness, frequency rate, severity rate, fatality rate and fatal accident rate. Theory of accident causation, nature of accident process.
Strategies for safety: Concept of Active, Passive, Inherent and Procedural Strategies.
Case Studies: Analysis of mistakes made and lessons to learn from four significant chemical industry disasters: Flixborough (England), Pasadena (Texas), Seveso (Italy) and Bhopal (India)

6. Toxicological Studies (4):
Entry routes of toxicants into biological system and appropriate control strategy, elimination of toxicants from biological system by various ways, target organ, acute and chronic toxicity and its toxicological studies, chemical and physical asphyxiates, TLV-TWA, TLV-STEL and TLV-C, LD 50 and LC 50, detection of possible hazard through senses.

7. Industrial Hygiene(4):
*Laws and Regulations:*Laws and regulations in Indian context and US context, role of OSHA, NIOSH, ACGIH, EPA, PSM vs. RMP, Safety work permits, Pre-startup and shut down procedures, emergency planning and response, mock drill, concept of HAZOP, HAZAN, HAZID, Risk Analysis, Risk Assessment, FTA, ALARP, accident and incident investigation, safety audit.
Role of industrial hygienist: Identification (MSDS), Evaluation (quantification methods) and Control methods (Dyke and Enclosures, Dilute and local ventilation, Wet methods, Good Housekeeping and Personal Protective Equipment).

8. Fire and Explosion (3):
Fire: Few basic definitions like fire, combustion, explosion,fire and flash point, auto-ignition etc., concept of fire triangle,flammability limits (LFL and UFL).
Explosion: Mechanical Explosion, detonation, deflagration, deflagration to detonation transition, confined and unconfined explosion, dust explosions, vapor cloud explosion, BLEVE etc.their causes and prevention.
*Fire Extinguish:*Classification of fires, various extinguishing mediumsand its selection, mobile and stationary fire fighting methods etc.

9. Introduction to Reliefs and Relief Devices(3):
Need for relief devices, concept of thermal runaway, few terminology like set pressure, max. allowable working pressure, operating pressure, accumulation, overpressure, backpressure, blowdown, max. allowable accumulated pressure etc., location of reliefs, various relief devices like spring loaded (relief valve, safety valve and safety relief valve), mechanical, buckling pin and rupture dick, selection criteria and combination criteria, effluent system, knock-out drum, cyclone, condenser, quench tank, scrubber, flare and incinerator, safety interlock and alarm system etc.

10. Miscellaneous topics and Case Studies (3):
Safety in laboratory of academic institute and R&D houses, safety in tank farm, safety during loading and unloading of chemicals, color codes for conveying system and electrical devices etc.

Text Book

1. Material science and Processes, by S. K. HajraChaudhry
2. Chemical Process Safety (fundamentals with application) by Daniel A. Crawl and Joseph F. Louvar, Prentice Hall International Series, 2nd Ed,

Reference Book

1. Material Science, by M.S.Vijya and G. Rangrajan
2. Nature & Properties of engineering Materials, by D. ZasterZebski
3. Chemical Engineering Materials by F. Rumford
4. Engineering Physical Metallurgy & Heat Treatment by Lakhtin
5. Elements of Material Science by Van Valk
6. Industrial Hazards and Plant Safety by Sanjoy Banerjee, Taylor and Francis
7. Safety and hazards management in chemical industries by M N Vyas, Atlantic publishers

SEMESTER – VIII (CH)

AF – 801: PROJECT/INDUSTRIAL TRAINING

SEMINAR:

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
		6				100	100

Under the above subject, each student will be assigned one topic related to chemical engineering field by his/her guide. The student will make an up-to-date literature survey with reference to the topic assigned to him under the supervision of his/her guide.

PROJECT/TRAINING

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
		24			300	100	400

Each student is required to undergo practical training in a chemical industry for 16 weeks and he is required to submit a project report on the designing of a chemical plant. The report will consist of important chapters such as,

i. Introduction
ii. Literature survey
iii. Selection of the process & process details with justification
iv. Thermodynamic & Kinetic consideration
v. Physico-chemical data & properties
vi. Material balance with flow sheet
vii. Energy balance with flow sheet
viii. Process design of various equipments & optimum operating conditions

ix. Fabrication drawing of the major equipment with all relevant necessary details
x. Other important considerations such as instrumentation & process control, plant layout, safety, precautions, etc.
xi. Cost estimation
xii. Conclusions

* * * * *

ELECTIVES FOR SEM: V & SEM:VI & SEM:VII

1. Environmental Engineering
2. BioChemical Engineering
3. Multicomponent Distillation
4. Numerical Techniques
5. Mass Transfer with Chemical Reaction
6. Petrochemical Technology
7. New Separation Techniques
8. Fluidization
9. Polymer Technology
10. Advanced Control Systems
11. Fermentation Technology
12. Catalysis
13. Computer aided Design
14. Bioreactor Design and Operation
15. Petroleum Refinery Engineering
16. Chemical Engineering Practice
17. Introduction to Nanotechnology

New Syllabus (WEF Dec 08) Elective E01
CH – 705 ENVIRONMENTAL ENGINEERING

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-		60	40			100

1. Introduction
Types of pollution & their impacts on the environment

Air Pollution
2. Sources & Effects
Definition, ways of expressing concentration, classification & properties of air pollutants, emission sources – classification according to source types, major emissions from global sources & emission source in India, behaviour & fate of air pollutants, effect of air pollution on – human health, vegetation & materials, air pollution laws & standards

3. Meteorological Aspects of Air Pollution
Pollutant dispersion, temperature lapse rate & stability, wind velocity & turbulence, plume behaviour, dispersion of air pollutants – atmospheric dispersion model & the Gaussian plume model, estimation of plume rise

4. Air Pollution Sampling & Measurement
ambient air sampling & stack sampling, analysis of air pollutants

5. Air Pollution Control Methods & Equipment
source correction methods, particulate emission control methods & gaseous emission control methods with special emphasis to Control of sulphur oxides, nitrogen oxides, carbon monoxide & hydrocarbon emissions

Water Pollution
6. Origin, Characteristics and Flow Rates of Waste Water (W. W)
Sources of wastewater in process industries, W. W. composition & physical, chemical & biological characteristics of W. W., Flow rates and general characteristics of waste water from various industries. Methods of waste water sampling, methods of analysis & water quality standards.
7. W. W. Treatment

Objectives & classification of W. W. treatment methods, Use of physical unit operations like screening, communition, grit chambers, flow equalisation, mixing, flocculation, sedimentation, floatation & filtration in waste water treatment. Use of chemical unit processes like chemical precipitation, gas transfer, adsorption, disinfect ion with chlorine & ozone, dechlorination in wastewater treatment

8. Biological Unit Processes

fundamentals of microbiology, bacterial growth & biological oxidation, kinetics of growth, aerobic suspended growth, treatment processes, activated sludge process & its design, aerobic aerated lagoons, aerobic digestion, aerobic stabilisation ponds, aerobic attached growth treatment processes – trickling filters & its design, rotating biological contactors, anaerobic suspended growth, treatment processes – anaerobic digestion, anaerobic attached growth treatment process & design – anaerobic filter & anaerobic ponds, combined aerobic/anoxic or anaerobic treatment processes – facultative lagoons (ponds), sludge treatment & disposal

9. Solid Waste Management: sources & classification, methods of collection & disposal

10. Noise Pollution:sources of noise pollution & their control methods

11. Environmental Legislation: Water and air act, hazardous waste handling & management act, environmental impact assessment, environmental audit

12. Introduction to concept of cleaner production and a case study on cleaner production.

13. Introduction to pollution prevention and resource conservation techniques.

Text Book

1. Environmental Pollution Control Engineering by C. S. Rao
   Wiley Eastern Ltd.
2. Waste Water Engineering – Treatment, Disposal & Reuse by Metcalf & Eddy Inc.
   Tata McGraw Hill Publications

Reference Book

18. Introduction to Environmental Engineering by Mackenzie L. Davis & David A. Cornwell
    McGraw Hill International Publications
19. Environmental Engineering by Raw, Peavy & Tchobanoglous
20. Chemistry for Environmental Engineering 3rd Ed. by Sawyer & McCarty
    McGraw Hill Publications

Elective E02

CH – 608 BIOCHEMICAL ENGINEERING

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	-	60	40	-		100

(1) Introduction **[5]**
Structure of cells, Cell types, Chemicals of life – lipids, sugar, polysaccharides, RNA, DNA, Amino acids, proteins etc.

(2) Enzymed Catalyzed reactions **[8]**
Enzyme substrate complex & Enzyme action, Simple enzyme kinetics with one & two substrate, determination of elementary rate constant, other patterns of substrate concentration dependence, modulations & regulation of enzymatic activities, Enzyme deactivation.

(3) Kinetics of substrate utilization, product formation & bioproduction in cell culture.**[5]**

(4) Design & analysis of biological reactors **[7]**

(5) Fermentation technology & industrial microbiology **[5]**
Introduction, uses, type of fermenters, downstream processes, roll of yeast, solid state fermentation, fermented foods, lactose utilization, single cell protein, enzymes, immobilization of enzymes etc.

(6) Genetics **[4]**
Introduction, plasmids, cloning vehicles, strain construction, genetic recombination, antisence RNA technology , gene machine, DNA hybridazation, genetic disease, human gene therapy, biolistic missiles. Molecular engineering, etc.

(7) Production of useful substances by microorganisms like penicillin, lactic acid, vitamins alcohol etc. **[3]**

(8) Environment & energy **[3]**

Text books:

(i) Biochemical engineering fundamentals
Second edition- By J.E.Bailey & D.F.Ollis

(ii) A textbook on biotechnology- By H.D.Kumar

Reference book:

(i) Chemical Engineering –Vol-3, Coulson & Richardson

Elective E03

Multi-component Distillation

Session	Theory	Total
40	60	100

Teaching Hours

1. **Design Variables** **[5]**
   Application of phase rule to decide the degree of freedom fro different types of distillation columns and various parts of distillation column
2. **Fundamental concept of multicomponent distillation** **[6]**
   Distillation fundamentals, deciding operating condition for distillation column, separation of multicomponent mixtures using single stage, separation of binary mixture using staged column, separation of multicomponent mixture at total reflux.
3. **VLE and equilibrium flash calculation** **[7]**
   Vapor liquid equilibrium models, Calculation of distribution coefficient, calculations of BUBL P & T and DEW P & T, application of Deprister Charts
4. **general short cut methods** **[7]**
   θ method, FUG method (Fansky Underwood Gilliland)
5. **Rigorous methods** **[7]**
   Introduction to Lewis Mathenson, Thiele Gadde, Amundson-Pontinen method and Relaxation method
6. **Tray hydraulics** **[7]**
   Selection of types of tray (bubble cap or perforated), various terminologies associated with tray design, pressure drop on each tray, material of construction of tray, tray layout.
7. **Tray efficiency** **[7]**
   Experimental efficiency, empirical coefficients, AIChE correlations, calculation of efficiency based on vapor and liquid diffusivities, overall column efficiency.
8. **Introduction to azeotropic, extractive and reactive distillation** **[4]**

Total 50hrs

Books:

1. Design of equilibrium stage processes by B.D.Smith, McGraw Hill Publication
2. Distillation Operations by Henry Kister, McGraw Hill Publication
3. Distillation Design by Robinson and Gilliland, McGraw Hill Publication

References:

1. Multicomponent Distillation by C.D.Holland, Prentice Hall Publication
2. Distillation Design in practice by L.M.Rose, Elsevier Publication
3. Handbook of separation processes for chemical engineers by Schwitzer, McGraw Hill Publication
4. Introduction to process engineering and design by S.B.Thakore and B.I.Bhatt, Tata McGraw Hill Publication

Elective E04
Numerical Techniques

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	-	60	40	-		100

1. Error analysis [3 hrs]
   Significant figures, accuracy and precision, error definitions and round of errors, truncation errors, error propagation, Taylor series, total numerical errors, formulation errors and data uncertainty.
2. Solution of polynomial equation [5 hrs]
   Roots of equations, bracketing methods – graphical, bi section and false position methods, Open methods – Newton Raphson, secant methods, Roots of polynomials – computing methods like Mular method and Bair Stows methods
3. Linear algebraic equations [5 hrs]
   Gauss elimination, gauss Jordan, non-linaer system of equations, gauss seidel method
4. Matrices and eigen value identification [4 hrs]
   Matrix inverse, error function and analysis, special matrices, eigen values and eigen vactors
5. Ordinary Differential Equations [7 hrs]
   Euler's methods, Runge-Kutta method, systems of equations, multistep methods, boundary value problem, eigen value problem
6. Partial Differential Equation [7 hrs]
   Finite difference method, elliptic equations, parabolic equations, finite element method
7. Matlab introduction and hands on practice [4 hrs]
   Introduction to mathematical equation solutions, programming, use of different tool boxes.
8. Introduction to Optimization [5 hrs]
   One dimensional unconstrained optimization – golden section search and newton's methods, multidimensional unconstrained optimization – direct and gradient methods, constrained optimization – linear programming

Books:

1.Numerical methods for engineers by steven C.Chapra, Raymond P.Canale (Tata McGraw Hill 4th Ed.)

2. Applied mathematical methods for chemical engineers by Norman W.Loney (CR press 2nd Ed)
3. Problem solving in chemical engineerin with numerical methods by M.B.Cutlip and Mordechai Shacham (Prentice hall international series)
4. Applied mathematics and modeling for chemical engineers by Rice and Do (Jhon Wiley publication)

Elective E05
Mass Transfer with Chemical Reaction

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	-	60	40	-		100

Subject: Mass Transfer with Chemical Reaction (MTCR)

Subject: Mass Transfer with Chemical Reaction (MTCR)

1. Introduction: Significance of MTCR. Industrially important systems having Gas-Liquid, Liquid-Liquid, Liquid- Solid catalytic and non-catalytic phases.
2. Theory of MT accompanied by irreversible and reversible reactions. Theories for systems having very slow (Regime-1), slow (Regime-2), fast (Regime-3) and instantaneous reactions (Regime-4). Situations falling between very slow and slow, slow and fast, fast and instantaneous reactions. Discussion and examples falling in different above categories.
3. Theory of mass transfer accompanied by consecutive and two step reactions. Both the reactions very slow or slow, first step reaction is fast and second step slow or between slow and fast reaction regime. Both reactions fast pseudo first order (R-3) and situation where depletion of liquid reactant in the film is encountered. Systems with first step reaction are instantaneous. MTCR for two step reactions.
4. Theory of systems with absorption of gas in solutions containing two reactants. Systems involving very slow, slow, fast and instantaneous reactions with discussion on examples.
5. Systems with simultaneous absorption of two gases. Theory for cases where the depletion of liquid reactant in the film does not prevail and do prevail. Instantaneous reaction of one of the gases.
6. Systems involving both liquid phases. Theories for situations when reaction occurs in one liquid phase only. Systems with fast and instantaneous reactions and those falling between fast and instantaneous regime.
7. Theory of MTCR for solid-liquid non catalytic reactions in various types of reactors. Systems with sparingly soluble and insoluble solids.
8. Systems with reactions in fluid-fluid-solid phases. Situations with solids sparingly soluble and insoluble solids. Systems with one or more gases and solid.

9. Theory of MTCR in catalytic fluid – fluid systems. Effect of hydrodynamics and temperature in slurry reactors and fixed bed reactors.
10. Types of contactors and their relative merits for gas-liquid, liquid-liquid and gas-liquid-solid (catalytic and non catalytic) systems.
11. Some recent developments in mass transfer with chemical reaction.

Text Book:
Heterogeneous reactions: Analysis, Examples and reactor design, Vol.2 by L K Doraiswamy and M M Sharma, John Wiley & Sons, NY, 1984
Reference Books. Gas-Liquid reactions, P V Danckwerts, McGraw Hill, NY, 1970

ELECTIVE E06

PETROCHEMICAL TECHNOLOGY

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	-	60	40	-		100

1. Introduction: [2]
   Petrochemical Industry, feed stocks, purification, mechanical and chemical impurities, separation of gases, separation of aromatics,
2. Chemicals from methane: [3]
   Methanol(formaldehyde, acetic acid), ethanol, halides of methane(PTFE), methyl amines

Chemicals from ethane: [4]

Ethylene, acetylene, ethylene production, naphtha cracking, ethylene derivatives(VCM-direct chlorination, oxychlorination, VAM, ethanol, acetaldehyde), acetylene production (calcium carbide, Wuffs process), Acrylic acid

4. Chemicals from C3, C4 and higher carbon atoms: [6]
   Propane, propylene, acetone, acrylonitile(SOHIO process), phenol, separationof C4 cuts, butanes, butanes, butanol, butadiene, MTBE, isoprene.
5. Synthesis Gas and chemicals: [4]
   Steam reforming of hydrocarbons, reformer, pressure wing adsorption system, processes(Lurgi process),OXO synthesis, Fischer Tropsch synthesis
6. Petroleum aromatics: [5]
   BTX production, catalytic reforming, fractionation, aromatics from polymer gasoline, isomerization of xylene,xylene separation(o,p, m, parex process) benzene derivatives, toluene derivatives (caprolactum, terephthalic acid)
7. Polymers, rubbers and synthetic fibers, plastics: [6]
   Polyethylene, polypropylene, nylon 6, polyester, acrylic fibers, PET, BUNA rubber, SBR, chloroprene rubber, engg plastics, phenol-fromalehyde resins, ABS plastics and polyurethanes.

Synthetic detergents: [5]

Anionic detergents, cationic detergents, production of LAB, mfg f sulphonates, nonionic detergents, finishing of detergents.

9. Elements of design of steam reformer, naphtha cracker, catalytic reformer, etc.[5]

REFERENCE:

DR. B.K. Rao, ‘A text on Petrochemicals’, Khanna Publications, Delhi.

Elective E08
FLUIDIZATION

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	-	60	40	-		100

1.Characteristics of fluidized systems (9 hrs)
Properties of gas-solid and liquid-solid system, effect of fluid velocity on pressure gradient, minimum fluidization velocity, minimum fluidization velocity in terms of terminal falling velocity, types of fluidization, Circulating fluidized bed systems, risers, importance of CFB, comparision with fluidization ,

2.Behavior of fluidized bed (4 hrs)
Fixed bed-particles of one size, solids with distribution sizes, bubble formation, importance of distributors, voidage in fluidized bed

3. Flow pattern of gas through fluidized beds (4 hrs)
experimental findings, Bubbling bed model for gas interchange, residence time distribution of gas, interpretation of gas-mixing data in terms of bubbling bed models

4. Mass and Heat transfer between fluid and solid (4 hrs)
Mass transfer rate, heat transfer rate from bubbling bed models, distribution of solids among the bubbles, cloud and emulsion region

5 Entrainment and Elutriation (4 hrs)
model for entrainment from a dense fluidized bed, applications of the entrainment model to elutriation, Entrainment at or above the TDH, entrainment below TDH

6. Residence time distribution and size distribution of solids in fluidized bed (5 hrs)
Particles of changing size, derivation of general performance equation , single size feed, performance equation, rate expression for particle growth and shrinking, particles of unchanging size, single and multistage bed, feed of wide size distribution

7. Circulation systems (4 hrs)

Flow of high bulk density mixture, detail of circulation rate for solids, for deactivating catalyst, for a required heat removal rate, flow of low bulk density mixture

8.Industrial applications of fluidized bed (6 hrs)
Physical operations, transportation, heat exchange, mixing of fine powders, drying and sizing, adsorption, synthesis reaction, Carbonization and gasification of coal and coke

Text book:

(i) Fluidization engineering
D.Kunii and O.Levenspiel, Krieger publication

Reference Books :

(i) Chemical Engineering Vol.-II(4^{th} ed.)
J.M.Coulson and J.F. Richardson,Pergamon press

(ii) Fluidization Technology Vol. I
D.L.Keairns, McGraw Hill publication

ELECTIVE E09

POLYMER SCIENCE & ENGINEERING

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	-	60	40	-		100

1. Introduction to Polymers (5)**:** polymers, polymerization, history of polymers, pioneers in polymer science, molecular weight and molecular weight distribution, degree of polymerization, addition polymerization (free radical, cationic, ionic, coordination catalyst), condensation polymerization (step-growth), polymerization conditions (bulk, solution, precipitation, suspension, emulsion, interfacial), amorphous and crystalline polymers, copolymers, basic polymer properties

2. Plastics (15): preparation, properties, applications of thermoplastics and thermoset resins - polyethylene; polypropylene; polystyrene; acrylic polymers; PVC, poly(vinyl esters); Teflon; Nylon; polyesters; cellulose polymers; phenolic and amino resins; epoxy resins; polyurethanes; silicone polymers; composites, others

3. **Fibers** (5): denier, tenacity, fiber spinning – melt spinning, wet spinning, dry spinning, fiber properties

4. **Elastomers** (5): natural and synthetic elastomers, classification, preparation, properties, application of elastomers, vulcanization; reinforcement.
5. **Adhesives** (2): classification, properties, applications
6. **Polymer Additives and Compounding** (2): fillers; colorants; stabilizers; plasticizers; flame retardants; lubricants; others
7. **Measurement of Molecular Weight and Size** (3): light scattering; solution viscosity; gel permeation chromatography, colligative properties
8. **Polymer Rheology** (5): Newtonian fluids, non-Newtonian fluids, Hookean solids, viscous flow, rubber-like elasticity, viscoelasticity, viscoelastic models, glassy state, glass transition temperature, crystalline melting temperature, mechanical properties of polymers, orientation
9. **Polymer Processing** (6): extrusion, compression molding, injection molding, blow molding, cast film, calendering, other processing techniques

Text Book

"Textbook of Polymer Science" by Fred W. Billmeyer, Jr.

Reference Books

"Polymer Science" by V.R. Gowariker, N.V. Vishwanathan;, J.Sreedhar
"Principles of Polymer Science" by P. Bahadur and N.V. Sastry
"Polymer Science & Technology" by P. Ghosh

Elective E10
ADVANCED PROCESS CONTROL

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	-	60	40	-		100

1. Review of Single Input Single Output (SISO) Control. [3]
2. Model Based Control; Multivariable control strategies [4]
3. Internal Model Control Preliminaries and Model Predictive Control, Model forms for Model Predictive Control. [4]
4. Parametric and Non-parametric Models, State space and Transfer Function Representations and their inter relationships. [5]
5. Control Relevant Process identification; Choice of Input Signals and Model Forms. [5]
6. Parameter Estimation using batch and Recursive Least Squares. [3]
7. Model Validations using Correlation Concepts. [3]
8. Model Predictive Control; Analysis of Dynamic Matrix Control (DMC) and Generalized Predictive Control (GPC) Schemes. [5]
9. Controller Tuning and Robustness Issues; Extensions to Constrained and Multivariable Cases. [5]

10. Case studies including dynamic simulation and control wit the help of Matlab and Simulink [4]

Text/References

- L.Ljung, "System Identification - Theory for the User", Prentice Hall, 1987.
- E. Camacho and C. Bordons, "Model Predictive Control in the Process Industry", 1995

Elective E11
FERMENTATION TECHNOLOGY

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	-	60	40	-		100

1. Introduction and scope of microbial processes. Alcoholic fermentation and resent developments. Glycerol fermentation. [7]
2. Malting and brewing: beer production, wine manufacturing and other distilled liquors. [7]
3. Microbial production of organic acids and fermentation processes. [6]
4. Biomass as a fermentation product: Baker's yeast, Bioinsecticides, Biofertilizers. [6]
5. Amino acids: Lysine and glutamic acid. Commercial enzymes: Solid and submerged fermentation, recovery etc. [7]
6. Citric acid production by (a) solid state and (b) submerged fermentation. [7]

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REFERENCE:

1. Fermentation and enzyme Technology Technology
By Wang Daniel, Cooney Charles, Demon Arnold.
John Wiley Publication, New York.

2. Fermentation and Bio Chemical Engineering
By Vogel Henry.
Noyes Publication, New Jersy.

Elective E12

CATALYSIS

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-		60	40			100

1. Introduction to catalysis [4]
2. Homogeneous catalysis: Basic functions of catalysis , carriers, promoters, accelerators, poisons, surface area of catalyst, pore size distribution, determination of selectivity of a catalyst [4]
3. Kinetics of heterogeneous catalytic reactions, experimental reactors, power law type rate equations, Adsorption Langmuir equation, LHHW Maxwell rate equation , Initial rates approach [8]
4. Fixed bed fluidized bed catalytic reactors, relative merits and demerits of these reactors [4]
5. Design of isothermal adiabatic fixed bed and fluidized bed catalytic reactors [6]
6. Three phase reactors: Introduction to design and analysis of slurry and trickle bed reactors [6]
7. Case studies of some independent industrial reactors [4]
8. Introduction to enzyme catalyzed reactions [4]

Texts/References

- J M. Smith Introduction to chemical kinetics Mc. Graw hill London
- Somorjai, G. A., Introduction to Surface Chemistry and Catalysis, New York, 1994.

- Satterfield, C. N. and Sherwood, T.K., the Role of Diffusion in Catalysis, Addison-Wisley, 1963.
- Dumesic, J. A., Rudd, D. F., and Aparicio, L. M., The Microkinetics of Heterogeneous Catalysis, ACS, 1993.
- Masel, R. I., Chemical kinetics and catalysis, Wiley-Interscience, 2001.

Leach, B. E., Applied Industrial Catalysis, Vols. 1-3, Academic press, 1984.

Elective E13

COMPUTER AIDED DESIGN

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	-	60	40	-		100

1. Introduction to Computer Aided Design (CAD) [2]
2. Engineering Tools for CAD [2]
3. Development of simple algorithms for problems related to chemical engineering. [5]
4. Computer aided design of chemical process equipments. [6]
5. Concept of modular design, optimum design, parameter optimization. [5]
6. Principles of process synthesis, Pinch technology, Optimal design of processes. Problem solving in the areas of Process Synthesis [5]
7. Process Control. [5]
8. Methodology involved in Steady state and dynamic simulation of Processes [5]
9. Process Simulators – Steady State Simulators, Dynamic Simulators with the help of one case study which includes energy and material recycle [5]

Texts/References

- Lesley, M. L. (Editor), Computer Aided Process Plant Design, 1982.
- Westerberg, A.W. (Editor), Proceedings of the Second International Conference on Foundations of Computer Aided Process Design, 1984.
- User Manuals of Selected Commercial Software Packages, namely, Aspen Plus, HYSYS, Design II, Fluent, MATLAB, and GAMS.
- Computer Aided Design of Chemical Equipments, B.C. Bhattacharya and Narayan, 1980
- Product And Process Design Principles 2nd Ed., W.D.Seider, J.D.Seader, D.R.Lewis

Elective E14

Bioreactor Design and operation

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	-	60	40	-		100

1. Introduction to bioreactor and basic principles: Definition of bioreactor, basic principles of bioreactor. classification of bioreactors (Batch, plug flow reactor (PFR), continuous stirred rank reactors (CSTR), fluidized bed reactor, bubble column, air life fermenter etc.) and their configurations (4)

2. Concept of ideal and non-ideal reactor:- Residence time distribution; Models of non-ideal reactors – plug flow with axial dispersion, tanks-n-series model, age distribution model.
(5)

3. Multiphase bioreactors: Packed bed with immobilized enzymes or microbial cells; three – phase fluidized bed trickling bed reactor. Chemostat model with cell growth kinetics.
(5)

4. Design and analysis of reactors: Batch, plug flow reactor (PFR), continuous stirred rank reactors (CSTR), fluidized bed reactor, bubble column, air life fermenter, fed batch and semi-continuous bioreactors, etc. mechanical design of bioreactors and its components.
(9)

5. Optimization of reactor systems: Optimization of parameters, like temeperature, flowrates and products

   (5)

6. Gas liquid reactors; Unconventional bioreactors like Hollow fiber reactor, membrane reactor, perfusion reactor for animal and plant cell culture.

   (4)

7. Bio reactior operation: control of bioreactor; bioreactor modelling and stabiliy analysis. Introduction to Transient Bioreactor Behavior and the Stability Criteria; Recycle Systems.

   (8)

Text Books:

Landfill **Bioreactor Design** and **Operation**, by Debra R. Reinhart, Timothy G. Townsend – 1998, Lewis publishers

Reference books:

B.Atkinson, “Biochemical Reactors”, Pion Ltd., London, 1974.

Bioreactor System **Design** - Page 47
by Juan A. Asenjo, José C. Merchuk - 1995

ELECTIVE E15

PETROLEUM REFINING ENGINEERING

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	-	60	40	-		100

1. Origin, formation and composition of petroleum: [2]
   Origin and formation of petroleum, composition of petroleum. Types of Crudes- composition, classification of petroleum.
   Oil fields and Refineries in India- Indian petroleum Industry, crude and gas reserves, refining picture.
2. Oil Exploration and drilling: [3]
   Types of rocks, formation of oil, oil banks, drilling operation, offshore drilling, onshore drilling, oil recovery- primary, secondary and tertiary recovery methods,
3. Petroleum processing data:[3]
   Evaluation of petroleum, the crude assay, characterization factors, ASTM distillation, TBP distillation, equilibrium flash vaporization, inter conversion of boiling points, important crude products , their properties, Test methods for various refinery products, refinery configuration development.
4. Fractionation of petroleum: [8]
   Dehydration and desalting of crude, heating of crude (pipe still heaters), arrangement of towers, (types of reflux), Atmospheric distillation unit, Vaccum Distillation unit, design aspects, topping operations, blending of gasolines
5. The conversion and Treatment techniques:
   [10]
   impurities, treating of chemical impurities, treatment of LPG(sweetening operation for gases), treatment of Gasoline(lead doctoring, merox sweetening etc), treatment of Kerosene(liquid sulfurdioxide extraction of aromatics) and treatment of Lubes(sulfuric acid treatment, solvent treatment, phenol extraction, furfural extraction), treatment of Wax and purification(dewaxing, propane deasphalting).
6. Thermal and catalytic processes:
   [12]
   Cracking: thermal cracking reactions, visbreaking catalytic cracking:carbonium ion chemistry, types of catalytic crackers, catalytic cracking processes, FCC (reactions, factors, catalyst), fixed bed process, catalytic reforming(reactions, conditions, catalysts, processes-platforming),

naphtha cracking, coking(delayed coking, fluid coking, flexi coking), hydrogen processes (hydrocracking, catalysts, processes, hydrodesulfurization, hydrotreatments, alkylation- HF alkylation) isomerization processes.

7. Corrosion in refineries. [2]
8. Safety and environmental considerations in petroleum refineries [3]

REFERENCE:

1. B.K. Rao, 'Modern Petroleum Refinery Process', Oxford-IBH Publishing Co.(1990).
2. Nelson, 'Petroleum Refinery Engineering', TMG Pub.

Elective E16
Chemical engineering practice

Chapter I [5]

1) Getting the details of the product and total capacity overall capacity in the world
2) Market value of the product and raw materials
3) Competitors technical as well as commercial
4) Technology providers
5) Block diagram of the process
6) Tracing the lines and identifying the line codes

Chapter- II [5]

1) Thermodynamic/physiochemical properties of all the materials used in the process
2) Material balance of the process for the capacity specified by the guide
3) What are various type of reactors and separation equipment present in the industry
4) Various type of pumps used in the plant their characteristics, suppliers

Chapter- III [5]

1) Energy balance of the process with block diagram
2) Details of the control valves required
3) What are various control valve options available and why a particular valve is selected
4) Cost of the control valves
5) Operational details of control valves
6) Draw all control loops in the plant

Chapter IV [5]

1) Design all separation equipment (minimum of Three)
2) Identify all safety measures taken in the industry
3) Identify all safety related equipment their location and reason for selecting that location
4) Identify all the auxiliary equipment related to safety

Chapter V [8]

1) Design major equipments
2) Collect the cost of each of the equipment including, auxiliary equipment (with standby), piping
3) Estimate the cost of the plant designed

4) Identify the breakeven point and payback period etc.

Chapter- VI [7]

1) Complete the mechanical design
2) Draw the P& ID of the plant on a drawing sheet which is signed by your guide
3) Identify various pollution control measures taken by the industry
4) Identify proper location for each equipment based on the wind robs of the region
5) Draw the plant layout

Chapter VII [5]

1) Raw material consumption pattern and sustainability
2) Suggestions to improve the conversion and yield
3) Suggestions you feel like giving to the industry
4) Statutory requirements to start a project

Elective E17
NANOTECHNOLOGY

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-	-	60	40	-		100

1. Introduction

2.Nanostructure and properties of nanomaterial, crystal structures, measurement of properties of nanostructures. Particle size and surface area, use of SEM, TEM, AFM, X-Ray Diffraction, etc. Molecular cluster of metals, semiconductors, gases, etc. Quantum wells, wires and dots.

3. Carbon nanostructure, carbon molecules, carbon clusters, carbon nanotubes Application of carbon nanotubes.

4. Catalysis, self-assembly, monolayres, surface area, porosity, colloidal.

5. Monomers and polymers, homo and copolymers. Supramolecules and dendrimers.

6. Methods of preparation of nanomaterials, chemical vapor deposition, physical vapour deposition, microscopy, lithography, colloids, emulsion and size reduction, etc.

7. Applications of nanotechnology in process industries. Energy, separations and purification, new molecules for dyes, pharmaceuticals and speciality chemicals.

8. Nano-Biotechnology: Tissue Engineering, Biosensors, drug delivery, diagnostics and therapeutics.

Text Books :

1) Introduction to nanotechnolgy
Chartes P. Poole Jr. & Frank J. Owens, Wi,ey Intersei, N.J. 2003

2) Nanotechnology, M. Ratner & D. Ratner, Pearson Education, Delhi, 2003

Reference Books:

1) Hand book of Nano Structured Materials and Nanotechnology Vol. 1 to 5, Academic Press, Boston, 2000

2) Springer Hand book of Nanotechnology, Bharat Bhusan(Ed.) Springer verlag, Berlin, 2004.

Subject: Mass Transfer with Chemical Reaction (MTCR)

12. Introduction: Significance of MTCR. Industrially important systems having Gas-Liquid, Liquid-Liquid, Liquid- Solid catalytic and non-catalytic phases.
13. Theory of MT accompanied by irreversible and reversible reactions. Theories for systems having very slow (Regime-1), slow (Regime-2), fast (Regime-3) and instantaneous reactions (Regime-4). Situations falling between very slow and slow, slow and fast, fast and instantaneous reactions. Discussion and examples falling in different above categories.
14. Theory of mass transfer accompanied by consecutive and two step reactions. Both the reactions very slow or slow, first step reaction is fast and second step slow or between slow and fast reaction regime. Both reactions fast pseudo first order (R-3) and situation where depletion of liquid reactant in the film is encountered. Systems with first step reaction are instantaneous. MTCR for two step reactions.
15. Theory of systems with absorption of gas in solutions containing two reactants. Systems involving very slow, slow, fast and instantaneous reactions with discussion on examples.
16. Systems with simultaneous absorption of two gases. Theory for cases where the depletion of liquid reactant in the film does not prevail and do prevail. Instantaneous reaction of one of the gases.
17. Systems involving both liquid phases. Theories for situations when reaction occurs in one liquid phase only. Systems with fast and instantaneous reactions and those falling between fast and instantaneous regime.
18. Theory of MTCR for solid-liquid non catalytic reactions in various types of reactors. Systems with sparingly soluble and insoluble solids.

19. Systems with reactions in fluid-fluid-solid phases. Situations with solids sparingly soluble and insoluble solids. Systems with one or more gases and solid.
20. Theory of MTCR in catalytic fluid – fluid systems. Effect of hydrodynamics and temperature in slurry reactors and fixed bed reactors.
21. Types of contactors and their relative merits for gas-liquid, liquid-liquid and gas-liquid-solid (catalytic and non catalytic) systems.

Text Book:
Heterogeneous reactions: Analysis, Examples and reactor design, Vol.2 by L K Doraiswamy and M M Sharma, John Wiley & Sons, NY, 1984
Reference Books. Gas-Liquid reactions, P V Danckwerts, McGraw Hill, NY, 1970

ELECTIVE: BIOCHEMICAL ENGINEERING

Teaching Scheme (hr/week)			Exam Scheme (Marks)				
L	T	PR	TH (3 hrs.)	SES (1 hr.)	PR	TW	TOTAL
4	-		60	40			100

(9) Introduction
Structure of cells, Cell types, Chemicals of life – lipids, sugar, polysaccharides, RNA, DNA, Amino acids, proteins etc.

(10) Enzymed Catalyzed reactions
Enzyme substrate complex & Enzyme action, Simple enzyme kinetics with one & two substrate, determination of elementary rate constant, other patterns of substrate concentration dependence, modulations & regulation of enzymatic activities, Enzyme deactivation.

(11) Kinetics of substrate utilization , product formation & bioproduction in cell culture

(12) Design & analysis of biological reactors

(13) Fermentation technology & industrial microbiology
Introduction, uses, type of fermenters, downstream processes, roll of yeast, solid state fermentation, fermented foods, lactose utilization, single cell protein, enzymes, immobilization of enzymes etc.

(14) Genetics
Introduction, plasmids, cloning vehicles, strain construction, genetic recombination, antisence RNA technology , gene machine, DNA hybridazation, genetic disease, human gene therapy, biolistic missiles. Molecular engineering, etc.

(15) Production of useful substances by microorganisms like penicillin, lactic acid, vitamins alcohol etc.

(16) Environment & energy

Text books:

(iii) Biochemical engineering fundamentals
Second edition- By J.E.Bailey & D.F.Ollis

(iv) A textbook on biotechnology- By H.D.Kumar

Reference book:

Chemical Engineering –Vol-3, Coulson & Richardson