

॥ अंतरी पेटयु ज्ञानच्योत ॥



North Maharashtra University,

Jalgaon

**Syllabus for Second Year Engineering
Degree Course in**

CHEMICAL ENGINEERING

(w.e.f. July, 1999)

NORTH MAHARASHTRA UNIVERSITY, JALGAON.

B.E. (CHEMICAL ENGG.)

SEMESTER - I

(W.E.F. JULY, 1999)

SR. NO	CODE	SUBJECT	TEACHING SCHEME (HRS/WEEK)		DURATION PAPER (hrs)	EXAMINATION SCHEME			
			LEC	PRA		MAX. MARKS	TH.	TW.	PR.
01		STRENGTH OF MATERIALS	04	02	03	100	25	—	—
02		APP. ORGANIC CHEMISTRY	04	02	03	100	25	25	—
03		ENGINEERING MATHS — III	04	—	03	100	—	—	—
04		UNIT OPERATION — I (FLUID MECHANICS)	04	02	03	100	25	—	25
05		APP. INORGANIC CHEMISTRY	04	02	03	100	25	25	—
06		COMPUTER APPLICATION — I	—	02	—	—	25	—	—
TOTAL			20	10		500	125	50	25
GRAND TOTAL			30				700		

B.E. (CHEMICAL ENGG.)

SEMESTER - II

(W.E.F. JULY, 1999)

SR. NO	CODE	SUBJECT	TEACHING SCHEME (HRS/WEEK)		DURATION PAPER (hrs)	EXAMINATION SCHEME			
			LEC	PRA		MAX. MARKS	TH.	TW.	PR.
01		INDUSTRIAL ECONOMICS & MANAGEMENT	04	---	03	100	--	--	--
02		PROCESS CALCULATIONS	04	02	03	100	25	--	--
03		CHEMICAL TECHNOLOGY - I	04	02	03	100	25	25	--
04		PROCESS HEAT TRANSFER	04	02	03	100	25	--	25
05		PHYSICAL CHEMISTRY	04	02	03	100	25	25	--
06		COMPUTER APPLICATION - II	--	02	---	--	25	--	--
TOTAL			20	10		500	125	50	25
GRAND TOTAL			30				700		

**STRENGTH OF MATERIALS
(B.E. CHEMICAL)**

Teaching Scheme:
Lectures: 4 Hrs./Week
Practicals: 2 Hrs./Week

Examination Scheme:
Paper: 100 Marks
Term Work: 25 Mark

UNIT - 1 : 10 Hrs

Introduction:

Concept of stress, strain, elastic limit, stress-strain curve for steel, Hook's law, Poisson's ratio. Stress strain relationship in elastomeric & viscoelastic materials; effect of temp. Stresses & strains in determinate axially loaded members, axial force diagrams, stresses due to changes of temp. in simple & composite members. Relation between different elastic constant.

UNIT - 2 : 10 Hrs.

Introduction to stresses in composites:

Shear force & bending moment diagrams, bending stresses & shear stresses developed in determinate beam subjected to transverse loading.

Stresses & strains in determinate circular shafts subjected to twisting moment, Twisting moment diagrams, power transmitted by shafts, flanged coupling

UNIT - 3 : 10 Hrs.

Stresses under combined loading:

Stresses on inclined sections, principal stresses & strains (analytical & Mohr's circle method), direct & bending stresses, combined torsion & bending, combined torsion-bending moment, axial thrust.

UNIT - 4 : 10 Hrs.

Thin walled pressure vessel:

Thin cylinders & spheres subjected to internal pressure.

Thick cylinders & spheres:

Lame's Formulae.

Strain energy & impact.

UNIT - 5 : 10 Hrs.

Axially loaded column:

Euler's & Rankine's formula.

Slope & deflection of beam:

Introduction & elementary treatment only, (moment area method; deflecting by strain energy method).

Practicals:

- 1) Tension test on mild steel, aluminium & plastic
- 2) Izod & Charpy impact tests for comparing the toughness of different metals like mild steel, copper, brass, aluminium.
- 3) Bending test on cast-iron & timber
- 4) Shear Test: single & double shear test on mild steel & aluminium.
- 5) Different types of hardness tests on metals i.e. Rockwell's hardness test, Brinell's hardness test, Shore scleroscope test.
- 6) Tension test on m.s. & cast iron.

All the above practicals should be performed as per the Indian standard code

Reference Books:

1. Mechanics of Materials by Timoshenko & Young.
2. Strength of Materials by Singer & Pytel.
3. Strength of Materials by Beer & Johnson.
4. Mechanics of Structures, Vol.-1 by Ashi & Junnarkar.
5. Strength of Materials by Ashi H.V.
6. Strength of Materials by Walawalkar Y.N.
7. Mechanical Testing of Plastics by S.Turner.

**APPLIED ORGANIC CHEMISTRY
(S.E. CHEMICAL)**

Teaching Scheme:
Lectures: 4 Hrs./Week
Practicals: 2 Hrs./Week

Examination Scheme:
Paper: 100 Marks
Practicals: 25 Marks
Term Work: 25 Marks

UNIT - 1 : 10 Hrs

Electron Theory:

Types of bonds, Hybridization, Bond fission.

Types of intermediates:

Structure & formation of carbonium ion, Carbanion ion & free radical, their stability. Factors affecting electron availability such as resonance, inductive effect, hyperconjugation & steric effect. Electrophiles & nucleophiles concept of acidity & basicity of organic compounds.

Reaction involving carbonium ion & carbanion & free radical with reference to the mechanism involved:

- i) Aldol condensation
- ii) Cannizzaro & Cross Cannizzaro reaction
- iii) Claisen ester condensation
- iv) Reimer-Tiemann reaction
- v) Chloromethylation, formylation reaction
- vi) Grignard reaction
- vii) Nucleophilic substitution reaction— Hydrolysis of $-Cl$ to $-OH$, $-Br$ to $-CN$ etc.
- viii) Electrophilic substitution in aromatic rings — Nitration, Sulphonation, Halogenation, Friedle Craft alkylation & acylation
- ix) Fries reaction
- x) Basic rearrangement like Fries, Beckman, Claisen etc.
- xi) Elimination reactions.

UNIT - 2 : 10 Hrs

Stereochemistry:

Basic concept of stereochemistry, Different method of representation of three dimensional molecule on paper. Conformational isomerism, Conformation of ethane & n-butane & their relative stability, Geometrical isomerism, Cis-trans isomerism shown by alkenes, Optical isomerism, Specific rotation, Enantiomers, necessary condition of optical activity, Diastereoisomers, Stereochemistry of cycloalkanes, Conformation of cycloalkanes, Concept of angle strain, Equatorial & axial bonds in cyclohexane, Conformation of other cycloalkanes, Geometrical & optical isomerism shown by cycloalkenes.

UNIT - 3 : 10 Hrs

Chemistry of Heterocyclic compounds:

Structure, sources & reactions shown by five membered rings — Furan, pyrrol & thiophene, Six membered ring of pyridine & fused rings of quinoline & isoquinoline.

Oxidation & Reduction:

Reagents & reactions involved in oxidation, reduction mechanisms & application of oxidizing & reducing agents like dissolving metal reductions, catalytic hydrogenation, Merrifield-Ponndorf-Verley reduction. NaOH, $LiAlH_4$, OsO_4 , per acids (Baeyer Villiger oxidation) oxidation, oxidation & reduction of glucose.

Basic principles & applications of:

UV, IR, Mass spectroscopy & NMR spectroscopy.

UNIT - 4 : 10 Hrs

Nitration:

Nitrating agents, Kinetics of aromatic nitration, Process equipment for nitration, Typical industrial nitration process, Vtz. Preparation of Nitrobenzene, Nitro naphthalene, Chloronitrobenzene & Nitroacetanilide.

Sulphonation & Sulfation:

Sulphonating & Sulfating agents, Kinetics & thermodynamics, industrial equipment & technique, Technical properties of sulphonates & sulphates such as aliphatic & aromatic sulphonates, Sulphonation of castor oil, naphthalene, Sulfation of alpha lauryl alcohol, dimethyl ether etc.

UNIT - 5 : 10 Hrs

Halogenation:

Thermodynamics & Kinetics of halogenation reactions, Apparatus & material of construction, Technical properties of styf chloride, DDT, Chlorobenzene, BHC, Dichlorodifluoromethane, Vinyl chloride etc.

Principles of Polymer chemistry & practice:

Principles of polymer chemistry, Industrially important polymerization products, Polystyrene, Polyvinyl chloride, Polyvinyl acetate, Epoxy resins, Phenolics, Caprolactum & Isocyanates.

Reference Books:

1. A Guide Book to mechanism in Organic chemistry — Peter Sykes, Orient Longman Ltd.
2. Organic Chemistry — Pine, Hendriksen, Gram Hammett, McGraw Hill International Co.
3. Organic Chemistry — Morrison & Boyd, Allyn Bacon Inc.
4. Organic Chemistry — I.L.Finer (Vol. I & II) etc.
5. Applications of Absorption Spectroscopy of Organic Compounds — John R.Dyre, Prentice Hall of India Pvt. Ltd.
6. Advance Organic Chemistry — Fleiser & Fleiser, Asian Publication House, Mumbai.
7. Unit Processes in Organic Synthesis — P.H.Groggins, McGraw Hill.

PRACTICALS

1. Identification of an organic compound through elemental analysis, group detection, physical constants (M.P./B.P.) (Any Six).
2. Detection & estimation of selected organic compounds like Aniline, Phenol, Formaldehyde, Acetone, Glucose, Glycerol etc. (Any Two).
3. Study experiments in spectroscopy — IR, UV, Mass, NMR.
4. Single Stage Preparations. (Any Two)
 - (i) Preparation of p-nitro acetanilide from acetanilide.
 - (ii) Preparation of Aspirin from Salicylic acid.
 - (iii) Preparation of Benzoic acid from Ethyl benzoate.
 - (iv) Preparation of Quinone (p-Benzoquinone) from Hydroquinone.

Reference Book (For Practical)

A Laboratory Hand Book of Organic Quantitative Analysis & Separation By Kulkarni V.S.
Publisher — Dastane Ramchandra & Co. Pune.

ENGINEERING MATHEMATICS – II
(S.E. CHEMICAL)

Teaching Scheme:
Lectures: 4 Hrs./Week

Examination Scheme:
Paper : 100 Marks

UNIT – 1 : 10 Hrs.

Linear Differential Equation:

Linear differential equations of order 'n' with constant co-efficients, Method of variations, Homogeneous linear differential equation, Legendre's LDE, Application to chemical engg. problem involving batch reactors.

UNIT – 2 : 10 Hrs.

(a) Simultaneous Linear Differential Equations of form :

$$\begin{aligned} 1) P_1(D)x + P_2(D)y &= Q_1(x) \\ (D)x + (D)y &= Q_2(x) \end{aligned}$$

Where, $D = d/dx$.

$$2) dx/P = dy/Q = dz/R.$$

(b) Partial Differential Equations:

Solutions of (i) One dimensional heat flow equation.

(ii) Two dimensional heat flow equation (Laplace Equation)

(iii) Laplace Equation in Polar form.

(c) Differential equation of first order & higher degree.

UNIT – 3 : 10 Hrs.

Laplace Transform:

Definition of Laplace Transform, inverse laplace transform, Properties & theorems, Laplace transforms of standard functions, Unit step functions, Ramp functions, Impulse functions, Error functions, Jump functions, Laplace inverse Transform.

Applications to the solutions of liquid systems, consisting of single tank & two tanks in series (interacting & non-interacting), Second order systems (Damped vibrator).

UNIT – 4 : 10 Hrs.

(a) Vector Differentiation:

(i) Differentiation of vector functions.

(ii) Tangential & normal components of linear acceleration, Radial & transverse components of linear velocity & acceleration, Law of central orbits.

(iii) Gradient of a scalar point function, Divergents & out of vector point function, Irrotational & solenoidal vectors, Vector Identities.

(b) Applications of vector analysis to fluid mechanics:

Continuity equation, Stream lines, Equations of motion, Bernoulli's equation.

UNIT - 6 : 10 Hrs.

(a) Vector Integration :

(i) Line Integral, Surface Integral, Volume Integral.

(ii) Green's Lemma, Stoke's Theorem, Gauss's Divergence Theorem.

(b) Finite Fourier Cosine & Sine transforms, Complex Fourier transforms, Infinite Fourier Sine & Cosine transforms, Applications of Fourier transforms to boundary value problems such as one dimensional & two dimensional heat flow problems.

Reference Books:

1. Engg. Mathematics - III By Prof. P.N.Wartikar & J.N.Wartikar.
2. Higher Engg. Mathematics By Dr. B.S.Grewal.
3. Advanced Engg. Mathematics By Wyle.
4. Advanced Engg. Mathematics - Ervin Kreegszig.
5. Fluid Mechanics - S.L.Loni.
6. Engg. Mathematics III - By Dr. Gokhale & A.N.Singh.
7. Chemical Reactor Systems - By E.Bruce Norman.
8. Process systems analysis & control - By Coughneur Donald R. (McGraw Hill,1991).
9. Modelling with differential equations in chemical engg. By Stanley M.Wales.

**UNIT OPERATION – I (FLUID MECHANICS)
(S.E.CHEMICAL)**

Teaching Scheme:

Lectures : 4 Hrs./Week

Practicals: 2 Hrs./Week

Examination Scheme:

Paper: : 100 Marks

Oral : 25 Marks

Term Work: 25 Marks

UNIT – 1:10 Hrs

Unit systems, Conversion of units.

Fluid Properties — Definition of fluid, Types of fluid — Compressible & incompressible, Newtonian & non newtonian, Laminar—Turbulent, Steady—Unsteady, Two & three dimensional flows. Non newtonian fluids, their types & examples.

Fluid statics & its applications.

Fluid flow phenomenon.

Viscosity & momentum flux, Nature of turbulence, deviating velocities in turbulent flow, intensity & scale turbulence, Eddy viscosity, Laminar & Turbulent flow in boundary layers.

UNIT – 2:10 Hrs

The continuity equation, Bernoulli's equation, Euler's equation of motion along streamline, Bernoulli equation as integration of Euler's equation, Momentum changes in fluid. The energy of fluid in motion, Pressure & fluid head, Pressure volume relationships for incompressible & compressible fluids, Reynolds number, Laminar & turbulent flow in close conduit, Hagen-Poiseuille equation, Velocity distribution in turbulent flow. The relation between maximum & average velocity. Friction factor chart. Drag reduction in turbulent flow, Friction factor in flow through channels & non-circular cross section. The friction loss from sudden expansion & contraction. Effect of fittings & valves. Distribution of flow of fluids through branched pipes. Measurement of viscosity. Darcy's law. (No Derivation).

UNIT – 3 :10 Hrs

Flow of compressible fluids:

Continuity equation, Total energy balance, Mechanical energy balance, Ideal gas equations.

Flow past immersed bodies, Drag coefficient — Friction in flow through bed of solids.

Boundary layer theory:

Simple concepts of boundary layer, Boundary layer growth along a flat plate, Thickness of boundary layer (definitions & formulae only), Separation of boundary. Hydrodynamically smooth & rough boundaries.

UNIT – 4:10 Hrs

Dimensional analysis & model studies:

Dimensional analysis, Buckingham's PI theorem, Dimensionless numbers, Application to fluid flow problem.

Two phase co-current & counter-current flow, Liquid—liquid & Gas—liquid systems, Flow patterns (No mathematical treatment).

Flow & Pressure measurement:

Principle & types of manometers, The flow through nozzles Orificemeter, Venturimeter, Pitot tube, Rotameter, Notches & Weirs.

Other flow measuring devices such as Ultrasonic flowmeters, Anemometers, Electromagnetic flowmeter, Recording rotameter, Flowmeter using thermistors.

UNIT - 6 : 10 Hrs

Pumping of fluids:

Pumping equipments for liquid. The Reciprocating pump, Positive displacement pump, Rotary pumps, Centrifugal pumps. Design & operating characteristics. NPSH Calculations. Air lift pumps.

Pumping equipments for gases:

Reciprocating Piston compressors, Rotary blowers & compressors, Centrifugal blowers & compressors including turbocompressor, Vacuum producing equipments.
Power required for compression of gases, Clearance volume, Multistage compressor efficiency.
The Power requirement for pumping through pipe line for liquids & gases.

Reference Books

1. Unit operations in Chemical Engineering — W.L. McCabe & J.C. Smith, McGraw Hill / Kogakusha Ltd.
2. Unit operations of Chemical Engineering — Volm. I, P. Chattopadhyay, Khanna Publishers, New Delhi, 2nd edition 1996.
3. Chemical Engineering — Volm. I, Richardson & Coulson.
4. Fluid Mechanics — A.K. Jain, Khanna Publication.
5. Fluid Mechanics — V.L. Steeter, McGraw Hill / Kogakusha Ltd.
6. Momentum transport operations — Gupta.
7. Fluid & particle mechanics — S.J. Mitchell, Pergamon Press Ltd.

PRACTICALS

(Minimum Eight experiments should be conducted)

1. Determination of viscosity.
2. Study of manometers — Different types.
3. Bernoulli's theorem.
4. Venturimeter. (Flow through)
5. Orificemeter. (Flow through)
6. Notch & Weirs.
7. Study of flow through pipe fittings.
8. Verification of Darcy's law.
9. Characteristics of centrifugal pump.
10. Study of flow through pipe.
11. Reynold's experiment.
12. Study of different types of fans, blowers & compressors.

**APPLIED INORGANIC CHEMISTRY
(S.E. CHEMICAL)**

Teaching Scheme:
Lectures: 4 Hrs./Week
Practicals: 2 Hrs./Week

Examination Scheme:
Paper: 100 Marks
Practicals : 25 Marks
Term Work: 25 Marks

UNIT - 1 : 10 Hrs

Ionic covalent & co-ordinate bonds, Bond properties, Bond polarity, The ionic model, Lattice energy, Applications of lattice energetics, Bonding in metals. The covalent bond, The valence bond & molecular orbital theories of the covalent bond, hybridization & resonance. The valence shell pair repulsion theory : Hydrogen Bond, Vander Waals forces.

UNIT - 2 : 10 Hrs

General aspects of the chemistry of non transition elements including the study of one representative element of each group. Study of some industrially important compounds of the non-transition metals.

Oxides & oxyacids of Nitrogen, Phosphorus, Sulphur & Halogens, Hydrogen & Hydrides, Noble gases & their compounds.

UNIT - 3 : 10 Hrs

General Principles & Processes of Metallurgy.

Occurrence, Mineral wealth of India, Ore dressing, Roasting, Calcination, Smelting, Fluxes, Slags, Types of furnaces, Refining of metals.

Metallurgical industries of Iron & Steel, Aluminium, Copper, Lead, Zinc.

UNIT - 4 : 10 Hrs

Crystallography.

Classification of engg. materials, Crystal structure, Crystal imperfections such as point imperfections & line defects imperfections, Edge dislocations, Screw dislocation, Mixed dislocation, Sources of dislocation.

Surface imperfections;

Grain boundaries, Stacking fault, Low angle boundary, Twin boundaries.

Burger Vectors.

Crystal defects & Mechanical properties of solids such as plastic deformation, Creep, Fracture, Fatigue.

UNIT - 5 : 10 Hrs

Phase Diagrams.

Definition, Usefulness of phase diagrams, Classification of phase diagrams, Construction of phase diagrams.

Phase diagram of important alloy systems such as Steels, Brasses, Cupronickel etc. Heat treatment of steels.

Phase Rule.

Definition of phase rule, Definition of terms used in phase rule, Application of phase rule, Application of phase rule in metallic systems.

Reference Books :

1. Concise Inorganic Chemistry — J.D. Lee, D. Van Nostrand Co.
2. Introduction to valency theory — Jean Wormal, McDonald technical & scientific; London.
3. Principles of Inorganic Chemistry — B.R. Puri & L.R. Sharma, S. Chand & Co. Delhi.
4. Test book of Inorganic Chemistry — P.L. Soni, Sultan Chand & Sons, New Delhi.
5. Fundamental concepts of Inorganic Chemistry — E.S. Gilreath, McGraw Hill, Kogakusha Ltd.
6. Outlines of Chemical Technology — Dryden.
7. Chemical process industries — Shreve R.N. McGraw Hill.
8. Engineering Chemistry — Jain & Jain.
9. Engineering Chemistry — Uppal.
10. Material Science — G.B.S. Narang.
11. Engineering Metallurgy & Material Science — S.F. Nayak.
12. Engineering Materials & Technology — D.D. Agrawal & S.S. Arora, Khanna Publishers, New Delhi.
13. Material Science — Raghavan.

PRACTICALS

1. Volumetric Analysis:

Preparation & Standardisation of volumetric solutions.

Acid base reaction titrations of a mixture of

- (a) Hydrochloric & Acetic acid.
- (b) Sulphuric & Phosphoric acid.
- (c) Carbonate & Bicarbonate.

2. Oxidation & Reduction titrations involving Permanganate, Dichromate, Iodine (tri iodide), Potassium bromate.

3. Precipitation Titration:

Mohr's & Volhard's titrations.

4. Complexometric titrations involving EDTA.

5. Gravimetric determination of Fe, Ni, SO_4 , Cl

6. Analysis of Fe-Ni alloy.

Reference Book

Text book quantitative Inorganic Analysis By VOGEL.

**COMPUTER APPLICATIONS - I
(S.E.CHEMICAL)**

Teaching Scheme:
Theory & Practicals :2 Hrs./Week

Examination Scheme:
Term Work:25 Marks

UNIT - 1 :

Introduction to computers, Introduction to FORTRAN 4 & FORTRAN 77 & C.
Number of character representations, Programming simple computations.

UNIT - 2 :

Control structures, Data Types.

UNIT - 3 :

Arrays - Procedure & functions.

UNIT - 4 :

More data types.

UNIT - 5 :

Files in Pascal, The GO TO statement.

*Term Work should include a minimum 5 Pascal programming exercises including listing the programmes & run on PC, based on above syllabus.

NOTE : Students should demonstrate use of PC key board editing & execution of Pascal programmes.

Text Books :

1. Introduction to Pascal By A.P.Malhur, K.S.Arora & N.U.S.Reddy.
2. Scheum's Outline Series (Theory & Problems)
Programming with Pascal, 2nd edⁿ, B.S.Goffred, Tata McGraw-Hill.
3. Computer Fundamentals & Programming in Pascal & FORTRAN 77 By
C.G.Upasani,V.C.Upasani,Vinda Publication, Jalgaon,1990.
4. Computer Programming in FORTRAN 77 By Rajaraman.

INDUSTRIAL ECONOMICS & MANAGEMENT
(S.E.CHEMICAL)

Teaching Scheme:
Lectures: 4 Hrs./Week

Examination Scheme:
Paper: 100 Marks

In this course reference will be made to the Indian conditions wherever necessary.

UNIT - 1 :10 Hrs

Nature and significance of economics, usefulness to engineering organizations.
Central problems of economic society — Forms of state activity — Laissez Faire, socialism, capitalism.
Demand & supply schedule — Equilibrium, Law of diminishing, Marginal utility, Laws of returns.

UNIT - 2 :10 Hrs

Factors of production, Land, Labour, Capital & Organization.
Price determination, Perfect competition & imperfect competition.
National income, Concept, factors & measurement, Keynesian model, Role of banks in economic development, Theories of money.

UNIT - 3 :10 Hrs

Industrial economics, Prime cost, Overhead cost, total cost, standard cost and variances.
Forms of business organisations, financial statements, Income statement & balance sheet, shares, debentures & other sources of finance.
Theory & practice of management, Principles & functional areas of managements, managements by objectives.
Production, planning & control, plant maintenance, materials managements, store control, store records, quality control.

UNIT - 4 :10 Hrs

Marketing management, concept, sales management, function of sales manager, salesman's quota, marketing research.
Personel management, manpower planning, recruitment, selection and training, job evaluation methods, merit rating, role of trade unions in industrial relations, settlement of industrial disputes.

UNIT - 5 :10 Hrs

Organisational behaviour, individual and group dynamics, Leadership, Motivation and communication, human relations approach, employee participation.
Project planning, scheduling and control, introduction to PERT and CPM.

REFERENCE BOOKS:

1. Principle of economics by Alfred Marshall.
2. Industrial engineering science & management by Banga & Sharma.
3. Economics by Samuelson P.A.
4. Introduction to Industrial Organisation by P.T.Ghan.
5. Elementary Economic Theory by Dewett & Varma.
6. Industrial Engineering & Management by O.P.Khanna.
7. Principles of Management by H.Keogte & O'Donnel.
8. PERT & CPM — Principles & application by Srinath L.S.

**PROCESS CALCULATION
(S.E.CHEMICAL)**

Teaching Scheme:

Lectures: 4 Hrs./Week

Practical: 2 Hrs./Week

UNIT - 1 :10 Hrs.

Units & Dimensions:

Basic & derived units, Dimensional analysis, Dimensional & empirical equations. Different ways of expressing units of quantities & physical constants.

Properties of Gases, Liquids & Solids:

Ideal & real gas laws, Critical properties, Properties of mixtures & solutions & phase equilibria. Kay's rule.

UNIT - 2 :08 Hrs.

Basic Concept:

Humidity & saturation, Psychrometric chart, Solubility diagrams.

Thermodynamics:

Concepts of & calculations involving energy, heat, work & enthalpy of reversible & irreversible process.

UNIT - 3 :12 Hrs.

Material Balance:

Concepts of limiting & excess reactants, Tie element, Recycle, Purging, Bypass etc. in batch, staged & continuous operations in systems with & without chemical reaction, & in unit operations.

UNIT - 4 :10 Hrs.

Thermochemistry:

Heats of formation, combustion, solution, dilution etc. & the effects of pressure & temp. on them. Temp. of reaction. Energy balance for system with & without chemical reaction. Process efficiency.

UNIT - 5 :10 Hrs.

Unsteady material & energy balances, Energy balances for nuclear, electrochemical, photochemical & biochemical processes.

Less conventional separation processes.

Typical industrial applications.

Examination Scheme:

Paper : 100 Marks

Term Work: 25 Marks

Reference Books:

- 1) Stoichiometry: Bhal B. I. & Vera, Tata McGraw Hill.
- 2) Basic Principles & Calculations in Chemical Engineering by Himmelblau D.M. , Prentice Hall.
- 3) Chemical Process Principles, Part - 1 by Hougen O.A., Watson K. M. & Ragatz R.A. Asia Publishing House, Mumbai.
- 4) Process Calculations for Chemical Engineers -- Chemical Engineering Education Development Centre, I.I.T. Madras.
- 5) Process Calculations for Chemical Engineers By Durga Prasad Rao.
- 6) Chemical Engineering Vol. 8, Richardson & Coulson.

Term Work

Term work shall consists of study & solution of the typical industrial problems (Minimum 15)
Problems based on —

1. Properties of gases/liquids/solids.
2. Humidity & Saturation.
3. Thermodynamics.
4. Thermochemistry.
5. Material Balances.
6. Energy Balances.
7. Less conventional separation processes.

(2)

CHEMICAL TECHNOLOGY - I
(S.E. CHEMICAL)

Teaching Scheme:
Lectures : 4 Hrs./Week
Practicals: 2 Hrs./Week

Examination Scheme:
Paper: : 100 Marks
Practicals : 25 Marks
Term Work: 25 Marks

UNIT - 1 : 10 Hrs.

Introduction, Salient features of chemical industries in India, Role of chemical engineers in chemical process industries.

Unit processes & Unit operations, Symbols of unit operations, Flow sheet.

Industrial gases:

CO, CO₂, H₂, O₂, N₂, SO₂, C₂H₂, Synthesis gas, Helium & Nitrous oxide.

Industrial Carbon:

Activated Carbon, Lamp Black, Carbon black, Graphite, Industrial Diamond.

UNIT - 2 : 10 Hrs.

Industrial Acids:

Sulphuric acid, Nitric acid, Hydrochloric acid, Phosphoric acid.

Marine Chemicals:

Salt from sea water, By products of salt industry i.e. Bromine & Iodine.

UNIT - 3 : 10 Hrs.

Chlor-alkali industries:

Soda ash, Bicarbonates, Miscellaneous alkalis, Chlorine, Caustic soda, Bleaching powder, Hypochlorites & chlorites.

Electrolytic & Electrochemical industries:

Chlorates, Perchlorates, Primary & secondary cell, Artificial abrasives, Calcium carbides, Silicides & Nitrides.

UNIT - 4 : 10 Hrs.

Fertilizers:

Ammonia, Nitrogenous fertilizers, Phosphatic fertilizers, Potassium fertilizer, Compound & Complex fertilizers, Miscellaneous fertilizers.

Nuclear industries:

Nuclear industries & Reactors, Feed materials, Uranium, Nuclear reactors, Reprocessing of nuclear materials, Protection from radioactivity.

UNIT - 5 : 10 Hrs.

Materials of construction:

Selecting the right materials, Material failure, Material available, Important alloys of ferrous & non-ferrous metals.

Inorganic Pigments:

Study of the following pigments e.g. White, Black, Blue, Yellow.

Safety in chemical industry:

Chemical hazards, Chemical as source of occupational diseases & poisoning control of chemical plants, Hazards.

Reference Books :

- 1) Chemical Process Industries by R. N. Shreve & J. A. Brink, McGraw Hill Ltd.
- 2) Outlines of Chemical Technology by Charles E. Dryden.
Editors - M. Gopal Rao & Marshall Sittig, East West Press.
- 3) Chemical Technology by Pandey Shah.
- 4) Chemical Technology, Vol.-1 & 2 by Venkateshvarlu, Educational Development Centre I.I.T. Madras.

Practicals :

1. Purification of common salt.
2. Analysis of brass alloy.
3. Analysis of cement.
4. Analysis of pyrites.
5. Analysis of fertilizers.
6. Estimation of available chlorine in bleaching powder.
7. Preparation of some compounds as Ferrous ammonium sulphate, Sodium thiosulphate, Copper sulphate, Chrome Alum

(1)

**PROCESS HEAT TRANSFER
(S.E. CHEMICAL)**

Teaching Scheme:

Lectures : 4 Hrs./Week

Practicals: 2 Hrs./Week

Examination Scheme:

Paper: : 100 Marks

Practicals : 25 Marks

Term Work: 25 Marks

UNIT - 1 :08 Hrs

Heat transfer by conduction in solids:

Fourier's law of heat conduction, Steady state heat conduction through walls (single & multilayers), Heat flow through a cylinder, Unsteady state heat conduction, Derivation of Fourier's heat conduction equation in three dimensions, Equation for one dimensional conduction, Heat conduction through a semi infinite slab, Lumped capacity method of unsteady state conduction. Principles of heat flow in fluids.

UNIT - 2 :12 Hrs

Typical heat exchange equipment, Countercurrent & parallel flows, Energy balances, Overall heat transfer coefficient, Log Mean Temperature Difference, Individual heat transfer coefficient, Calculation of overall coefficient from individual coefficients, Transfer units in heat exchangers. Heat transfer to fluids without phase change.

UNIT - 3 :10 Hrs

Regimes of heat transfer in fluids, Heat transfer by forced convection in laminar & turbulent flow, Dimensional analysis method, Use of empirical equations, Heat transfer by forced convection outside tubes, Natural convection.

Heat transfer to fluids with phase change.

Droplet & Film-type condensation, Coefficients for film type condensation, Practical use of Nusselt's Equations, Applications to petroleum industries.

UNIT - 4 :08 Hrs

Heat transfer to boiling liquids:

Boiling of saturated liquid maximum flux & critical temp. drop, Minimum flux & film boiling.

Radiation heat transfer:

Fundamentals of radiation, Black body radiation, Kirchoff's law, Radiant heat exchange between non black surfaces, Combined heat transfer by conduction, convection, radiation.

UNIT - 5:12 Hrs

Heat exchange equipments:

Heat exchangers Single pass 1-1 exchanger, 1-2 Shell & tube heat exchanger, Correction for LMTD for cross flow, Simple design calculations in heat exchangers.

Chemical processes & heat transfer in plate & frame heat exchanger.

Evaporation:

Liquid characteristics & types of evaporators, Single effect evaporator calculations, Pattern of liquor flow in multiple effect evaporator.

Applications to sugar industry, Salt removal.

Entrainment separation, Removal of non condensed gases in chemical practices.

TEXT BOOK

Unit operations in Chemical Engineering — W.L.McCabe & J.C.Smith, McGraw Hill /
Kogakusha Ltd.

Reference Books

1. Chemical Engineering — Volm. I, Richardson & Coulson.
2. Process Heat Transfer — Kern D.Q. McGraw Hill Book 1NC New York, 1950.
3. Introduction to Chemical Engineering — W.L.Badger & J.T.Banchero, McGraw Hill International Book Company, New Delhi, 25th printing, 1982.

PRACTICALS

FOR TERM WORK (ANY EIGHT)

1. Conductivity of metals and/or insulator.
2. Experiment on Pin fins.
3. Experiment on forced convection apparatus.
4. Experiment on natural convection apparatus.
5. Determination of emissivity of test plate.
6. Stefan Boltzman apparatus.
7. Parallel flow/Counter flow heat exchanger.
8. Study of Pool boiling phenomenon & critical heat flux.
9. Study of heat transfer in evaporator.
10. Temperature profile in a rod.
11. Study of evaporators.
12. Dropwise & Filmwise condensation.

**PHYSICAL CHEMISTRY
(BETHEMICAL)**

Teaching Scheme:
Lectures : 4 Hrs./Week
Practicals: 2 Hrs./Week

Examination Scheme:
Paper : 100 Marks
Practicals : 25 Marks

Term Work: 25 Marks

UNIT - 1 : 10 Hrs.

Kinetic Theory Of Gases : Equation of state of ideal & real gases, Principle of corresponding states, Compressibility factor, Estimation of molecular diameters, Critical constants, Molecular velocities, Probability distribution of velocities, Mean free path, Collision diameter, Collision number, diffusion, Graham's law of diffusion, Viscosity & heat conduction in gases, Knudsen diffusivity & surface diffusion.

Heat Capacity Of Gases — C_p & C_v problems.

UNIT - 2 : 10 Hrs.

Chemical Kinetics : Objective of chemical kinetics, Rate of reaction, Velocity constant of a reaction, Elementary reaction steps & rate expressions, Order & molecularity of reaction, Complex reactions, Factors influencing the reaction rates, Integrated rate expressions for first, second, third & zero order reaction (with example), Methods for determining order of reactions, Experimental investigation of reaction kinetics.

Arrhenius equation, Relationship between chemical kinetics & thermodynamics. Problem based on above topics.

UNIT - 3 : 10 Hrs.

Classical Chemical Thermodynamics :

Objective & scope, definition of thermodynamic systems, State property etc.

Heat work reversibility, Maximum work, Isothermal & adiabatic process, First law of thermodynamics, Thermochemistry, Thermochemical laws, Standard heats of formation, Second law of thermodynamics, Entropy, Entropy changes, Enthalpy & free energy, Gibb's Helmholtz equation, Third law of thermodynamics. Problem based on above topics.

Criteria of chemical equilibrium, Le chatelier's theorem, its application to some systems like ammonia, sulphuric acid, nitric acid.

UNIT - 4 : 10 Hrs

Colligative Properties:

Colligative properties, Lowering of vapour pressure, Determination of molecular weights from vapour pressure, Lowering, Measurement of vapour pressure lowering.

Osmosis, Osmotic pressure, Measurement of osmotic pressure, The laws of osmotic pressure, Determination of molecular weight from osmotic pressure, Osmosis & semipermeability, Reverse osmosis.

Elevation in boiling point, Determination of molecular weight from boiling point elevation, Depression in freezing point, Determination of molecular weight from freezing point depression, Determination of freezing point depression.

Electrolytes: Conductors & nonconductors, Metallic conduction, Electrolytic conductance, Determination of conductance, Migration of ions, Transport number, Determination of Transport number. Kohlrausch's law & its application. Arrhenius theory of dissociation.

UNIT-5 :10 Hrs

Surface Phenomena:

Surface tension of liquids, Adsorption, Adsorption of gases by solids, Adsorption isotherm, The Langmuir's adsorption & application.

Colloids & Emulsion: Types, Methods of preparation, Determination of particle size, Properties.

Reference Books:

- 1) Physical Chemistry by G. M. Borron, Benjamin publishers.
- 2) Thermodynamics for Chemist by Glasstone s.
Affiliated east press New Delhi.
- 3) Principles of Physical Chemistry by Maren - Prutton.
- 4) Elements of Physical Chemistry by S. Glasstone & Leeds.
- 5) A text book of Physical Chemistry by Puri & Sharma.

PRACTICALS

(Any 10 Experiments)

1. Determination of radius of micromolecules by Ostwalds Viscometer.
2. Determination of molecular weight of substance by depression in freezing point method.
3. Determination of equivalent weight of metal by coulometer.
4. Determination of molecular weight of substance by elevation in freezing point method.
5. Determination of heat of solution of KNO_3 .
6. Determination of rate constant of hydrolysis of methyl acetate by dilute HCl & show that the reaction is first order.
7. Determination of rate constant of hydrolysis of ethyl acetate by NaOH & show that the reaction is second order.
8. Determination of surface tension of liquids by stalagnometer.
9. Determination of strength of acid by conductometric titration.
10. Determination of heat of neutralisation of strong acid & strong base by calorimeter.
11. Determination of water equivalent of the calorimeter taking heat of neutralisation of strong acid & strong base.
12. Determination of molecular weight of the given liquid by Victor Mayer method.

COMPUTER APPLICATIONS - II
(S.E. CHEMICAL)

Teaching Scheme:
Theory & Practicals :2 Hrs./Week

Examination Scheme:
Term Work:25 Marks

UNIT - 1 :

Computer Applications for trial error solution of Vander Waaf's equation.

UNIT - 2 :

Computer Applications for Newton - Raphson solution of Vander Waaf's equation.

UNIT - 3 :

Computer Applications for Gauss - Jordan Method for solving simultaneous equations.

UNIT - 4 :

Computer Applications for integration of Polynomial equation with the help of Simpson's Rule.

UNIT - 5 :

1. Computer Applications for C.S.T.R.
2. Computer Applications for Optimization of steam balance.

*Term Work should include a minimum 5 Basic\FORTRAN\Pascal\C programming exercises including listing of the programmes & run on PC, based on above chemical engg. syllabus.

Text Books :

1. FORTRAN 77 2nd edⁿ, Davis & Hoffman, Tata McGraw-Hill.
2. The 'C' Programming language, 2nd edⁿ, Kernighan & Ritchie, PHI.
3. Programming with 'C', B.S. Golifred, Tata McGraw-Hill.
4. Programming with Pascal, 2nd edⁿ, B.S. Golifred, Tata McGraw-Hill.