University of Pune
Structure for SE Chemical Engineering- 2008 Course

S. E. TERM – I

Subject Code No.	Subject	Teaching Scheme			Examination Scheme				Total
		Theory	Practical	TW/ Drawing	Paper	Practical	Oral	TW	
209341	Chemistry I	4	4		100	50	--	--	**150**
209342	Fundamentals of Chemical Engineering	1		2	--	--	--	50	**50**
209343	Chemical Engineering Fluid Mechanics	3	2	-	100	50	-	-	**150**
209344	Chemical Engineering Materials	3	2	-	100	--	50	-	**150**
209345	Process Calculations	4		-	100	--	--	--	**100**
209346	Technical Communication	1	2	-	-	-	-	50	**50**
207004	Engineering Mathematics –III	4	-	-	100	-	-	-	**100**
	Total	**20**	**10**	**2**	**500**	**100**	**50**	**100**	**750**

TERM – II

Subject Code No.	Subject	Teaching Scheme			Examination Scheme				Total
		Theory	Practical	TW/ Drawing	Paper	Practical	Oral	TW	
209347	Chemistry II	4	4		100	50	-	-	**150**
209348	Heat Transfer	4	2		100	50	-	-	**150**
209349	Principles of Design	3	-	2	100	-	-	50	**150**

209350	Chemical Engineering Thermodynamics I	3	-	-	100	-	-	-	**100**
209351	Mechanical Operations	4	2		100	50		-	**150**
211353	Workshop Practice	-	2	-	-	-	-	50	**50**
	Industrial Training I (to be evaluated in Fifth Semester)	-	-	-	-	-	-	-	-
	Total	**18**	**10**	**2**	**500**	**150**		**100**	**750**

SEMESTER I

209341 Chemistry-I

Teaching Scheme	Examination Scheme
Theory: 4 Hrs/Week	Paper: 100 Marks
Practical : 4 Hrs/Week	Practical: 50 Marks

Unit –I Bonding and reactivity 08 lectures

Covalent bonding- Introduction to VBT (revision). Molecular orbital theory, MO structures of s-s, s-p , p-p overlaps , molecular orbital structure of butadiene, benzene, MO energy diagrams for diatomic molecules H_2 , O_2 , CO. Aromaticity-conditions necessary for delocalization of electrons, resonance structures stability rules, resonance in phenol, aniline, ,benzaldehyde ,nitrobenzene molecules, Effect of inductive effect and resonance on pKa and pKb values of acids and bases. Reaction intermediates –carbonations, carbanions, free radicals and their stability. Types of reagents, types of reactions

Unit-II Reaction mechanisms

Substitution at saturated carbon (S_N^1 , S_N^2)- mechanism, kinetics, stereochemistry, factors favoring. Electrophilic aromatic substitution in benzene and mono substituted benzenes , activating and deactivating groups , nitration, Friedal-Craft reactins, sulphonation,diazotization. Nucleophilic substitution on on carbonyl carbon. Addition of HX on C=C 1,2-Eliminations- E_1 mechanism, E_2, (Saytzeff,Hoffman products) ,factors favoring. Rearrangements- Beckman , Claisen , Reformatsky.

Unit-III Instrumental methods of analysis 08 lectures

Conductometry : Conductance by solutions (specific, equivalent), cell constant , measurement of conductance, conductometric tirations. Potentiometry: Ion selective electrodes, theory of potentiometric titrations, potentiometric titration curves.Flame photometry: Principles of flame photometry, applications

Unit –IV Kinetics and photochemistry 08 lectures

Kinetics : Rate of reaction, rate constant, order of reaction, kinetics of first and second order reactions, numericals on above, Activated complex theory of reaction rates kinetics of complex reactions. Photochemistry : Introduction and importance, Stark-Einstien law,photochemical rate law, examples of photochemical reactions kinetics of i) H_2, Cl_2 reaction ii) dimerisation of anthracene ,

Unit-V Chromatography, Batteries 08 lectures

Chromatography ,: Adsoption and partition principles, Study of TLC, column , HPLC, Gas Chromatography and their applications. **Batteries**: Batteries and their importance,types of cells, terms-capacity, power density, cycle life , energy efficiency, NICAD cell, Lithium batteries (lithium ion ,polymer electrolyte,lithium alloy) , Fuel cells (alkaline, PAFC, polymer electrolyte membrane) , their applications

Unit-VI Heterocyclic compounds , Dyes 08 Lectures

Aromaticity, preparation, reactions of pyrrole, furan, pyridine, quinoline.

Dyes- Nomenclature, methods of application, colour and chemical constitution (chromophore-auxochrome theory), classification of dyes on the basis of chemical structure, diazotization and coupling for azo dyes ,synthesis of crystal violet, alizarin, methyl orange, phenolphthalein.

Practicals

1 Diameter of solute molecule by viscosity measurements.
2 To determine rate constant of first order reaction of acid catalysed hydrolysis of ester.
3 Preparation of benzoic acid from benzamide , crystalisation and purity checking by TLC.
4 Conductometric titration between strong acid and strong base
5 Conductometric titration between $AgNO_3$ and NaCl
6 To estimate the weight of ferrous sulphate in given solution by potentiometric titration
7 To determine pKa value of weak acid by pH metric titration
8 To find molecular wt. of solute by depression in freezing point of solvent
9 Partition coefficient of a iodine between water and CCl_4
10 To estimate sodium ion conc. In solution by flame photometer
11 Colorimetric estimation of cobalt/ nickel ion in solution

(Any **seven expts** of above)

12 Identification of given organic compound (with maximum one functional group) by systematic analysis
(Minimum eight compounds)

Note – practical examination will be for four hours and students will perform TWO experiments(one organic analysis and one other)

Reference Books

1 Instrumental methods of chemical analysis ----B.K.Sharma , Goel publ.)
2 Instrumental methods of chemical analysis ----Chatwal –Anand

3 Organic chemistry –I L Finar volume I and II

4 Engineering Chemistry ---S.S.Dara

5 Physical chemistry –P L Soni

6 Inorganic chemistry –Huheey

7 Inorganic chemistry ----Cotton, Wilkinson

8 Spectroscopy ---Kalsi

209342 Fundamentals of Chemical Engineering

Teaching Scheme	Examination Scheme
Theory: 1 Hrs/Week	TW : 50Marks
TW : 2 Hrs/Week	

Unit-I:

INTRODUCTION: introduction to chemical engineering; history of chemical engineering and chemical technology; Scope of Chemical Engineering, Nature of Industries.

Unit-II

Basic Chemical Calculations: units and dimensions, conversion and conversion factors.

Basic Concepts: concept of mole, weight percent, mole percent, normality, molarity, molality, vapor pressure, partial pressure.

Unit-III:

Unit Operations: Introduction, Definition, examples like Size reduction, sedimentation, filtration, Distillation, evaporation, absorption, extraction, fluid handling, fluid-solid contacting, fluid-solid separation, fluid storage, mixing, solid handling, crystallization, drying, leaching, size separation.

Unit-IV:

Unit processes: introduction to unit processes with simple examples like sulphonation, polymerization, oxidation, hydrogenation, saponifoication, etherification, nitration , chlorination.

Unit-V:

Basic concept of chemical processes: Conversion, Yield, efficiency, flow diagram, flow sheets, & block diagram, with examples.

Unit-VI:

Process instrumentation and safety: Temperature scale, measurement of temperature using bimetallic thermometer, mercury expansion thermometer, gas filled thermometer. Pressure scales & units, measurement of pressure. Level measurement. Flow measurement. Measurement of viscosity. Personal protection devices.

Reference Books

1. Unit operations in chemical engineering by W.L. McCabe and J.C. Smith and Peter Harriott, Mc Graw Hill 5th ed. 1993.

2. Himmelblau, D.H, Basic Principles and Calculations in Chemical Engineering, 5th Edn., Prentice Hall, New York, 1990.

3. Coulson J M and Richardson J F, Chemical Engineering, Vol. I and II, Pergamon Press, NY, 1990.

4. Badger and Banchero, Introduction to Chemical Engineering, 1st Edn., McGraw Hill, NewYork, 1954.

TW: Based on the study of the Laboratory equipments. Minimum 8.

209343 Chemical Engineering Fluid Mechanics

Teaching scheme	Exam scheme-
Lecture: 3 hrs. /week	Paper: 100 Marks
Practical: 2 hrs. /week	**Practical: 50 marks**

UNIT 1: INTRODUCTION

Fluid, Properties of fluid, Classification of fluids, Newton's law of viscosity, Rheological classification of fluids, Pressure and temperature dependence, Types of flow, Lines to describe the flow, Application of fluid flow in Chemical Engineering.

UNIT 2: FLUID STATISTICS AND ITS APPLICATIONS

Hydrostatic equilibrium, Barometric equation, Hydrostatic equilibrium in centrifugal field; Concept of atmospheric, gauge and absolute pressure, manometers, pressure measurement by simple and differential manometer.

Basic equations of fluid flow: Continuity equation, equation of motion, mechanical energy balance equations.

UNIT 3: FLOW OF INCOMPRESSIBLE FLUIDS IN CONDUITS

Shear stress distribution, Relation between skin friction and wall shear, The friction factor; Laminar flow through circular pipe, on inclined plane, through annular space,; Relation between average and maximum velocity, Darcy Weisbach equation, Friction factor chart.

UNIT 4: BOUNDARY LAYER AND DIMENSIONAL ANALYSIS

Concept of hydrodynamic boundary layer, Growth over a flat plate, Different thickness of boundary layer, Fundamental dimensions of quantities, Dimensional homogeneity, Dimensional analysis by Reyleigh's method and Buckingham's method, Dimensionless numbers.

UNIT 5: FLOW PAST IMMERSED BODIES

Drag and drag coefficient, Flow through beds of solids, Motion of particles through fluids, Fluidization, Introduction to compressible flow.

UNIT 6: TRANSPORTATION AND FLOW METERING

Pipes and tubings, Joints and fittings, Major and minor losses, Different types of valves,; Flow measurement using orificemeter, venturimeter, pitot tube and rotameter; Pumps: Centrifugal pump, Performance of centrifugal pumps.

Reference Books

1. McCabe, Smith, Hariot, "Unit Operations in Chemical Engineering" , 7th ed.,
2. .M. Coulson, J.F. Richardson, with J.R. Backhurst and J.H. Harker, Coulson "Richardson Chemical Engineering, Volume-1" , 6th ed., Butterworth-Heinemann, 1999
3. R K Bansal, "A Textbook of Fluid Mechanics and Hydraulic Machines", 9th ed. Laxmi Publications, New Delhi, 2004
4. *Modi, L.P., Seth, S.M., "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi,2002*
5. Bird R.B., Stewart W.E., Lightfoot E.N. "Transport phenomena" 2ed., Wiley Publications,2002

209344: Chemical Engineering Materials

Teaching Scheme:	**Exam Scheme:**
Lecture: 3 hr/ week	**Paper: 100 Marks**
Practical: 2 hr/week	**Oral: 50 Marks**

---

1. Introduction to materials and their principle properties, Simple stresses and strains, Concept of stress, strain, shear stress, shear strain, Hooks law, Elastic limit, stress-strain curve for mild steel and elastomeric materials, factor of safety, Poisson's ratio, Strain energy due to axial load and impact. Introduction to determination of mechanical properties of materials ASTM methods. 7 Lect.

2. Basic principles in their selection for fabrication and erection of chemical plant.

Testing of materials, destructive and nondestructive tests, structure of atom and chemical bonds, crystal structures and their influence on material properties, Deformation and slip processes. 8 Lect.

3. Metals and their alloys: Iron – carbon diagram, Ferrous and nonferrous alloys, mild steel, special steels, stainless steels, brasses, brasses, aluminum alloys and titanium alloys, high and low temperature material, insulation, refractories. Methods for fabrication, rolling, bending, central punching, revetting, welding. Nickel and its alloys: aluminum and its alloys
9 Lect.

4. Corrosion and its control: Corrosion attack methods, Different types of corrosion: chemical, biochemical, and electrochemical; Internal and external factors affecting corrosion of chemical equipments, Methods to minimize corrosion, corrosion charts for process equipments. Polyaniline and Anticorrossive surface coatings electrochemical corrosion prevention corrosion case studies from the chemical industry 7
Lect.

5. Polymers, natural & synthetic: Selection of polymetric materials for equipment linings, fiber reinforced plastic, application of special polymers like Nylon 66, Teflon in engineering. Polymer Composites 7 Lect.

6. Ceramic and glasses: Definition of ceramics and glasses; interaction between structure, processing, and properties;
Applications of ceramic and glass materials; Crystalline and non-crystalline ceramics, silicates, refractories, clays, cements, glass vitreous silica, and borosilicate**.**

6 Lect.

Reference Books

1. James F. Shacketford, introduction to material science, McMillan publishing compony, Newyork ISBN 1990.
2. D.Z. Jestrazebaski, properties of Engg. Materials, 3rd Ed. Toppers.Co. Ltd.

3. J.L. Lee and Evans, Selecting Engineering materials for chemical and process plants, Business Works 1978.
4. “Design of machine elements”, Spott M.M. Prentice Hall.
5 A text book of machine design, Khurmi R.S. and Gupta J.K.
6.Material Science & Metallurgy for Engineers, Dr.V.D.Kodgire, Everest Publishing House.

Practical:

1. Microstructure observation and study of metals and alloys. (Minimum five) low carbon steel, medium carbon steel, high carbon Steel, tin, bronze, brass, phosphor bronze.

2. Study of properties of polymeric materials; impact test and polymeric Tests.

3. Corrosion testing (salt spray test for different samples such as plain carbon steel, chrome plate steel, galvanized steel.)

4. Different types of hardness test on metals. i.e. Rockwell hardness test, Brinell hardness test, Shore scleroscope tests.

5. Izod and Charpy impact test on mild steel, copper, brass and aluminum.

6. Chemical analysis of metals and alloys (Any one element to be analysed e.g. molybdenum from stainless steel, carbon from steel, copper from brass etc.

7. Macrostructure observation: (flow lines observation in forging by macro etching sulphur printing of steel.)

8. Study experiments based in, i) Dye penetration ii) Rubber lining, iii) Ultrasonic test, iv) Heat treatments.

*** Minimum 8 experiments to be performed from the above suggested practicals.**

209345: Process Calculations

Teaching scheme: **Exam scheme:**

Lectures: 4 Hrs / week **Paper: 100 Marks**

Unit 1. Basic Chemical Calculations **(4 lectures)**

Introduction to unit processes and operations and their symbols, process flow sheet, Dimensions and Units, Basic Chemical Calculations including mole, equivalent weights, solids, liquids, solutions and their properties, properties of gases.

Unit II. Material Balances without Chemical Reactions **(9 lectures)**

Concept, material balance calculations, recycling and bypassing operations, introduction to unsteady state processes.

Unit III. Material Balances involving Chemical Reactions (9 lectures)

Concept, material balance calculations, electrochemical reactions, recycling and bypassing operations, metallurgical operations.

Unit IV Energy Balances (8 lectures)

Concept, energy and Thermochemistry, energy balances, heat capacity of pure substances and mixtures, latent heats, enthalpy of pure substances and mixtures, absolute enthalpy, heat of reaction, adiabatic reactions, thermo chemistry of mixing processes, dissolution, liquid-liquid mixtures, gas-liquid systems.

5. Unit VI Stoichiometry and Unit Operations (10 lectures)

Distillation, absorption and stripping, extraction and leaching, crystallization, psychrometry, drying, evaporation, introduction to stoichiometry and industrial problems.

6. Combustion (5 lectures)

Calorific values, coal, liquid fuels, gaseous fuels, air requirement and flue gases, combustion calculations.

Reference Books

1. Stoichiometry by Bhatt & Vora
2. Basic Principles & Calculations in Chemical Engineering by Himmelblau.
3. Chemical Process Priciples Part I by Hougen & Watson

209346 Technical Communications

Teaching Scheme: **Exam Scheme:**

Lecture: 1 hr/ week **TW: 50 Marks**

Practical: 2 hr/week

Professional speaking: Interview process, characteristic of job interview, pre-interview preparation techniques, frequently asked interview questions.

G.D – Nature of G.D, G.D and debate, importance of G.D, strategy of G.D, techniques for individual contribution, group interaction strategy.

Presentation skills– Nature and importance of oral presentation, planning the presentation, preparing the presentation, organizing your presentation, rehearsing and presentation. Improving delivery, checklist for making presentation.

Professional writing: Routine business letters – letter writing skills, form and structure, style and tone, enquiry letters, replies to enquiry letters, P.O, letters urging action, complaint and adjustment letters.

Sales letters – Sales letters, organizing sales letters, opening, body, closing.

Resume and job application – Writing resume, job application letters.

Business memo– Principles and fundamentals, business memo, letter versus memo, form and structure of memo, writing strategies, characteristics of effective memo.

E-mail messages- Principles and fundamentals, advantages of Email messages, characteristics successful Email messages.

Reports – Nature and significance, types of reports, format of reports, writing strategies.

Proposals – Nature and significance, type of proposal, structure of formal proposal, writing tips.

Technical articles– Nature and significance, types of technical articles, journal articles and conference paper, review and research articles, writing strategies.

Soft skills: What are soft skills? , global competition, hard skills (technical skills) versus soft skills, emotional intelligence, interpersonal skills, motivation, leadership skills, decision making, negotiation skills, business etiquette, problem solving skills, conflict management, stress management, crisis management, social understanding, behaviors traits, teamwork.

Human values: Morals, values, ethics, integrity, work ethics, virtues, respect for others, caring, sharing, honesty, courage, time management, cooperation, commitment, empathy, self confidence, challenges in work place, spirituality.

Engineering Ethics: Overview, senses of engineering ethics, variety of moral issues, types of enquiries, moral dilemma, moral autonomy, moral development, consensus

And controversy, profession, models of professional roles, responsibility, ethical theories, self control, self interest, customs, religion, self respect, overview of safety, responsibility and human rights, case study.

Global issues: Globalization, multinational corporations, environmental ethics, computer ethics, moral leadership, code of ethics.

Engineers as managers: Foresight as future managers in organizations, as consulting engineers, as experts, as advisors, as CEO's, Entrepreneurship skills.

Term Work:

Term work and theory are considered to be integral part of the course.

Term work shall consist of a journal consisting of regular assignments and presentations completed in the practical class and at home, the total number of assignments should not be less than twelve, generally covering the topics mentioned above. As far as possible, submission should be word processed on a computer using a standard package by the student himself.

For the purpose of assignments, extensive use of research papers published in technical journals and articles published in magazines and newspapers may be ma\de so that there is no repetition by the individuals. Oral presentations exercises and group discussions should be conducted batch wise so that there is a closer interaction. Students should be sent to industrial visits for exposure to corporate environment.

Reference Books

1. Krishna Mohan and Neers Banarge (1996), Developing Communication Skills, Macmillan India Ltd.
2. Day (1995), How to write and publish a scientific paper, Cambridge Lowpriced Edition.
3. Bernice Hurst (1996) , Handbook of communication skill, 2nd Edition, Kogan page
4. Strunk W (Jr.) and White E.B., The elements of style, Latest edition, Macmillan Publishing Company, New York
5. University of Chicago Press Manual of Style, Publ. University of Chicago Press, (Chicago. Latest Edition).
6. M Ashraf Rizvi , Effective technical communication, Mc graw Hill
7. R.S. Naagarazan, Professional ethics and human values, New Age international Publishers.
8. Elizabeth Valuance, Business Ethics at work.

207004 ENGINEERING MATHEMATICS – III (2008 Course)

Teaching Scheme: Examination Scheme:
Lectures: 4 hrs./week Paper: 100 marks
Duration: 3 hrs.

Section I

Unit I: Linear Differential Equations (**LDE**) (09 Hours)

Solution of n^{th} order LDE with Constant Coefficients, Method of Variation of Parameters, Cauchy's & Legendre's DE, Solution of Simultaneous & Symmetric Simultaneous DE.

Unit II: Applications of DE (09 Hours)

Applications of LDE to chemical engineering problems involving batch reactions and mass spring systems.
Solution of Partial Differential Equations (**PDE**)
(1) $\partial u/\partial t = a^2 (\partial^2 u/\partial x^2)$, (2) $\partial^2 u/\partial t^2 = a^2 (\partial^2 u/\partial x^2)$ and (3) $(\partial^2 u/\partial x^2) + (\partial^2 u/\partial y^2) = 0$
by separating variables only. Applications of PDE to problems of Chemical and allied engineering.

Unit III: Fourier Transform (**FT**) (09 Hours)

Fourier Integral theorem. Sine & Cosine Integrals. Fourier Transform, Fourier Cosine Transform, Fourier Sine Transforms and their inverses. Finite FT, Application of FT to problems on one and two dimensional heat flow problems.

Section II

Unit IV: Laplace Transform (**LT**) (09 Hours)

Definition of LT, Inverse LT. Properties & theorems. LT of standard functions. LT of some special functions viz. error, 1^{st} order Bessel's, Periodic, Unit Step, Unit Impulse, ramp, jump, parabolic, Si(t) and Ei(t). Problems on finding LT & inverse LT.

Unit V: Vector Calculus (09 Hours)

Physical Interpretation of Vector Differentiation. Radial, Transverse, Tangential & Normal components of Velocity and Acceleration. Vector differential operator. Gradient, Divergence & Curl. Directional derivative. Vector identities. Line, Surface & Volume integrals. Work done. Conservative, Irrotational & Solenoidal fields. Scalar potential. Green's Lemma, Gauss's Divergence and Stoke's Theorem.

Unit VI: Applications of Laplace Transforms & Vector Calculus (09 Hours)

Applications of Vectors to problems in Fluid Mechanics, Continuity equations, Stream lines, Equations of motion, Bernoulli's equations.
Applications of LT for solving ordinary differential equations, liquid level systems, consisting of single tank and two tanks in series (interacting and non-interacting systems), second order systems (damped vibrator).

Text Books:

1. Advanced Engineering Mathematics by Peter V. O'Neil (Cengage Learning).
2. Advanced Engineering Mathematics by Erwin Kreyszig (Wiley Eastern Ltd.).

Reference Books:

1. Engineering Mathematics by B.V. Raman (Tata McGraw-Hill).
2. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
3. Advanced Engineering Mathematics, Wylie C.R. & Barrett L.C. (McGraw-Hill, Inc.)
4. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).
5. Applied Mathematics (Volumes I and II) by P. N. Wartikar & J. N. Wartikar (Pune Vidyarthi Griha Prakashan, Pune).
6. Advanced Engineering Mathematics with MATLAB, 2e, by Thomas L. Harman, James Dabney and Norman Richert (Brooks/Cole, Thomson Learning).

SEMESTER II

209347 Chemistry-II

Teaching Scheme	Examination Scheme
Theory: 4 Hrs/Week	Paper: 100 Marks
Practical : 4 Hrs/Week	Practical: 50 Marks

Unit –I Adsorption and Catalysis **08 Lectures**

Introduction to Freundlich and Langmuir theories of adsorption (revision) ,adsorption from solution, B.E.T. Theory of adsorption of gases, ,activation energy, , numerical on above.Catalysis- characteristics, types, adsorption theory of catalysis, promoters ,poisons, enzyme catalysis, industrial applications of catalysts;

i) Zeolites- structure, properties (adsorption, catalysis), applications as catalyst for reactions(amination of alcohol. NO_x pollution control, alkylation ,cracking convertion of methanol),
ii) Co-ordination catalysts- In Wacker process, cabonylation,photolysis of water
iii) Oxide catalysts- oxide surface structure,application of V_2O_5, $Fe_2(MoO_4)$ for oxidation.

Unit – II Biomolecules **08 Lectures**

Carbohydrate: Cyclic structure of glucose, cellulose, starches. Starch based products, Cellulose acetate, nitrate ,ether. Proteins-formation of peptide linkage, features of peptide linkage, alpha-helical configuration, beta-pleated structure, primary, secondary, tertiary, quaternary structures of proteins. Amino acids-alpha- amino acids, classification, properties and reactions. General introduction of cofactors and coenzymes, catalytic site of enzyme, factors affecting enzyme activity , classification of enzymes. Vitamins and harmones (in short)

Unit-III Spectroscopy

UV-Visible spectroscopy: Lambert-Beer law, λ_{max} , calculation of λ_{max} for olefinic and cyclic structures, instrumentation , interpretation of spectra , applications. IR spectroscopy: Introduction, instrumentation (double beam spectrophotometer) characteristic absorption in functional and finger print regions, interpretation of spectra , applications

Unit-IV Transition metals and Co-ordination chemistry 8 lectures

Electronic configuration of first series transition metals, shapes of d- orbital characteristics(variable oxidation states, magnetic nature, co-ordination, colour of transition metal compounds). Ligands, C.N. and geometry , nomenclature of complexes, chelates . Theories of co-ordination- i) Werner ii) EAN iii) VBT for tetrahedral and octahedral complexes iv) CFT (including crystal field splitting in octahedral field, CFSE , for octahedral complexes , applications of CFT)

Unit -V a) Green chemistry 04 lectures

Introduction , significance of green chemistry, issues related to chemical reactions, parameters for efficiency of reaction, principles of green chemistry with explanation, . Green pathways for synthesis of adipic acid from glucose, ibuprofen, polycarbonate, indigo, carbaryl, acrylamide

b) Biotechnology 04 lectures

Introduction, scope and importance of biotechnology, organisms involved, types of fermentation, applications of biotechnology for production of ethyl alcohol, glucose from cellulose , n-butanol, antibiotics, energy. Membrane bioreactors, bioremediation.

Unit-VI Waste treatments 8 lectures

Characteristics of municipal waste(brief), B.O.D., determination, C.O.D. determination, municipal waste treatment (preliminary, primary, secondary, tertiary).Water /waste treatments: charcoal treatment, reverse osmosis, electro dialysis, ultrafiltration. Types and characteristics of industrial waste(textile ,dairy, paper, tannery, dyeing), hazardous chemical waste treatments technology ,treatment and disposal.

Practicals:

1. Dissolved oxygen in water sample by Winkler method.

2 Estimation of Cu^{++} ions by spectrophotometer

3 Adsorption of acetic acid on charcoal to verify Freundlich isotherm

4 Determination of purity of sod. Bicarbonate by gravimetry

5 Determination of purity of sod. Carbonate by titration method

6 Determination of C.O.D. of a wastewater

7 Estimation of nickel ions by gravimetry

8 Preparation of tetramine copper (II) sulphate, pot. trioxalato aluminate (any one)

9 Preparation of biodiesel
10 Estimation of glucose/acetone in solution
11 Oxidation of toluene to benzoic acid by oxidation with $KMnO_4$
12 Chlorine demand of a water sample

13 Conversion of benzoic acid into its anilide derivative and its crystalisation

14 Purification of organic compounds by crystalisation and sublication (one each)

15 Application of XRD for study of adsorption

16 Preparation of tris ethylene diammine nickel (II) thiosulphate

17 Separation and identification of two metal ions by column chromatography

(Any 13 experiments of the above)

Note – practical examination will be for four hours and students will perform TWO experiments

Reference Books

1 Instrumental methods of chemical analysis -B.K.Sharma , Goel publ.)
2 Handbook of industrial chemistry --James Kent (CBS Publication)
3 Biotechnology --B.D.Singh(Kalyani publication)
4 Engineering Chemistry --S.S.Dara

5. Inorganic chemistry---J D Lee (ELBS)
6. Inorganic chemistry –Huheey
7 Inorganic chemistry ----Cotton, Wilkinson

8 Spectroscopy ---Kalsi

209348 HEAT TRANSFER

Teaching scheme	Exam scheme-
Lecture: 4 hrs. /week	Paper: 100 Marks
Practical: 2 hrs. /week	**Practical: 50 marks**

Unit-I ***Basics concepts of heat transfer***

The relation of heat transfer with thermodynamics, conduction heat transfer, convection heat transfer, radiation heat transfer, Thermal conductivity, thermal insulation, units and dimensions.

Unit-II ***Heat conduction***

General differential equation of conduction, Steady state heat conduction through a plane slab, composite slab, hollow cylinder, composite cylinder and hollow sphere. Contact resistance, heat transfer between surfaces and surrounding, critical thickness of insulation. Heat transfer through extended surfaces of uniform cross section.

Unit-III ***Convection heat transfer***

Convection without phase change:

Natural and forced convection, principal heat balance equation in laminar flow Empirical equations for convection heat transfer in turbulent flow through tubes, through annulus and over a flat plate. Dimensional analysis, dimensional groups used in heat transfer

Convection with phase change:

Condensation: Modes and features, Nusselt's equation, condensation on vertical and horizontal plate

Boiling: Pool boiling of saturated liquid, types of boiling, concept of critical heat flux

Unit-IV ***Radiation***

Thermal radiation, black body radiation, properties of radiation, laws of radiation. The radiation shape factor, various cases of radiation between two surfaces, radiation shields

Unit-V ***Heat Exchangers***

Basic types of heat exchangers, overall heat transfer coefficient, fouling factor. Double pipe heat exchanger design by LMTD and effectiveness-NTU methods calculations of overall heat transfer coefficient and area), Shell and tube heat exchangers

Unit-VI *Evaporation*

Introduction, types of evaporators, material and energy balance, boiling point elevation, capacity and economy, multiple effect evaporators

Practical:

1. Heat conduction

2. Natural convection

3. Thermal radiation-determination of emissivity

4. Double pipe heat exchanger

5. Shell and tube heat exchanger

6. Plate Heat exchanger

8. Heat transfer in agitated vessels

9. Double effect evaporator

10. Open pan evaporator

11. Heat pipe demonstrator

12. Fluidized bed heat transfer

Reference Books:

1. J P Holman, "**Heat Transfer**" 9th edition, Tata McGraw Hill Publications, New Delhi (2004)
2. Frank Kreith, Mark Bohn, "**Principles of Heat Transfer**" 5th edition, PWS Publishing company, Boston (1997)
3. S. P. Sukhatme, "A Textbook on Heat Transfer", 4th ed, Universities Press (India),., 2005
4. D. Q. Kern, "Process Heat Transfer", 11th ed., Tata Mc Graw Hill Publication, New Delhi
5. Bird R.B., Stewart W.E., Lightfoot E.N. "Transport phenomena" 2ed., Wiley Publications,2002

209349 PRINCIPLES OF DESIGN

Teaching scheme	Exam scheme-
Lecture: 3 hrs. /week	Paper: 100 Marks
Drawing: 2 hrs. /week	**Term work: 50 marks**

Unit 1. ***Basic Principles of design:***

Design Factors, Design procedure, Codes and Standards, Optimization,Design Loads, Combined Loading in Equipments, Concept of Stress and Strain, Types of Stress and Strain Curves for Ductile and Brittle Materials, Factor of Safety, Young's Modulus, Stress Concentration, Fatigue, Creep, Endurance Limit, Poisson's Ratio, Shear Modulus, Resilience, Toughness, Mass Moment of Inertia, Polar Moment of Inertia, Section Modulus, Correlation between Torque and Power

2. ***Basic Principles of Strength of Material***

Bending Stress and Shear Stress, Torsional Shear Stress, Variation of Bending and Shear Stress across the Section, Shear Force and Bending Moment Diagram for Simply- supported and Cantilever Beams, Principle Stresses and Planes, Theories of Failure.

3. ***Design of Machine elements***:

a) Direct, Torsional and Bending Stresses in Shaft, Design of Shaft subject to Bending, Twisting and a combination of Bending and Twisting,

b) Keys and Couplings: Types of Keys and Couplings, Design of a Sunk Key, Effect of Keyways, Requirement of a good Shaft Coupling, Design of Flanged Coupling and Muff Coupling.

4. ***Design of Machine Elements***

a) Belts and Pulleys - Selection of Belt Drive, Types of Flat and V- belt Drives, Types of Belts and Pulleys, Working Stresses in Belts, Velocity Ratio, Slip and Creep of the Belt, Length of Belt Drives, Ratio of Driving Tension for Flat and V-belt Drives condition for Transmission of Maximum Power.

b) Types of Bearings, Classification of Bearings, Sliding Contact Bearing, Rolling Contact Bearing, Application / Properties of Lubricants, Sliding and Rolling Contact Bearings, Sommeteld Number, Design Procedure for

Journal Bearing, Dynamic Load Rating for Rolling Contact Bearing, Life of a

Bearing, Reliability of a Bearing.

5. ***Design of Joints***

Types of Joints: Welded and Pipe Joints, Cotter and Knuckle Joints, Types of Pipe and Welded Joints, Design of Circular Pipe Joints and Flanged Pipe Joint, Strength of Transverse and Parallel Fillet Joints.

6. ***Piping, Valves and Pumps :***

Pipes and Piping Joints, Stress in Pipes, Design of Pipes, Pipe Sizing for Flow of Liquids and Gasses, Classification of Valves and Pumps and their selection criteria, Sizing of Control Valves, Valve Characteristics, Characteristic Curves for Pumps, NPSH calculation for pumps,.

Term Work

1. **Assembly drawings of valves.**
2. **Assembly drawings of pumps.**
3. **P & I Draigm.**
4. **Design of shaft, key, coupling, pulley.**
5. **AUTOCAD assignment on A4 sheets**

Sectional drawing of assemblies of components with the help of AUTOCAD

Components: Knuckle joints flange coupling, stuffing box, cotter Joints etc.

Reference Books:

1.Coulson & Richardson's Chemical Engineering, Vol 6, 4/e, R K Sinnot, Butterworth - Hienemann, MA

2.Strength of Material, Andrew Pytel & Ferdinando L Singer, Addision-Wesley Inc., Massachusetts

3.A Textbook of Machine Design, R S Khurmi & J K Gupta, Eurasia Publishing House

209350: Chemical Engineering Thermodynamics-I

Teaching Scheme:	**Exam. Scheme:**
Lectures: 3 hrs/week	**Theory: 100 Marks**

1) **Introduction to chemical engineering thermodynamic and first law:** The scope of thermodynamics, fundamental and derived quantities, first law of thermodynamics: Formation of 1^{st} law of thermodynamics, state and path functions, thermodynamic systems, steady state flow system, phase rule, reversible process heat capacity. (7 lectures)

2) **Volumetric properties of pure fluids:** The P.V.T. behavior of pure substance, the viral equation, the ideal gas, the constant volume, constant pressure, adiabatic, polytrophic processes, real gas, applications of Viral equation, critical properties, Vander Wall equation, Benedict- Webb – Rubin equation, Redlich –Kwong equation. (8 lectures)
3) **Heat effects:** sensible heat effects, temperature dependence of heat capacity, standard heat of reaction, standard heat of formation, standard heat of combustion, temperature dependence of ΔH^0, heat effects of industrial reactions. (3 lectures)
4) **Second law of thermodynamics:** Carnot cycle, entropy, mathematical statement of 2^{nd} law, statement of 3^{rd} law. (9 lectures)
5) **Thermodynamic properties of Fluids:** Maxwell relationships, residual properties, residual properties by equations of state, two-phase systems, Clausius- Clapeyron equation, type of thermodynamic diagram, availability. (8 lectures)
6) **Refrigeration:** Refrigeration cycle (p-v, t-s, h-s, and h-x diagrams) for vapor compression and Adsorption refrigeration systems, Evaluation of COP, duty and load of such cycles, heat pumps, liquefaction. (5 lectures)

Reference Books:

1) Introduction to Chemical Engineering Thermodynamics: J. M. Smith & H. C. Vanness
2) Principles of Chemical Equilibrium : Kenneth Denbigh
3) Chemical Engineering Thermodynamics : B. F. Dodge
4) Chemical Engineering Thermodynamics : T. E. Daubert
5) Thermodynamics for Chemists: Glasstone S.
6) Thermodynamics for Chemical Engineers: Weber and Meissner
7) Chemical and Process Thermodynamics: B. G. Kyle
8) Molecular Thermodynamic: Praunitz
9) Chemical Engineering Thermodynamics: Narayanan
10) Chemical Engineering thermodynamics: Y.V.C. Rao

209351 : Mechanical Operations

Teaching scheme:	**Examination scheme:**
Lectures: 4 Hrs / week	**Paper: 100 Marks**
Practicals: 2 Hrs / week	**Practical: 50 Marks**

1. Particle Technology and size reduction: 10 Lect.

Particle size and shape, Mixtures of particles, Determination of particle size, Standard screen series, screen analysis, Screen effectiveness and capacity, Industrial screening equipments.

Crushing efficiency, energy requirements calculations by using different crushing laws, Size reduction equipments: Primary crushers, secondary crushers, Intermediate & fine grinders, Ultra fine grinders, Cutting machines, Open circuit & Closed circuit grinding.

2. Handling And Transport of Solids: 8 Lect.

Storage of solids, characteristics of Bulk solids. Conveyors: Working principles, Construction, Advantages, Disadvantages and design calculation of Screw conveyors, Belt Conveyors, Chain & Flight conveyors, Bucket elevators, Pneumatic conveyors.

3. Mixing and Agitation: 5 Lect.

Necessity of mixing & agitation in chemical industries, Types of Impellers & propellers, Different flow patterns in mixing, Calculation of power requirement of mixing equipment, Mixing equipment of pastes & viscous material, Solid – Solid Mixing, Agitator selection.

4. Filtration: 6 Lect.

Filter media and filter aids, classification of filtration, pressure drop through filter cake, filter medium resistance, specific cake resistance, Continuous Filtration, Washing and dewatering of filter cakes, Centrifugal filtration.

5. Fluid – Solid systems: 12 Lect.

a. Motion of particles in liquid, drag force, drag coefficients

b. Gravity settling method: Terminal velocity, Stoke's law and Newton's law, free settling, sink and float method, differential settling.

c. Sedimentation and thickening: Batch sedimentation, equipments for sedimentation, Kynch theory of sedimentation, calculation of area and depth of continuous thickeners, batch thickeners, and continuous thickeners.

d. Fluidization: flow through packed beds, characteristics of fluidized systems, minimum fluidization velocity, types of fluidization, applications of fluidization technique, spouted beds and fixed bed.

6. Benefication Operations, Mineral dressing and centrifugal settling operations:

4 Lect.

Froth flotation, magnetic separator, scrubbers, fiber and fabric filter, and electrostatic precipitators. Mineral jig, cyclone separator, hydro cyclone types and centrifuges, centrifugal clarifier.

Reference Books

1. McCabe W. L. &Smith J.C. “Unit Operations in Chemical Engineering”. McGraw Hill Publications.
2. Coulson J. M. & Richardson J.F. “Chemical Engineering Vol. 2”, Pergamon Press.
3. Badger W. L & Banchero J.T. “Introduction to Chemical Engineering”, McGraw Hill Publications.
4. Foust A. S “Principles of Unit Operation”.
5. George G. Brown, “Unit operations”, CBS publishers and distributors.

List of Practical

Minimum numbers of Experiments to be performed for the term work eight out of the following list.

1. To determine effectiveness of given set of standard screen.
2. To determine energy consumption and crushing law constants for jaw crusher.
3. To determine Critical speed of Ball mill & Average particle size of the product obtained in ball mill **OR** Average particle size of product obtained in Bhrustone mill.
4. To determine mixing Index of a mixture in Ribbon Blender. **OR** To determine mixing Index of mixture in Sigma Mixer.
5. To determine filter medium resistance and cake resistance by using Vacuum Leaf filter.
6. To determine filter medium resistance and cake resistance by using Plate & frame Filter Press **OR** by using centrifuge machine.
7. To determine area of batch thickener by conducting batch sedimentation test.
8. To determine minimum fluidization Velocity & to verify Ergun’s Equation.
9. To determine separation efficiency by using froth flotation cell.
10. To determine separation efficiency by using magnetic separator.
11. To determine efficiency of Cyclone separator.
12. Any one Experiment based on the syllabus of subject Mechanical Operation.

211353: Workshop Practice

Teaching Scheme: **Exam Scheme:**

Practical: 2 hr/week **Term Work: 50 Marks**

Topics to be covered at the time of practicals:

1. General purpose Machine Tools.
2. Joining Processes.
3. Pattern making and Foundry.

List of Practicals:

1. One job on lathe with taper turning thread cutting, drilling.
2. One job on lathe + milling machine – keyway cutting, gear cutting etc.
3. One job of welding.
4. One job of pattern making and foundry – one simple job of non- ferrous material.

A record of the work performed should be presented in the form of a journal based on topics under (A) and the jobs completed under practicals (B).

Reference Books:

Hajra Choudhary; Workshop Technology; Vol. I & II

Industrial Training I

(To be evaluated in Fifth Semester)

Industrial training shall be as per norms of the institute. The list of industries where students can undergo training will be approved and published by the department. Period of training will be during vacation without affecting regular class work/examination. During the training, the student shall study/analyze the operation/process/design or the complete industry in detail. They shall submit a report in detail identifying the problems with their suggestion for solution and conclusions to the department through the faculty coordinator assigned for the same at the end of the training period. The minimum duration of industrial training is 1-2 weeks. A committee consisting of two faculty of the department will carry out assessment of the training. Students shall make a presentation before the committee.