# University of Pune

## Structure for SE Chemical Engineering- 2008 Course

### S. E. TERM – I

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<td>Theory</td>
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<td>TW/ Drawing</td>
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### TERM – II

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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 H₂, O₂, 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_N¹, S_N²)- mechanism, kinetics, stereochemistry, factors favoring. Electrophilic aromatic substitution in benzene and mono substituted benzenes, activating and deactivating groups, nitration, Friedal-Craft reactions, sulphonation, diazotization. Nucleophilic substitution on on carbonyl carbon. Addition of HX on C=C, 1,2-Eliminations- E₁ mechanism, E₂ (Saytzeff, Hoffman products), factors favoring. Rearrangements- Beckman, Claisen, Reformatsky.

Unit-III  Instrumental methods of analysis  08 lectures

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-Einstein law, photochemical rate law, examples of photochemical reactions, kinetics of i) H₂, Cl₂ reaction ii) dimerisation of anthracene.
Unit-V Chromatography, Batteries 08 lectures
Chromatography: Adsorption 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, crystallisation and purity checking by TLC.
4. Conductometric titration between strong acid and strong base.
5. Conductometric titration between AgNO₃ 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 CCl₄.
10. To estimate sodium ion conc. in solution by flame photometer.
(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, saponification, etherification, nitration, chlorination.

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

Unit-VI:

Reference Books

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

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.


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 Anticorrosive surface coatings electrochemical corrosion prevention corrosion case studies from the chemical industry 7 Lect.

5. Polymers, natural & synthetic: Selection of polymeric 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

5 A text book of machine design, Khurmi R.S. and Gupta J.K.

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.)

* Minimum 8 experiments to be performed from the above suggested practicals.
**209345: Process Calculations**

**Teaching scheme:**
Lectures: 4 Hrs / week

**Exam scheme:**
Paper: 100 Marks

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### 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 Principles Part I by Hougen & Watson
209346 Technical Communications

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<th>Exam Scheme:</th>
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<td>Lecture: 1 hr/ week</td>
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<td>Practical: 2 hr/week</td>
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**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 made 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**
6. M Ashraf Rizvi, Effective technical communication, Mc graw Hill
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)

\[
\begin{align*}
\frac{\partial u}{\partial t} &= a^2 \left( \frac{\partial^2 u}{\partial x^2} \right), \\
\frac{\partial^2 u}{\partial t^2} &= a^2 \left( \frac{\partial^2 u}{\partial x^2} \right) & (2) & \text{and} & (3) & (\frac{\partial^2 u}{\partial x^2}) + (\frac{\partial^2 u}{\partial y^2}) &= 0
\end{align*}
\]

by separating variables only. Applications of PDE to problems of Chemical and allied engineering.

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

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, $\text{Si}(t)$ and $\text{Ei}(t)$. Problems on finding LT & inverse LT.

Unit V: Vector Calculus (09 Hours)

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:

Reference Books:
SEMESTER II

209347 Chemistry-II

Teaching Scheme

Theory: 4 Hrs/Week
Practical : 4 Hrs/Week

Examination Scheme

Paper: 100 Marks
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\textsubscript{x} pollution control, alkylation, cracking conversion of methanol),

ii) Co-ordination catalysts - In Wacker process, cabonylation, photolysis of water

iii) Oxide catalysts - oxide surface structure, application of V\textsubscript{2}O\textsubscript{5}, Fe\textsubscript{2}(MoO\textsubscript{4}) for oxidation.

Unit – II Biomolecules  
**08 Lectures**


Unit-III Spectroscopy

UV-Visible spectroscopy: Lambert-Beer law, \( \lambda_{\text{max}} \), calculation of \( \lambda_{\text{max}} \) for olefinic and cyclic structures, instrumentation, interpretation of spectra, applications. IR spectroscopy: Introduction, instrumentation (double beam spectrophotometer) characteristic absorption in functional and fingerprint 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 crystallisation
14. Purification of organic compounds by crystallisation and sublimation (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  
Lecture: 4 hrs./week
Practical: 2 hrs./week

Exam scheme-  
Paper: 100 Marks
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:

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


6. Piping, Valves and 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 Sinnott, Butterworth - Hienemann, MA


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 1st 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 virial 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 $\Delta H^0$, heat effects of industrial reactions.  
   (3 lectures)

4) **Second law of thermodynamics:** Carnot cycle, entropy, mathematical statement of 2nd law, statement of 3rd 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:  
Lectures: 4 Hrs / week  
Practicals: 2 Hrs / week  

Examination scheme:  
Paper: 100 Marks  
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.


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:

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

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:

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.