

Applied Mathematics – IV
S.E. Sem. IV [CHEM]

EVALUATION SYSTEM

	Time	Marks
Theory Exam	3 Hrs.	100
Practical and Oral Exam	–	–
Oral Exam	–	–
Term Work	–	25

SYLLABUS

1. Fourier Series

- Definition of Fourier Series, Full range Fourier series for $(0, 2\pi)$, $(0, 2l]$, $(-\pi, \pi)$ and $(-1, 1)$.
- Half Range sine and cosine series, Parseval's identity and complex form of Fourier series.

2. Fourier Transform and Matrices

- Orthogonal and Orthonormal function, Fourier sine and cosine integral.
- Characteristic values and vectors, their properties for Hermitian and real symmetric matrices, Cayley Hamilton theorem (without proof).

3. Matrices

- Diagonalization of square matrix, Functions of square matrix, minimal polynomial, Derogatory and non-derogatory matrix.
- Quadratic form, Congruent and orthogonal reduction of quadratic forms, Rank, Index, Signature and Class value of quadratic form.

4. Complex Integration

- Line integral of a function of complex variable, Cauchy's theorem for analytic function, Cauchy's integral formula (with proof) and deductions.
- Singularities and Poles, Taylor's and Laurent's Series (without proof).

5. Applications of Complex Integration and Numerical Method

- Residue Theorem and its Evaluation, Residue Theorem application to evaluate real integrals of type $2\pi \int f(\cos \theta, \sin \theta) d\theta$ and $\int_{-\infty}^{\infty} f(x) dx$.
- Numerical solution of partial differential equation, Liebmann's method for Laplace equation, Derivative boundary conditions, Explicit and implicit methods for the heat equation.
- Crank Nicolson Method, Bender Smidth method.

6. Optimization (NLPP)

- Objective function and constraint maxima and minima for one and two constraint, Hessian Matrix, Lagrange's multiplier method (for not more than two constraints), Kuhn-Tucker conditions.

Reference :

1. Basic Principles & Calculations in Chemical Engineering – (D.M. Himmelblau) Prentice Hall of India Pvt. Ltd.
2. Stoichiometry- (Bhatt, B.I.U., Vora S.M.) Tata McGraw Hill
3. Process Calculation for Chemical Engineers (Ch.Durga Prasad Rao and D.V.S. Murthy) McMillan.
4. Elementary Principles of Chemical Processes (R.M. Felder, R.W. Rousseau) John Wiley Sons, Inc, New York, 1978.



Advanced Chemistry – II
S.E. Sem. IV [CHEM]

EVALUATION SYSTEM

	Time	Marks
Theory Exam	3 Hrs.	100
Practical Exam	3 Hrs.	25
Oral Exam	–	–
Term Work	–	25

SYLLABUS

1. Instrumental Methods of Analysis

- Chromatography – paper, Gas-liquid, Thinlayer, HPLC and applications.
- Optical Methods (Instrumentation and applications) UV, IR, flame photometry, NMR-Spectroscopy. Moss Bauer spectroscopy, Electron spin resonance spectroscopy (spectral interpretation and characterization of compounds).

2. Potentiometry, Conductometry, Amphotometry

- Polarography methods and applications, Titrations, Acid-base, precipitation and complexometric.

3. Ion Exchange and Solvent Extraction Techniques

- Ion exchange resins, cation and anion exchangers, Desalination by ion exchange and separation of lanthanides.
- Solvent extraction introduction, Distribution ratio, Calculations, Batch extraction, Counter current extraction. Numericals based on solvent extraction.

4. Colloidal State

- Origin of charge on colloidal particles concept of double layer, Helmholtz and system models, analytical idea of electrokinetic phenomenon, electrophoresis, electro-osmosis, streaming potential and Dorn effect.
- Colloidal electrolytes, Donnan Membrane equilibrium, Emulsions O/W and W/O types emulsifying agents surfactant, Micelle formation. Applications of surfactants in detergents, Pesticide formulations and food industry.

5. • Synthesis and Properties of malonic ester and Aceto acetic ester.

- Aromaticity and aromatic character, Introduction, Discussion of aromatic character of Benzene, Furan, Pyridine, Thiophene, Naphthalene, Anthracene, Huckel rule of aromaticity.

6. Reactions, Mechanism and Industrial Applications

- Knoevenagel's, Gatterman, Gatterman Koch, Kolbe's, Sommelet reaction, Wurtz fitting, Perkins, Reformatsky, Darzen condensation and Hoffmann Elimination.



Fluid Flow
S.E. Sem. IV [CHEM]

EVALUATION SYSTEM

	Time	Marks
Theory Exam	3 Hrs.	100
Practical Exam	2 Hrs.	25
Oral Exam	–	–
Term Work	–	25

SYLLABUS

1. Introduction

- Scope and application of fluid flow, Systems of units, conversion of units.
- Flow of fluids : Introduction, Internal energy, Types of Fluid-Incompressible fluid, Ideal gas, Non-ideal gas, The fluid in motion-Continuity, Momentum change in a fluid, Energy of a fluid in motion, Pressure and fluid head, Constant flow per unit area, Separation. Pressure-volume relationship – Incompressible and Compressible fluid.

2. Flow in Pipes and Channels

- The nature of fluid flow – Flow shearing characteristics of a fluid. The drop in Pressure for flow through pipe-Shear stress in fluid. Resistance to flow in pipes, Calculation of drop in pressure along a pipe, Roughness of pipe surface, Types of flow, Flow with free surface – Laminar flow down an inclined surface, Flow in open channels, Non-Newtonian behaviour-Steady-State shear dependant behaviour, Time-dependant behaviour, Viscoelastic behaviour, Characterisation of non-Newtonian fluids, Relation between rheology and structure of material, Flow in pipes and channels of regular geometry, General equations for pipe line flow, Turbulent flow.

3. Flow of Compressible fluids

- Flow of gas through orifice-Isothermal flow, Non-isothermal flow. Flow in pipe-Energy balance for flow of ideal gas, Isothermal flow of an ideal gas in a horizontal pipe, Non-isothermal flow of an ideal gas in a horizontal pipe, Adiabatic flow of an ideal gas in a horizontal pipe, Flow of non-ideal gas.

4. Flow of Multiphase Mixtures

- Two-phase gas-liquid flow-Flow regimes and flow patterns. Hold up, Pressure momentum and energy relations, Erosion, Newtonian and Non-Newtonian flow past immersed bodies, Friction in flow through beds of solids, motion of particles through fluids, fluidization.

5. Flow and Pressure Measurements

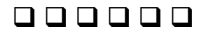
- Fluid pressure-Static pressure, Pressure measuring devices, Impact cell, Measurement of Fluid flow the Pitot tube, orifice meter, venturimeter, pressure recovery in orifice type meters, Variable area meters-Rota meters, other methods of measuring flow rates, Types of Valves.

6. Liquid Mixing

- Types of mixing-Single phase liquid mixing, mixing of immiscible liquids, Gas-liquid mixing, Liquid-solid mixing, Gas-liquid–solid mixing, Solid-Solid mixing, Mixing mechanisms-Laminar and turbulent mixing. Scale-up of stirred vessels, Power consumption in stirred vessels–Low and High viscosity systems, Flow patterns in stirred tanks, Mixing equipment.
- Pumping of Fluids : Introduction, Pumping equipment for liquids-Reciprocating pump, Positive displacement rotary pumps, Centrifugal pump, Pumping equipment for gases-reciprocating piston compressors, Rotary blowers and compressors, Centrifugal blowers and compressors, Power requirement for pumping through pipelines.

Reference :

1. Chemical Engineering Vol. 1,2 Fifth Edition, Butterworth Heinemann (*Coulson J.M. Richardson J.F. Backhurst J.R. and J.H. Harker*)
2. Unit Operations of Chemical Engineering (*McCabe, W.L. Smith, J.C. Harriot*) Mc Graw Hill International Edition.
3. Introduction to Chemical Engineering (*Badger W.L. Banchero J.T.*)



Strength of Materials and Fabrication Technology

S.E. Sem. IV [CHEM]

EVALUATION SYSTEM

	Time	Marks
Theory Exam	3 Hrs.	100
Practical Exam	–	–
Oral Exam	–	–
Term Work	–	25

SYLLABUS

1. Stress and Strain

Types of stresses and strains. Modulus of elasticity, Modulus of rigidity. Bulk modulus, Poisson's ratio. Relations between elastic constants. Study of stress-strain curve. Thermal stresses and strains for simple and composite bars.

Shear Force and Bending Moment

Basic concept of shear force, bending moment and axial force. Shear force, bending moment and axial force diagrams for statically determinate beams (Excluding beams with internal hinge).

2. Bending Stresses

Theory of simple bending. Expression for bending stress, position of neutral axis, section modulus, moment of resistance, Problem on Bending Stresses in symmetrical and unsymmetrical sections.

Shear Stresses in Beams

Distribution of shear stress across plane sections used commonly for structural purposes.

Direct and Bending Stresses

Introduction, Load eccentric to one or both the axes. Resultant stresses at the corners. Condition for no tension in the section. Practical application- Chimneys involving lateral loads.

3. Columns and Struts

Introduction, Classification of columns. Equivalent length concept, Euler's theory for long columns with different end conditions, {Derivation only for column with both ends hinged), Rankine's Hypothesis for columns.

Thick and Thin Cylinders

Thin and Thick cylinders under internal pressure. Design of composite shell using Lamé's theory.

4. Fabrication Technology

- Cold working and Hot working of metals, cold working-shearing and cutting, forming and Drawing, Bending of sheets, rods and pipes .Hot working - Hot spinning and Hot rolling.
- Welding-classification, types. Gas welding, glass cutting, electric arc welding, spot welding, TIG/MIG welding, Arc welding, Plasma, ultrasonic, laser beam welding, Flaws in welding, Simple Calculations involving strength of welded joints, Riveted Joints, Temporary Joints.
- NDT, Visual methods. Magnetic particle test. Surface Penetrate liquid method. Radiography, Ultrasonic technology

- 5. • Plastics, Types of plastics, important properties, additives used, molding characteristics etc.
- Refractories-Types, applications, fabrication with refractory materials. Lining of Vessels /pipes, PVC, rubber, refractory, FRP glass, lead lining.

6. • Injection molding. Types, molding equipments, technique, process parameters and their effect on quality of molding, various defects in molding, causes and remedies, Blow molding, Types- Extrusion, injection and stretch blow molding, process parameters and their effect on quality of molding. Defects in molding, causes and remedies. Rotational molding and fabrication with FRP.

Reference :

1. Mechanics of materials (*E.P.Popov*) Prentice Hall of India Pvt. Ltd.
2. Engineering Mechanics (Timoshenko & Young) Tata McGraw Hill Book Publishing Co.
3. Mechanics of Structures (Vol.I) (*S.B. Junarkar*) Charotar Publishers.
4. Strength of Materials (*R.K. Rajput*) S. Chand Publications
5. A Course in Workshop Technology Vol I 7 Vol II (*B.S. Raghuvanshi*) Dhanpat Rai & Sons
6. Workshop Technology Vol I & Vol II (*Hajra & Chourdary*) Media Promoter & Pub. Pvt. Ltd.
7. Machine Drawing (*N.D. Bhatt & Panchal*) Chartor Publications.
8. ASM Handbook Vol 17 – Welding, Brazing & Soldering, ASM International USA



Material Science and Technology

S.E. Sem. IV [CHEM]

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	Time	Marks
Theory Exam	3 Hrs.	100
Practical Exam	–	–
Oral Exam	–	–
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SYLLABUS

1. Introduction to Materials

Scope of materials science and technology and its importance in chemical course-B.E. Chemical Engineering.

Atomic Structure and Chemical Bonding

Structure of the Atom, the quantum states, the periodic table, ionization potential, electron affinity and electro negativity. Wave nature of electron and Schrodinger wave equation. Chemical Bonding : Bond energy, Bond type and bond length, ionic bonding. Covalent bonding, metallic bonding, secondary bonding (dispersion bonding, dipole bonding and hydrogen bonding). Variation in bonding character and properties.

2. Crystal Structure and Determination

Geometry Crystals The space lattices (a brief mention of the Bravais lattices), basis, cubic and hexagonal crystal structure. Crystal directions and planes. (Miller indices and planes) Structure Determination by X-ray diffraction: The Bragg law of x-ray diffraction, the Bragg spectrometer the powder method and structure determination.

Crystal Imperfections

Point imperfections, dislocations or line imperfections, Burgers vector, critical resolved shear stress, dislocation theory, surface imperfection and volume imperfection.

3. Structure of Solids

Ionically-bonded structures, properties of ionic solid, covalently-bonded structures, properties of covalent solids, metallically-bonded structures and their properties, molecularly-bonded structures and their properties.

Deformation of Materials

Elastic deformation, anelastic deformation, Plastic deformation of a single crystal, deformation by a slip critical resolved shear stress, dislocation theory work hardening.

4. Mechanical Properties : Fundamental properties : Fatigue : mechanism of fatigue failure, characteristics of fatigue failure, factors affecting fatigue strength; Creep: types of creep, creep curve, design for creep, factors affecting creep, mechanism of creep; fracture: types of fractures, cleavage, brittle fracture and Griffith crack theory; Factors affecting mechanical properties. Changes in mechanical properties by heat treatment.

5. Electrical & Magnetic Properties of Materials :

Electrical conductivity, Band Model of Conductivity (brief description) Semiconductors, Valence band model (brief description). Dielectric Properties and dielectric materials, Ferro-electricity, Piezo-electricity.

Introduction to Magnetism & Magnetic Properties

(Definitions and brief explanations) Magnetization and Classification of magnetic materials, hysteresis.

Introduction to Superconductivity

(Definition and brief explanation) Critical transition temperature, type-I and type-II superconductors, Applications.

Thermoelectricity

Thermocouples, Thermoelectric electromotive force, Seebeck effect, Peltier effect, Thompson effect. Laws of intermediate metals and temperatures, Uses of thermocouple as a thermometer, pyrometer.

6. Selection of Materials of Construction for Chemical Process Industries :**Factors Determining Choice of Materials**

- (a) General factors {topic 6, 7 and 8 of this syllabus}
- (b) Corrosion : Definition, units of measurement, Eight forms of corrosion (sub-types, mechanisms and examples), Prevention of corrosion.

Engineering Materials

- (a) Metals and alloys and their applications (ferrous and nonferrous).
- (b) Non-metallic materials : Polymeric materials and applications, Ceramics (Clays, Refractories and Glasses). Others (e.g., Graphite).

Reference :

1. Physical Metallurgy : Principles and Practice (*V. Raghavan*) Prentice Hall of India, New Delhi, 1983.
2. Materials Science and Engineering (*V Raghavan*) Addison Wesley New York, 1989
3. Corrosion Engineering (*M. G. Fontana*) Tata McGraw Hill, 1985
4. Introduction to Material Science for Engineers (*J. F. Shackelford*) McMillan New York 1990 2nd ED
5. Elements of Material Science and Engineering A first Course (*L. H. Vlac*) Prentice Hall of India, New Delhi 1997 4th ED
6. Materials Science and Engineering (*W.D. Callister Jr*) John Wiley New York 1997.
7. The Nature and Properties of Engineering Materials (*Z.D. Jastrzebski*) John Wiley 1987.
8. Perrys Chemical Engineers Handbook (*R.. Perry and D.W. Green*) 2001 7th Ed
9. Smith Materials Science



Plant Utilities
S.E. Sem. IV [CHEM]

EVALUATION SYSTEM

	Time	Marks
Theory Exam	3 Hrs.	100
Practical Exam	–	–
Oral Exam	–	–
Term Work	–	25

SYLLABUS

1. Introduction

Identification of common plant utility, importance of utility in industry.

Water

Raw water storage and treatment. Treatment of water, soft water and DM water. Cooling water system, Fire water system.

2. Steam

Properties of Steam; Steam generation of boiler; Types of boiler and their operation; Steam generation by utilizing process waste heat using thermic fluid; Re-generators and re-evaporators; Distribution of steam in plant; Efficient use of steam.

3. Air

Compressed air from blower and compressor. Air drying system for instrument air and plant air, Humidification and de-humidification of air.

4. Refrigeration

Principle of refrigeration; Refrigeration system like compression refrigeration absorption refrigeration and chilled water system. Type of refrigerants.

5. Vacuum System

Selection of Vacuum system; Operation of various process equipment under vacuum distillation, reactor, evaporators.

6. Flaring and Venting

Introduction; Types of vent flares.

Reference :

1. Theory and practice of Heat Engine (*Wangham D. A.*) ELBS Cambridge University Press 1970.
2. Use of Steam (*Lyle O. Efficient*), 1963.
3. Thermal Environmental Engineering (*Thikeld J. K.*) Prentice Hall, 1970.

