### SYLLABI FOR BACHELOR OF ENGINEERING (CHEMICAL) EXAMINATIONS 2013 - 2014
### SCHEME OF TEACHING AND EXAMINATION

<table>
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<tr>
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Practicals

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L: Lectures/Week  
T: Tutorials/Week  
P: Practical Hours/Week  
C: Number of Credits  
NC: No Credits

Note: Mid Term marks includes: Evaluation towards one best out of two minor tests (60% of marks), Assignments (20% of the marks), Class Surprise Tests, presentation, class attendance etc. (20% of the marks).
### SCHEME OF TEACHING AND EXAMINATION (2013 - 2014)

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**Practicals**

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*The Comprehensive Viva Voce-I Examination (Paper CHE 454) will cover the subjects taught during the First, Second, Third and Fourth Semesters.*
### SCHEME OF TEACHING AND EXAMINATION (2013 - 2014)

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**Practicals**

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**Open Elective –I**

1. Operations Research
2. Managerial Economics
**SCHEME OF TEACHING AND EXAMINATION (2013-2014)**

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| Total | 15 | 5  | 12 | 28 | 250 | 450 | 700 |

*There will be 6-8 weeks’ compulsory industrial training after 6th semester theory examination during summer vacation. Every student will submit the Industrial Training report within one month from the start of teaching of the 7th Semester. After that it will be evaluated by the team of Training & Placement Officers.

**Open Elective-II**

1. Research Methodology
2. Introduction to Bio-chemical Engineering
3. Membrane Separation Process
## SCHEME OF TEACHING AND EXAMINATION (2013 - 2014)

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**Total**

| | 12 | 4 | 8 | 21 | 200 | 325 | 525 |

### Departmental Elective - I

1. Analytical techniques
2. Polymer Science and Engineering

### Department Elective - II

1. Alternate Energy Technology
2. Low Temperature Engineering
3. Plant Utilities
### SCHEME OF TEACHING AND EXAMINATION (2013 - 2014)

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<td>CHE 851</td>
<td>Project Work</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CHE 852</td>
<td>Process Modelling and Simulation Lab.</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CHE 853</td>
<td>Process Control Lab.</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CHE 854</td>
<td>Literature Survey, Report Writing and Seminar</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>NC</td>
</tr>
<tr>
<td>CHE 855</td>
<td>Viva Voce-II (Comprehensive)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
</tbody>
</table>

**Total** | 12 | 4 | 7 | 23 | 250 | 275 | 525 |

*All independent/self study courses shall be graded in terms of ‘S’ (Satisfactory) or ‘X’ (Repeat).*

**Departmental Elective III**

1. Petrochemicals Technology
2. Nano Technology
3. Complex Flow Hydrodynamics
4. Fluidization Engineering
5. Polymer Synthesis and Characterization

**Open Elective III**

1. Project Management
2. Financial Management
3. Human Resource Development
4. Industrial Relations and Labour Laws

1. The project work will be evaluated by the committee of the institute. The constitution of the committee is as under:
   a) Chairperson of the institute
   b) One Professor of the institute
   c) One Associate Professor of the Institute
   d) Co-ordinator of the Project Work
   e) Supervisor of the Project Work

2. Requirement for the award of B.E. (Chemical) is 200 credits.
SYLLABUS FOR
BACHELOR OF ENGINEERING (CHEMICAL)
FIRST SEMESTER

Paper Title: Mathematics-1 (Theory)
Paper Code : CHE 101  Max. Marks 50  Credits : 4  Time: 3 hours

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions.  4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Convergence and divergence of infinite series and some simple problems, trigonometric and
exponential functions of a complex variable, hyperbolic functions, separations into real and
imaginary parts, summation of series (“C+IS” method only).
Successive differentiation, expansion of function, applications of maxima and minima of a
function of two or more variables, curves in polar co-ordinates, angle between radius vector and
tangent line, curvature, partial differentiation, Asymptotes singular and multiple points, curve
tracing.

SECTION-B

Definite integrals and their properties, definite integrals as the limit of a sum of the fundamental
theorem of integral calculus, determination of areas and lengths of curves, volumes and surfaces
and solids of revolution. Double and triple integrals with their simple applications.
Solution of ordinary differential equations of first order and first degree with simple applications
of engineering problems.

Books Recommended:

Paper Title: APPLIED PHYSICS (Theory)
Paper Code: CHE 102  Max. Marks 50  Credits: 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Relativity: Frames of reference, Michelson – Morley experiment, Galilean and Lorentz transformation, Lorentz Fitz Gerald contraction, time dilation, postulates of special theory of relativity, variation of mass with velocity, mass energy relation.
Mechanics: Surface tension, how to calculate surface tension for a drop, experimental determination of surface tension by Jaeger’s method.
Viscosity: Coefficient of viscosity, critical velocity, Poiseuille’s equation for flow of a liquid through a tube, motion in viscous medium, Reynolds number, Bernouille’s equation and its applications: venturimeter and pitot tube.
Physics of Materials: Magnetic materials, classification of materials, ferromagnetism, ferri and anti ferromagnetism, hysteresis. Superconductivity, Meissner effect, thermodynamics of superconducting transitions, qualitative idea of BCS theory.

SECTION-B

Optics: Ultrasonics: production, detection and uses of ultrasonics.
Interference: Formations of colours in thin films, Newton’s rings, Michelson interferometer.
Diffraction: Diffraction at a single slit, double slit diffraction grating, its theory, dispersive power and resolving power.
Polarization: Polarization by reflection, scattering, absorption and double refraction. Quarter wave and half wave plates, production and analysis of plane, circular and elliptically polarized light.
Fiber optics: Basic principle, step index and graded index fiber, qualitative idea of signal distortion and dispersion, transmission losses, fiber optics sensors and their applications.
Laser: Elementary ideas, He-Ne and Ruby laser, uses.
Holography: Basis principle, theory.
Quantum Physics: Difficulties with classical physics, blackbody radiation, photoelectric effect, Compton effect, Debroglie hypothesis, uncertainty principle, time dependent and independent Schrodinger’s equation, properties of well behaved wave function. Operators and their expectation value. X-ray diffraction and Bragg’s law.

Books Recommended:
Paper Title: CHEMISTRY (INORGANIC) (Theory)

Paper Code : CHE 103        Max. Marks 50        Credits : 4        Time: 3 hours

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

Section A

1. Quantum theory and atomic structure: Introduction to wave mechanics, the Schrodinger
   equation, the Schrodinger equation as applied to hydrogen atom, the origin of quantum
   numbers and shapes of orbitals.
2. Chemical Bonding: Molecular orbital and valence bond theories of bond formation and
   application of molecular orbital theory to the formation of homonuclear and heteronuclear
diatomic molecules.
3. The Solid State: A recapitulation of close packing of spheres, structures of NaCl, CsCl, ZnS,
   CaF2, crystal defects and applications of defect structures (transistors, rectifiers, photovoltaic
   cells and computer chips).
4. Coordination Compounds: Part 1: Werner’s theory, effective atomic number, bonding of
   transition metal complexes: valence bond theory, crystal field theory, crystal fieldsplitting in
tetrahedral, octahedral and distorted octahedral (square planar) crystal fields. Thermodynamic
   aspects of coordination compounds (crystal field stabilization energies of octahedral and
tetrahedral complexes, spectrochemical series).
5. Coordination Compounds: Part 2: Kinetic aspects of coordination compounds (substitution
   reactions in complexes with coordination number 4 and 6 and their mechanism - SN1, SN2).
   Magnetic behaviour of complexes – Para magnetism, diamagnetism, ferromagnetism and
   antiferromagnetism and measurement of magnetic susceptibility of complexes by Guoy’s
   method.

Section B

6. Organometallic Compounds: Nomenclature, types of ligands and bonding in organometallic
   compounds, use of organometallics in industry.
7. Inorganic polymers: Types of inorganic polymers, polyphosphazenes, polysiloxanes – their
   structures and properties.
8. Role of Metals in Biological Systems: Bio-inorganic Chemistry of Iron – Heme proteins & Non-
   Heme iron proteins; bioinorganic chemistry of cobalt-vitamin B12 and metalloenzymes.
9. Metal toxicology: Toxic effects of heavy metals with special reference to Cd, Pb, Hg
   and As.
10. Theory of quantitative inorganic analysis.

Books Recommended:
   1982.

**Paper Title: ENGINEERING MECHANICS (Theory)**

**Paper Code**: CHE 104  
**Max. Marks**: 40  
**Credits**: 3  
**Time**: 3 hours

**Course Duration**: 35 Lectures of one hour each.

**Note for the Paper setter**: The question paper should be divided into Section A and Section B  
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**


*Equipments*: Force body diagram, equations of equilibrium and their applications to engineering problems, equilibrium of two forces and three-force member.

*Structure*: Plane truss, perfect and imperfect truss, assumption in the truss analysis, analysis of perfect plane trusses by the method of joints, method of section and graphical method.

*Friction*: State and kinetic friction, laws of dry friction, co-efficient of friction, angle of friction, angle of repose, cone of friction, frictional lock, friction of flat pivot and collered thrust bearings, friction of journal-bearing, friction in screws, derivation of equation \( \frac{1}{T_1} + \frac{1}{T_2} = \mu_c A \) and its application.

*Distributed Forces*: Determination of centre of gravity, centre of mass and centroid by direct integration and by the method of composite bodies, mass moment of inertia and area moment of inertia by direct integration and composite bodies method, radius of gyration, parallel axis theorem, Pappus theorems, polar moment of inertia.

**SECTION-B**

*Dynamics*: Rectilinear motion, plane curvilinear motion-rectangular co-ordinates, normal and tangential coordinates.

*Kinetics of Particles*: Equation of motion, rectilinear motion and curvilinear motion, work energy equation, conservation of energy, impulse and momentum, conservation of momentum, impact of bodies, co-efficient of restitution, loss of energy during impact.

*Kinematics of Rigid Bodies*: Concept of rigid body, types of rigid body motion, absolute motion, introduction to relative velocity, relative acceleration (Corioli's component excluded) and instantaneous centre of zero velocity. Velocity and acceleration polygons for four bar mechanism and single slider mechanism.

*Kinematics of Rigid Bodies*: Equation of motion, translatory motion and fixed axis rotation, application of work energy, principles to rigid bodies conservation of energy.

*Vibration*: Classification, torsional free vibrations-single rotor and two rotar systems. Spring mass system-its damped (linear dash pot) and undamped free vibrations, spring in series and parallel, simple problems.

**Books Recommended**:

1. Meriam, J. L. & Kraige, L. G.  
2. Meriam, J. L. & Kraige, L. G.  
3. Hidgen, Stiles  
   : Statics and Dynamics, Longman
Paper Title: INTRODUCTION TO CHEMICAL ENGINEERING (Theory)

Instructions for the paper setter: Total number of questions to be set = 08 with the following distribution:
Unit-I: 01 question, Unit-II: 02 questions, Unit-III: 02 Questions, Unit-IV: 03 questions.

Students are required to attempt FIVE Questions selecting at least ONE question from each Unit. Q.1 from Unit-I shall be in the form of an Objective Type Question.

Unit-I

1. What is Chemical Engineering? A.I.Ch.E. Definition of Chemical Engineering. Brief history of Chemical engineering. General aspects of Chemical Engg. like communications, human relations, technical reading and professional bodies. Engg. problems in chemical processes in scaling up from laboratory to commercial scale.
2. Systematic analysis of Chemical processes; unit operations and unit process, material and energy balances, thermodynamics and kinetics, process instrumentation and control and economics.
3. Functions of chemical engineer/career opportunities for chemical engineers.
4. Scope of chemical engineering with respect to the new emerging areas in the field of chemical engineering like environmental engineering, bio-chemical and bio-medical engineering, membrane separation techniques, polymer science and engineering etc.
5. Factors for selecting a suitable site for the location of a process plant.

Unit-II

6. Systems of units and unit conversions involving process variables like pressure, viscosity, temperature, density/specific gravity etc.
7. Composition of mixtures and solutions; mass fractions/mole fractions, molarity and normality etc.

Unit-III

8. P-V-T relations for gas and gas mixtures, calculations using ideal gas law, compressibility factor and vander Waal’s equations of state.
9. Liquid and liquid mixtures; Vapour pressures (cox chart, Duhrings lines, Clausius Clapeyron equation), vapour-liquid equilibrium calculations using Raoult's law, Henry’s law.
10. Gas-vapour mixtures; humidity calculations from partial pressures and vapour pressures. Dry bulb, wet bulb and adiabatic saturation temperatures.

Unit-IV

11. Introduction to material balances with and without chemical reactions, combustion calculations, use of by-pass, recycle and purge streams.
12. Introduction to energy balances: Various forms of energy, types of systems, intensive/extensive properties, general energy balance equation for a flow process, heat capacity and mean heat capacity, energy balances for simple flow processes.

13. Thermo chemical calculations: Laplace Law and Hess’s Law, heats of formation, heats of combustion, heats of reaction, Kirchoff’s equation for calculating heats of reaction at different temperature.

(17 Hrs)

Books Recommended:

TextBooks:


Reference Books:


Paper Title : PHYSICS LAB (Practical)
PAPER CODE CHE 151

- Coefficient of viscosity of water by flow through a capillary tube.
- Surface tension of water by Jaeger's method.
- Mechanical equivalent of heat by Calandar and Borne's apparatus.
- Refractive index of the material of glass prism by spectrometer.
- Wave length of sodium light by Newton's rings. Wavelength of sodium light by diffraction grating.
- Vertical and horizontal distance using sextant.
- Density of a given wire using sonemet box.
- Magnetic-meters. Internal resistance of Leclanche cell by Post Office Box and voltmeter method.
- Conversion of a galvanometer into an ammeter or a voltmeter of a given range, comparison of e.m.f.'s of two cells by (I) Potentiometer (II) Lumsden's method. Value of H by using tangent galvanometer and copper voltmeter. Accuracy of a given meter being copper voltmeter.
- Total intensity of earth's magnetic field using dipcircles.

Books Recommended:

Paper Title : INORGANIC CHEMISTRY LAB (Practical)
Paper Code CHE 152       Max. Marks 50       Credits : 2

1. Volumetric Analysis
   (i) Redox Titrations:-
       Titrations involving
       (a) KMnO₄ (Estimation of C₂O₄²⁻)
       (b) K₂Cr₂O₇ (Estimation of Fe²⁺/Fe³⁺)
       (c) Iodine [Iodometry & Iodimetry] (Estimation of Cu²⁺, AsO₃⁻³ and Sb³⁺)
   (ii) Complexometric Titrations- Determination of Zn by EDTA titration.

2. Gravimetric Analysis
   (a) Estimation of Ba²⁺/SO₄²⁻ as BaSO₄
   (b) Estimation of Fe²⁻/Fe³⁻ as Fe₂O₃

Paper Title : ENGINEERING GRAPHICS-1 LAB (Practical)
Paper Code CHE 153       Max. Marks 25       Credits : 1

Introduction to Engineering Graphics, Methods of projections, Theory of orthographic projection.
Conventional practices, dimensioning as per BIS SP 46-1988
Pictorial sketching
Projection of points, lines and planes on principal planes
Projection on auxiliary planes

Recommended Books

1. James D. Bethune : AutoCAD, Pearson Publishers

Paper Title : BEHAVIORAL SCIENCES AND COMMUNICATION SKILLS (Practical)
Paper Code CHE 154       Max. Marks 25       Credits : 1

Need and Importance: Need of good communication skills, Presentation skills – with and without physical media (Computer and Multimedia Projector), Communication skills in a group – Group discussion, communication skills in an employment interview, Communication skills and proper body language, Professional and Social etiquette, Professional meeting skills.

1. Role Playing: Role playing as an event comparer, Role playing as Chairman, Role playing as team leader. The workshop would involve learning of practical skills to develop and perfect communication ability. Students would be required to give presentations both as an individual and in a team. Group discussions would be held to develop the communication skills while in a group.
   Role playing would require the students to practice the knowledge and expertise gained in communication skills to various situations where they would be required to perform the roles mentioned.
   The students would be evaluated on the basis of their communication skills, participation in various activities and on the ability to work in a team.

Books Recommended:
SYLLABUS FOR
BACHELOR OF ENGINEERING (CHEMICAL)
SECOND SEMESTER

Paper Title: MATHEMATICS-II (Theory)
Paper Code: CHE 201          Max. Marks 50    Credits :4    Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Relationship between cartesian, cylindrical polar and spherical polar co-ordinate systems:
standard forms of equation of sphere, cone, cylinder.
Matrices: Rank of matrix, elementary transformation, Eigen-values, Eigen-vectors, Cayley-
Hamilton Theorem.
Fourier Series: Euler’s Formulae, Dirichlet’s Conditions for Expansion, Change of interval, Odd
and Even Functions, Expansion of Odd and Even Periodic Functions, Introduction to Harmonic
Analysis.

SECTION-B

Vectors: Gradient, Divergence, Curl, Statement of Green’s Gauss and Stoke’s Theorem and their
simple applications.
Linear Differential Equations with constant Coefficients, Homogeneous Linear Equations, method of
variation of Parameters, Simultaneous Linear Differential Equations with Constants Coefficients.

Books Recommended:

Paper Title: STRENGTH OF MATERIALS (Theory)
Paper Code: CHE 202          Max. Marks 50    Credits :4    Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Simple Stresses and Simple Strains: Load, various types of load stress (tensile and compressive).
Principle of St. Venant strain, Hooke’s law, modulus of elasticity (young’s modulus). Tensile test,
factor of safety, compound bars, temperature stresses, shear stress, complementary shear
stress, shear strain, modulus of rigidity, stresses under impact loads, stress under suddenly applied load, numerical problems.

**Compound Stresses and Compound Strains**: Oblique stress, simple tension, state of pure shear, pure normal stresses of given planes, general two-dimensional stress system, principle planes, principle stresses, maximum shear stress, Mohr’s stress circle, Poisson’s ratio, principle strains in three dimensions. Principle stresses determined from principal strains, analysis of strain, Mohr's strain circle, volumetric strain, elastic constants and relations between them, numerical problems.

**Shearing Force and Bending Moments in Beams**: Shearing force, bending moment, types of load on beams, types of supports, relations between \( w, V \) and \( M \). Concentrated loads, uniformly distributed loads, graphical method, numerical problems.

**Bending Stresses and Shearing Stresses in Beams**: Pure bending, graphical determination of moments of inertia, bending stress, composite beams, reinforced concrete beams, moments of inertia variation of shear stress, rectangular section, I-section, principle stresses in I-beams, solid circular sections, thin circular tubes, numerical problems.

**Axial and Bending Loading Combined**: General eccentric loading, eccentric longitudinal loads, load eccentric about both the axes, middle third rule of rectangular section, middle quarter rule of circular sections, numerical problems.

**Deflection of Beam**: Introduction, Macauly's integration method, moment area method, superposition method, deflection due to shear, numerical problems.

### SECTION-B

**Torsion of Shafts**: Circular shafts, shafts of varying diameter, compound shafts, combined bending and torsion, torsion of thin circular tubes, combined end thrust, bending and torsion, equivalent torque, equivalent bending moment, numerical problems.

**Struts and Columns**: Definition, pin ended (hinged) strut axially loaded, direction fixed at one end and free at the other, direction fixed at one end and position fixed at the other, strut with eccentric load, limitations of Euler theory, Rankine-Gordon formula, strut with lateral loading, numerical problems.

**Stresses and Strains in Thin Shells**: Thin cylinder under internal pressure, thin spherical shell under internal pressure, cylindrical shell with hemispherical ends, volumetric strain, modifications for built-up shells, numerical problems.

**Stresses and Strains in Springs**: Close coiled helical springs, open coiled helical springs, leaf springs, numerical problems.

**Strain Energy and Theories of Elastic Failure**: Strain energy in tension energy in compression, strain energy in shear, strain energy in bending, strain energy in torsion, strain energy under compound loading, theories of elastic failure and their graphical representation, numerical problems.

**Books Recommended**:

SECTION-A


Chemistry of hydrocarbons: House synthesis, halogenation of alkanes, free radical mechanism, cracking, effect of structure on physical properties of compounds. Alkenes, catalytic hydrogenation, dehydrogenation of alcohols, dehydrohalogenation, Saytzeff rule, electrophilic addition reactions, peroxide effect, mechanism of allylic substitution, acidity of 1-alkynes, conjugated dienes, 1,2- and 1,4-additions, free radical and ionic mechanisms of addition polymerisation reactions, ring-opening reactions of cyclopropane and cyclobutane, chemistry of benzene and alkylbenzenes, aromatic electrophilic substitution reactions, Friedel-Crafts reactions.

SECTION-B

Delocalisation: Concept of aromaticity, stability of cycloalkanes, resonance concept, inductive and mesomeric effects, directive effects, activating and deactivating groups. Hydrogen-bonding, organic reagents and reaction intermediates.

Chemistry of functional groups: Alkyl and aryl halides, nucleophilic substitution, synthetic utility of Grignard reagents and alkylolithiums, mechanism of Grignard reactions of alcohols, benzylalcohol, acidity of phenols epoxy compounds, Anisole nucleophilic addition, benzaldehyde, acetophene, benzophenone, aldol condensation, acidity of acids, alkyl and aryl amines.

Synthetic utility of diazonium salts, basicity of amines, multistep synthesis.

Books Recommended:


SECTION-A

Review: Stoichiometric and composition relationship gas laws; Gaseous mixtures, vapor pressure, humidity, etc.
Material Balances for Non-reaction systems including balances involving recycle and by-pass streams.
Material Balances for Reacting systems including balances involving recycle and purge streams.

SECTION-B

Combustion Calculations.
Energy balances on nonreactive and reactive systems.

Books Recommended:


SECTION-B

Photochemistry: Laws of photochemistry, principles of photochemical excitation, quantum efficiency, Kinetics of photochemical reactions

Electrochemistry: Conductance of electrolytic solutions, transference number and its determination, Kohlrausch’s law of independent migration of ions, Interionic attraction theory, activity and activity coefficients of strong electrolytes, ionic equilibria. Ionization of water, ionization constants of weak acids and weak bases, hydrolysis, pH, commonion effect, solubility product and salt effect.

Electrochemical Cells: Reversible and irreversible cells, e.m.f. and its measurement, cell reactions and e.m.f., thermodynamics of electrode potentials, half- cell potential and its determination, Nernst equation, concentration cells, liquid junction potential, determination of activity co-efficient from cell potential data, potentiometric titrations.

Books recommended:

3. Barrow, M. Gorden : Physical Chemistry, McGrade Hill, N.Y.
4. Rose, J. : Dynamics of Physical Chemistry, Lond Pitman

Paper Title: ENVIRONMENTAL STUDIES (Theory)
Paper Code: CHE 206 Only Qualifying Exam. Credits : nil Time: 3 hours
Course Duration: 22 Lectures of one hour each.

The Multi-disciplinary nature of Environmental Studies: Definition, scope and importance; need for public awareness.
Ecology and Ecosystems: Definition of ecology: Structure and function of ecosystem; Producers, conserver and decomposers; Energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids.
Introduction, types, characteristic features, structure and function of the
following ecosystems: Forest ecosystem; Grassland ecosystem; Desert ecosystem; Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries).

Biodiversity and its conservation: Introduction - Definition: Genetic species and ecosystem diversity. Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and option values; Biodiversity at global, National and local levels; India as a mega-diversity nation; Hotspots of biodiversity; Threats to biodiversity: Habitat loss, poaching of wildlife, man wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity; In-situ and Ex-situ conservation of biodiversity.

Natural Resources: Natural resources and their conservation:
(a) Air Resources: Features, composition, structure; air quality management.
(b) Forest Resources: Use and over-exploitation, deforestation, case studies, timber extraction, mining, dams and their effects on forests and tribal people.
(c) Water Resources: Use and over utilization of surface and ground water, floods, drought, conflicts over water, dams benefits and problems; water quality management; manager of water resources e.g. rivers, lakes, ground water, etc. Fluorosis and arsenic problems.
(d) Mineral Resources: Draw on and exploitation, environmental effects of extracting and using mineral resources, case studies.
(e) Food Resources: World food problems, changes caused by agriculture and overgrazing, effects of modem agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
(f) Energy Resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.
(g) Land Resources: Land as a resource, land degradation: Man induced landslides, solid erosion and desertification.
   Role of an individual in conservation of natural resources and prevention of pollution; Equitable use of resources for sustainable lifestyles; Disaster management: Floods, earthquake, cyclone and landslides.

Environment Pollution: Definition - Air pollution: Definition, causes, effects and control measures: Air Quality Management; Air Pollution Case Studies.
Water Pollution: Definition, causes, effects and control measures; Case studies;
Water Quality Management: Definition, causes, effects and control measures.
Marine pollution.
Thermal pollution.
Soil pollution: Definition, causes and control measures: Case studies.
Noise pollution.
Nuclear hazards waste management.
Waste management through cleaner technologies: Reuse and recycling of wastes.
Solid waste management: Causes, effects and control measures of urban and industrial wastes, hazardous waster; bio-medical waste; Role of an individual in prevention of pollution; Pollution case studies.
Disaster Management: Floods, earthquake, cyclone and landslides.
Social issues and the Environment: From Unsustainable to Sustainable development; Urban problems related to energy; Water conservation, rain water harvesting, watershed management; Resettlement and rehabilitation of people: Its problems and concerns. Case studies; Environmental ethics: Environmental value
relationships; Environmental ethics and species preservation; Climate change: 
Global warming, acid rain, ozone layer depletion, nuclear accidents and 
holocaust. Case studies. Wasteland reclamation; Consumerism and waste 
products. Legislation to Protect the Environment: Environmental Protection Act; 
Air (Prevention and Control of Pollution) Act; Water (Prevention and Control of 
Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Environmental 
Impact Assessment (EIA); Environmental Management Systems (EMS); 
Environmental Information Systems (EIS); P.I.L: Public Hearing and Role of 
NGO’s; ISO 9000 and 14000; Issues involved in enforcement of environmental 
legislation; Public awareness.

Environmental Economics: Environment and standard of living.

Human Population and the Environment: Population growth, variation among 
nations; Population explosion "Family Welfare Programme"; Environment and 
human health; Human Rights; Value education; HIV/AIDS; Women and Child 
Welfare; Role of Information Technology in Environment and human health. 
Case studies.

Paper Title : ENGINEERING GRAPHICS –II LAB (Practical)
Paper Code CHE 251      Max. Marks 25  Credits : 1

Projection of solids, solid modeling
Section of solids
Elementary development and intersection of solids
General introduction to isometric views
Applications: Drawing of threaded fasteners and assembly drawing using 1\textsuperscript{st} angle/3\textsuperscript{rd} angle 
projections.
Introduction and application to CAD software.

Recommended Books

1. James D. Bethune : AutoCAD, Pearson Publishers

Paper Title : ORGANIC CHEMISTRY LAB. (Practical)
Paper Code CHE 252     Max. Marks 50  Credits : 2

1. Lab – Safety
2. Preparation of Benzamide & Aspirin-Purification, determination of melting point and 
percentage yield.
3. Identification of unknown organic compounds – Hydrocarbons, Phenols, Aldehydes, 
Ketones, Carboxylic acids, Amides and Amines.

Paper Title : PHYSICAL CHEMISTRY LAB.(Practical)
Paper Code CHE 253      Max. Marks 50  Credits : 2

1. Surface tension of liquids using Stalagmometer and calculation of Parachor values.
2. Distribution of Iodine between water and carbon tetrachloride.
3. Kinetics of the hydrolysis of methyl acetate in the presence of hydrochloric acid.
4. Adsorption of acetic acid on activated charcoal.
5. Viscosity of liquids and composition of a binary solution.
6. Conductometry
   • Variation of equivalent conductance and specific conductance on dilution.
   • Dissociation constant of acetic acid.
   • Solubility of sparingly soluble salts.
   • Conductometric titrations of HCl vs NaOH and acetic acid vs. NaOH.
7. Potentiometric titration of HCl vs NaOH and acetic acid vs NaOH and determination of
   dissociation constant of acetic acid.
8. Colorimetry
   • Verification of Lambert-Beer Law.
   • Determination of concentration of solution of KMnO₄/K₂Cr₂O₇.
   • Determination of composition of Fe-Salicylic Acid Complex by Job’s Method.

Books Recommended:
SYLLABUS FOR
BACHELOR OF ENGINEERING (CHEMICAL)
THIRD SEMESTER

Paper Title: MATHEMATICS – III (Theory)
Paper Code : CHE 301  Max. Marks 50  Credits : 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Solution of differential equations in series with reference to Bessel and Legendre equations,
elementary properties of Bessel and Legendre functions.
Solution of difference equation with constant coefficients.
Formation and classification of partial differential equations, first order linear equations,
standard forms of non linear equations, Charpit’s method, homogeneous linear equations with
constant coefficients.
Solution of partial differential equations of engineering interest by method of separation of
variables.

SECTION-B

Laplace transform: Definition, Transforms of Elementary functions, Properties of Transforms,
Inverse Transforms, Transform of Derivative Unit. Unit Step Function, Dirac Delta Function &
Unit Impulse function. Period Functions, Application of Transform to the solution of ordinary
Differential equations.
Function of complex variable, analytic functions, Cauchy’s theorem, Cauchy’s integral formula,
introduction to Taylor’s series and Laurent’s series, Residues, theorem and its simple
applications.

Books Recommended:

    Wiley & Sons.
    Publishers, Delhi.

Paper Title: MECHANICAL OPERATIONS (Theory)
Paper Code : CHE 302  Max. Marks 50  Credits : 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Size Reduction: Crushers and Grinders: jaw crusher, crushing rolls, Gyratory Crusher
Tumbling/revolving mills, hammer Mill and Fluid energy mill. Closed and open circuits grinding.
Power requirements. Laws of crushing.

- Motion of particle through a fluid: Stoke’s Newton’s law. Free and hindered setting.
- Setting tank and double cone classifiers
- Batch and continuous thickeners
- Settling chamber, cyclone, filter bag and electrostatic precipitators.

SECTION-B

Filtration: Plate and frame filter press, continuous rotary vacuum filter, filter aids, theory of filtration for non-compressible cakes.

Centrifugation: Tubular bowl centrifuge, disk centrifuge and batch basket centrifuge.


Mixing and Agitation: Basic ideas and characteristics of mixing equipment power consumptions scale-up.

Conveying: Mechanical and pneumatic conveying systems, storage & handling of materials.

Books Recommended:


Paper Title: FUNDAMENTALS OF ELECTRICAL & ELECTRONICS ENGINEERING (Theory)
Paper Code : CHE 303 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.
SECTION-A

**DC Circuits and Single Phase A.C. Fundamentals**: General introduction to Electrical Engineering, Kirchoff’s Laws, Mesh and Node analysis, Superposition theorem, Thevenin Theorem, Norton Theorem, Maximum power transfer theorem. Generation of alternating voltages and currents, Equations for AC quantities, cycle, time period, frequency, amplitude, calculation of R.M.S values, Average values for different waveforms, solution and phasor diagram of single phase AC circuit with sinusoidal source of excitation, series and parallel combination of R-L-C circuits.

**Three Phase AC Fundamentals**: Disadvantages of single phase system, star and delta connection in three phase circuits, relation between line and phasor quantities, power in three phase system, solution of three phase balanced circuits, power and power factor measurement by two wattmeter method.

**Electrical Machines**: Introduction to magnetic circuits, Basic principle and construction of transformers, E.M.F equation, approximate equivalent circuit, phasor diagram, losses, efficiency and condition for maximum efficiency, open circuit and short circuit test on single phase transformers. Operating principle and construction of three phase induction motors, production of rotating field, concept of slip, frequency etc. Operating principle and construction of DC generators, types of DC Generators, E.M.F equations, Principle of DC Motors and their applications.

SECTION-B

**Semiconductor Diodes and Transistors**: General introduction to Electronics. Concept of stiff Voltage and Current Source. PN Junction, Depletion layer, Barrier Potential, Forward and Reverse Bias, Breakdown voltage, V-I characteristics, Half wave and full wave rectifiers, Zener diode. Introduction to junction transistors, Transistor amplifying action, CB, CE, CC-configuration characteristics.

**Operational Amplifiers**: Block Diagram, characteristics of an ideal OP-AMP, Application of OP-AMP as an Inverting amplifier, Non-Inverting Amplifier, Adder, Differential, Integrating amplifier.

**Digital Electronics**: Binary and Hexadecimal number system, conversion of numbers from one system to other, OR, AND, NOR, NAND, NOT Gates, Universal Gates, Exclusive OR, NOR gates, De-Morgan’s Theorem, Boolean Relations: Commutative, Associative and Distributive Laws. Concept of flip-flops, RSJK flip flops, shift register.
Books Recommended:


2. Nagsarkar, T.K. and Sukhija M.S.


3. Nagrath, I.J. and Kothari, D.P.

: Basic Electrical Engg., TMH, New Delhi.


Paper Title: FLUID FLOW (Theory)
Paper Code : CHE 304 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Fluid Statics: Normal forces in fluids, Pressure Measurements, Forces on Submerged bodies, Buoyancy and Stability.

SECTION-B

Dimensional analysis and its Applications to Fluid Flow.
Flow of compressible fluids: Compressible flow and flow through nozzles.
Flow Measurements: Pilot tube, Orifice, Venturi, Rotameter and Notches, wet gas metre etc.
Fluid Machinery: Classification and Performance of Pumps, Turbines, Compressors, and Blowers, Selection and Specification, Net positive Suction Head.

Books Recommended:

Paper Title: ENGINEERING MATERIALS (Theory)  
Paper Code : CHE 305  
Max. Marks 50  
Credits : 4  
Time: 3 hours  

Course Duration: 45 Lectures of one hour each.  
Note for the Paper setter: The question paper should be divided into Section A and Section B  
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Atomic Structure: Review of bonding in solids, structure –property-processing  
Relationships  
Crystal Structure : Space lattice, crystal systems, Miller indices, effect of radius ratio on co-ordination, structures of common metallic, polymeric, ceramic, amorphous and partly crystalline materials.  
Imperfections in atomic arrangement: various defects in atomic arrangement, diffusion phenomenon in solids, Fick’s first and second law of diffusion, solid solution, slip systems, various methods of strengthening materials, Schmid’s law.

SECTION-B

Phase Diagrams and phase transformation: binary phase diagrams – Fe-Fe₃C, Cu-Ni, Pb-Sn. microstructure development, TTT diagrams, heat treatment processes-hot and cold working, hardening and softening processes.  
Materials: Standards and specifications, unified alloy numbering system, ferrous metals and alloys, non-ferrous metals and alloys; overview of ceramic, polymeric and composite materials; Mechanical tests: standard test procedures for mechanical property determination-strength, toughness, fracture toughness, hardness, deformation, fatigue, creep etc.  
Corrosion: Types and mechanism of corrosion, factors influencing corrosion, combating corrosion, selection of materials of construction for handling different chemicals.

Books Recommended:

1. Askelland, Donald R.  
   : The Science & Engineering of Materials, PWSKENT.  
2. Shackelford, J.F.  
3. Van-Vlack, L.H.  
   : Elements of Material Science & Engineering, Addison Wesley  
4. Raghavan, V.  
   : Material Science & Engineering, Prentice Hall of India  
5. Callister Jr. William D.  
   : Materials Science and Engineering- An Introduction, Wiley
**Paper Title:** COMPUTER PROGRAMMING (Practical)  
**Paper Code:** CHE 351  
**Max. Marks:** 25  
**Credits:** 1

**C++ fundamentals**

- Control statements
- Loops and Decisions: Relation operators, Iterations: While loop, for loop, do loop, Decisions: if statement, if else statement, nested if else statement, switch statement. Logical operators, other control statements: break statement, continue statement and go to statement.
- Programming and Compiling, Exercises.
- Functions

**Books Recommended:**


**Paper Title:** ELECTRICAL & ELECTRONICS ENGINEERING LAB. (Practical)  
**Paper Code:** CHE 352  
**Max. Marks:** 50  
**Credits:** 2

**Note:** Minimum eight experiments are to be done.

1. Overview of the equipments, instruments and procedure to be used, safety precautions and report writing.
2. To study resonance in R-L-C series and parallel circuit.
3. Measurement of power and power factor by three voltmeter method.
4. Measurement of power and power factor by three ammeter method.
5. To measure power and power factor using a single wattmeter in a single phase circuit.
6. Measurement of power and power factor of three phase balanced load by two wattmeter method.
7. To perform open circuit test and short circuit test on a single phase transformer and draw equivalent circuit.
8. To obtain magnetization characteristics of DC Machine
9. Study the forward and reverse biased diode characteristics.
10. Study the CB, CE, CC transistor characteristics.
11. To obtain the waveforms of half wave rectifier circuit on CRO
12. To obtain the waveforms of full wave rectifier circuit on CRO
13. To study the OP-AMP as an Inverting amplifier, Phase Shifter, Integrator, Differentiator.
14. Verification of basic and universal gates.
Paper Title: FLUID MECHANICS LAB. (Practical)
Paper Code CHE 353  Max. Marks 50  Credits : 2

1. General study of pipe fittings, valves and other equipments in the unit operations laboratory.
2. Pressure drop for flow through pipelines, valves & fittings.
3. Characteristics of pumps.
4. Flow measurement by the use of orificemeter, venturimeter, rotameter & pitot tube.
5. Flow over weirs and notches.
6. Flow measurement of compressible fluids.

Paper Title: BASIC WORKSHOP TECHNIQUES (PRACTICALS)
Paper Code CHE 354  Qualifying  Credits : NC

Carpentry Shop: Introduction to various types of timber and particle, boards defects in timber, seasoning of wood. Description and use of carpenter's tools, i.e. saws, planes, chisels, adze, etc. Different types of timber in common use, making of lap joint, Bridle joint, dovetail joint and Mitre joint.

Electric Tools: Exercise of wiring in link clip and casting and causing wiring of lights with switches in parallels, series and with 2 ways switches. Connecting energy meter, main switch and distribution board, testing a wiring installation for insulation resistance. Relevant Indian Electricity Rules.

Machine Shop: Classification of fabrication processes, machine tools and materials, introduction to working of lathe, shapper, milling and drilling machines, power hacksaw, shearing machine and grinding wheel. Simple turning, threading, drilling board and knurling operations on a lathe.

Welding: Use of arc welding and gas welding in making different types of joints.
SYLLABUS FOR
BACHELOR OF ENGINEERING (CHEMICAL)
FOURTH SEMESTER

Paper Title: HEAT TRANSFER (Theory)
Paper Code : CHE 401    Max. Marks 50    Credits : 4    Time: 3 hours
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Conduction: Steady state conduction in one dimensional system, general conduction equation,
effect of variable thermal conductivity, steady state conduction involving internal heat generation,
lagging on pipes, the critical thickness of insulation on pipes, extended surfaces of uniform
thickness and fin effectiveness, fin efficiency.

Convection: Free and forced convection, concept of heat transfer co-efficient, dimensionless
numbers in free and forced convection, Dimensional analysis, Determination of Heat transfer
coefficient using heat and momentum transfer analogies, experimental determination of heat
transfer coefficient and common working correlations.

Radiation Heat Transfer: Black Body radiation, and grey body radiation, physical mechanism,
radiation properties and shape factor, heat exchange between non-black bodies, radiation shields
pyrometry and effect of radiation on temperature measurement.

SECTION-B

Condensation and Boiling: Condensation heat transfer phenomenon, film condensation on
vertical plates and cylinders as well as on horizontal cylinders. Effects of non-condensable gases
and vapor velocity on condensation, pool boiling, forced convection boiling, working correlations
for pool boiling.

Evaporation: Types of Evaporators, single and multiple effects, single and multiple effects
calculations, evaporator capacity, economy, effect of liquid head and boiling point elevation,
methods of feeding.

Heat Exchangers: Various types of heat exchangers, overall heat transfer coefficients, heat
exchanger mean temperature differences, heat exchanger effectiveness and the number of transfer
units.

Books Recommended:
7. Geankoplis, C.J. : Transport Processes and Unit Operations, Prentice Hall of
Paper Title: CHEMICAL ENGINEERING THERMODYNAMICS (Theory)
Paper Code: CHE 402  Max. Marks 50  Credits: 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A


SECTION-B

Phase Equilibria:
Partial molar properties, partial molar Gibbs free energy, Chemical potential and its dependence on temperature and pressure Ideal solutions (Lewis-Randel Rule).
Chemical Equilibria:
Equilibrium constant in terms of measurable properties variations of equilibrium constant with temperature and pressure.
Adiabatic reactions, Gibbs phase rule, equilibria in heterogeneous reactions.

Books Recommended:

Paper Title: ENVIRONMENTAL ENGINEERING (Theory)

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B. Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Ambient air and water standards. Principal sources of pollution.
Inter-relationship between energy and environment pollution. Prevention of environmental pollution through conservation, raw material substitutions, process and equipment modifications. A case study on the concept of zero discharge.

Air Pollution:
- Principal air pollutants and their usual sources.
- Effect of air pollutants on human health, animals, vegetation and materials.
- Atmospheric dispersion of air pollutants, temperature inversions, Estimation of pollutants by Gaussian plume model.
- Process and equipments used for the control of particulate pollutants.

SECTION-B

Water Pollution:
- Types of water pollutants, their sources and effects.
- BOD and COD
- Waste water treatment techniques and equipments, flocculation, skimming, floatation, etc.
- Primary Treatment-through settling.
- Secondary Treatment-Aerobic and anaerobic digestion, activated sludge process, trickle filter and oxidation ponds.

Solid wastes: Control and disposal, sanitary landfill, incineration, pyrolysis gasification and recycling.

Books Recommended:


Paper Title: ENERGY TECHNOLOGY (Theory)

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B. Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.
SECTION-A

**Fuels:** Types of conventional fuels, their merits and demerits. Non-conventional/renewable energy sources, their importance for sustainable development and environmental protection.

**Solid Fuels:** Origin of coal, proximate and ultimate analysis of coal, coal preparation and washing methods, safe storage of coal. Low and High temperature carbonization, products of carbonization, By product coke ovens. Synthetics fuels from coal –Bergius process and Fischer Tropsch process.

**Liquid fuels:** Origin of petroleum, refining and distillation of crude oil, uses of petroleum products.

**Gaseous fuels:** Natural gas, manufacture of water gas and producer gas, gas cleaning methods.

SECTION-B

**Principles of combustion:** Combustion calculations, waste heat utilization.

**Furnaces:** Classification of furnaces, draught, furnace atmosphere, Portland cement continuous rotary kiln, blast furnace, glass melting furnace.

**Alternate sources of energy:**
- Introduction to solar radiation and evaluation of radiation incident on a solar collector.
- Applications of solar thermal energy such as solar water heater, solar cooker, solar concentrators and solar thermal power generation.
- Types of solar photovoltaic systems and applications.
- Photosynthesis and biomass conversion systems.
- Other renewable energy sources such as geothermal, tidal, ocean and wave.

**Books Recommended:**

**TEXT BOOKS**

**REFERENCE BOOKS**

**Paper Title:** NUMERICAL METHODS IN ENGINEERING
**Paper Code : CHE 405**  
**Max. Marks** 50  
**Credits : 4**  
**Time: 3 hours**

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.
SECTION-A


SECTION-B


Numerical Solution of Partial Differential Equations: Finite-Difference Approximation to Laplace’s Equation, Parabolic Equations and Hyperbolic Equations

Books Recommended:

Paper Title : PROCESS EQUIPMENT DESIGN (Practical)
Paper Code CHE 451 Max. Marks 25 Credits : 1

1. General design considerations for pressure vessels: Design pressure, design temperature, materials, design stress (nominal design strength), welded joint efficiency and construction categories, corrosion allowance, design loads, minimum practical wall thickness.
2. Design of thin-walled vessels under internal pressure: Cylinders and spherical shells, heads and closures, design of flat ends, design of domes ends, conical sections and end closures.
3. Design of vessels subject to external pressure: Cylindrical shells, design of stiffening rings, vessels heads.
4. Design of vessels subject to combined loading: Weight loads, wind loads (tall vessels), torque.
5. Design of Foundation and supports.
6. Design of Bolted flanged joints and welded joints.

Books Recommended:
1. Battacharyyya, B.C. : Introduction to Chemical Equipment Design Mechanical aspects, Chemical Engineering Education Development Centre.

Paper Title : PARTICLE MECHANICS LAB. (Practical)
Paper Code CHE 452 Max. Marks 50 Credits : 2

1. Pressure drop and two phase flow characteristics in packed and fluidized beds.
4. Constant pressure filtration.
5. Mixing, crushing, grinding, screening and particle size analysis.

Paper Title : ENVIRONMENTAL ENGINEERING LAB. (Practical)
Paper Code CHE 453 Max. Marks 50 Credits : 2

1. To find BOD of water sample.
2. To find COD of waste sample.
3. To find the total dissolved solids (TDS) and its volatile and non-volatile components.
4. To find the total suspended solids (TSS) and its volatile and non-volatile components.
5. To do the chromium separation by different techniques from electroplating wastes.
6. To find the phenol content of water sample and evolution of parameters.
7. To operate the electrodialysis apparatus.
8. To find the biodegradation constant (K) and the effect of timing on it.
9. To use the membrane separation techniques for salt brine and reverse osmosis process for sugar.
10. To use stack monitoring kit to find:
    (a) Efficiency of a cyclone.
    (b) Dust sampling.
    Note: Any six of the above mentioned experiments are to be conducted.

CHE 454 VIVA VOCE-I (COMPREHENSIVE)
The viva-voce examinations will be comprehensive and covering all subjects taught during first to fourth semesters.
SYLLABUS FOR
BACHELOR OF ENGINEERING (CHEMICAL)
FIFTH SEMESTER

Paper Title: Open Elective-1 (Theory)
Paper Code: CHE 501  Max. Marks 50  Credits: 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

1. OPERATIONS RESEARCH

SECTION-A
Linear Programming: problem formulation, graphical method, simplex method, duality
sensitivity analysis.
Transportation model, Transhipment problem, traveling salesman problem, Assignment
models, Sequencing model, Replacement model.

SECTION-B
Theory of Games: Pure strategy games, principle of dominance; mixed strategy games
(Algebraic, Graphical & Linear programming method), 2-person, non-zero- sum games.
Queuing Theory: Introduction, elementary queuing system; single channel queuing model,
queuing cost behaviour, multiple channel queuing model, Poisson arrivals and Erlang service
distribution; benefits and limitations of queuing theory.

Books Recommended:
McGraw Hill.
Sons, New Delhi;

2. MANAGERIAL ECONOMICS (Theory)

SECTION-A
Introduction to Managerial Economics: Nature Scope and Importance of Managerial
Economics, opportunity costs, incremental principle, time perspective, discounts and equi
marginal principles.
Demand Concepts and Analysis: Individual Demand, Market Demand, Kinds of
Demand, Determinants of Demand, Demand Functions, Functions, Demand Schedule and
Law of Demand.
Theory of Consumer Behavior: Cardinal Utility Approach and Ordinal Utility (Indifference
Curves) Approach;
Elasticity of Demand: Concept, Types, Measurement and importance.
Demand Forecasting: Sources of Data-Expert Opinions, Surveys and Market
Experiments;

Time Series Analysis: Trend Projection; Barometric Forecasting-Leading Indicators,
Composite and diffusion Indices.
SECTION-B

Production Function: Concept and types, Returns to Factor and Returns to Scale, Law of Variable Proportions.

Cost concepts and Analysis: Concept of Cost, Short run and Lung-run Cost Curves, Relationships among various costs, Break-even Analysis.

Revenue Curves: Concept and Types.

Perfect Competition: Characteristics, Equilibrium Price, Profit Maximizing output in Short Run and Long Run;

Monopoly: Characteristics, Equilibrium Price, Profit Maximizing output in Short Run and Lung Run; Price Discrimination;

Imperfect Competition: Monopolistic Competition, oligopoly and Barriers to Entry.

References:
8. Mote, Paul Gupta: Managerial Economics, Vikas Publisher, New Delhi, 1st ed.

Paper Title: PETROLEUM PROCESSING ENGINEERING (Theory)
Paper Code: CHE 502       Max. Marks: 50      Credits: 4      Time: 3 hours
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Introduction to petroleum industry, world petroleum resources, petroleum industry in India. Origin, exploration & drilling of petroleum crude. Transportation of crude and products. Crude pretreatment: Refining and distillation of petroleum crude, composition and classification of petroleum crude, methods of evaluation: ASTM, TBP and EFV distillation. Properties and specifications of petroleum products such as LPG, gasoline, naphtha, kerosene, diesel, lubricating oils and waxes.

SECTION-B

Separation Processes: Design and operation of topping and vacuum distillation units and tube still furnaces. Solvent extraction processes for lube oil base stock and for aromatics from naphtha and kerosene steams, solvent dewaxing.
Conversion Processes: Thermal cracking: visbreaking and coking processes, catalytic cracking, thermal reforming and catalytic reforming, alkylation, polymerization, isomerisation and hydroprocessing.
Safety and pollution considerations in refineries.

**Books Recommended:**


**Paper Code:** CHE 503   **Max. Marks 50**   **Credits : 4**   **Time: 3 hours**

**Course Duration:** 45 Lectures of one hour each.

**Note for the Paper setter:** The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**

Introduction and a brief review of the kinetics of homogeneous reactions.
Interpretation of rate data from constant volume and constant pressure systems.
Single Ideal reactors.
Design for single reactions.

**SECTION-B**

Design for multiple reactions.
Thermal characteristics of reactors: temperature and pressure effects.
Non-ideality in reactors and its effects on chemical conversion. One parameter models to represent the behaviour of chemical reactors.

**Books Recommended:**


**Paper Title:** MASS TRANSFER – I (Theory)
**Paper Code : CHE 504**   **Max. Marks 50**   **Credits : 4**   **Time: 3 hours**

**Course Duration:** 45 Lectures of one hour each.

**Note for the Paper setter:** The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**

Mass transfer operations, classification of mass transfer operations, choice of separation methods, methods of conducting mass transfer operations, design principles.
Introduction to mass transfer and diffusion, molecular diffusion in gases and liquids, diffusion coefficients for gases and liquids, diffusion in solids, types of solid diffusion.
Mass transfer coefficients, types of mass transfer coefficients, mass transfer coefficients in laminar flow, theories of mass transfer.
Interphase mass transfer, concept of overall mass transfer coefficient.

SECTION-B

Working principle, construction and industrial applications of various gas liquid contacting equipments like sparged vessels, mechanically agitated vessels, tray towers, packed towers, spray chambers, venturi scrubbers.
Humidification operations, psychometric chart, adiabatic saturation temperatures, wet bulb temperature, adiabatic operations, types of cooling towers.
Principle of drying, batch drying, drying curve, constructional details and working of different dryers.

Books Recommended:


Paper Title: CHEMICAL TECHNOLOGY (INORGANIC) (Theory)
Paper Code: CHE 505 Max. Marks 50 Credits: 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Chlor-Alkali Industry: Voltage efficiency, Current efficiency, Current density, Decomposition efficiency, Manufacture of soda ash by Solvay and Modified Solvay process, Manufacture of caustic soda.
Sulphuric Acid: Introduction, Manufacture of sulphuric acid by Chamber and Contact process, Material of construction, Storage and handling.
Ceramics: Introduction, Properties of ceramics, Classification of refractories, Important steps involved in the manufacture of refractories.

SECTION-B

Industrial gases: Manufacture and uses of carbon dioxide, oxygen and nitrogen, acetylene.
Paints: Introduction, Classification of paints, Manufacture of paints, Requirement of a good Paint.
Books Recommended:


Paper Title : PROCESS PLANT DESIGN –I (Practical)
Paper Code CHE 551     Max. Marks 50     Credits : 2

2. Selection, specification & power requirements of process pumps, fans and blowers.
3. Design of settling equipments like Dor thickeners, dust chambers, cyclone separators and centrifuges.
4. Design of agitated vessels using various types of impellers.
5. Design of Conveyor system for solids.

Books Recommended:


Paper Title : CHEMICAL TECHNOLOGY LAB (INORGANIC) (Practical)
Paper Code CHE 552     Max. Marks 50     Credits : 2

1. Fertilizers  (i) Determination of N-P-K Values
   (ii) Determination of micronutrients
2. Cement:  Loss of ignition, silica, insolubles, estimation of Mg, Ca, Fe.
3. Water

Paper Title : PETROLEUM PROCESSING ENGINEERING LAB. (Practical)
Paper Code CHE 553     Max. Marks 50     Credits : 2

1. To plot ASTM distillation curve for gasoline, diesel oil.
2. To determine Flash point (Closed – cup) and smoke point for kerosene.
3. To determine Aniline point, Diesel Index and cetane number for diesel oil.
4. To determine pour point and cloud point for furnace oil and diesel oil.
5. To determine viscosity at different temperatures using Ostwald viscometer for hydrocarbon solvents.
6. To determine softening point and penetration number for asphalt and grease samples.
7. To determine viscosity index of lubricating oil by Redwood viscometer.
8. To determine water content in petroleum products by Dean and Starks method.
Errors analysis, Solution of linear and non-linear algebraic equations.
Numerical differential & integration.
Interpolation.
Least squares approximation.
Ordinary and partial differential equations.
Development of computer programs based on the above topics using Matlab and their applications in chemical process computations.

Books Recommended:

SYLLABUS FOR
BACHELOR OF ENGINEERING (CHEMICAL)
SIXTH SEMESTER

Paper Title: CHEMICAL REACTION ENGINEERING-II (Theory)
Paper Code : CHE 601  Max. Marks 50  Credits : 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Heterogeneous catalyses: A brief review of catalyses catalytic specificity. Preparation testing and characterisation of catalysts, catalyst poisoning and catalyst regeneration.
Fluid Solid catalytic reaction: Kinetics; external transport processes, Reaction -and diffusion within porous catalysts. Effective diffusivity, thermal conductivity and effectiveness factors.

SECTION-B

Analysis of rate data design outline and selection of fixed bed, fluid bed and slurry reactions.
Fluid - fluid reactions rate equations and their application to the design of reactors.
Fluid Solid non-catalytic reactors rate equations and their application to the design of reactors.

Books Recommended:
1. Levenspiel, O : Chemical Reaction Engg., John Wiley

Paper Title: MASS TRANSFER-II (Theory)
Paper Code : CHE 602  Max. Marks 50  Credits : 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Distillation: Limitations and applications, prediction of VLE using thermodynamic & experimental techniques. Dew point & bubble point estimations for binary & multicomponent mixtures.
Distillation methods – flash distillation, differential distillation for binary systems, steam distillation, optimum reflux ratio. Fractionation of binary mixtures using McCabe – Thiele

SECTION-B

*Liquid-Liquid Extraction*: Ternary Equilibria and its representation on various plots. Selection criteria for solvent, Multistage extraction using partially miscible & immiscible solvents. Stagewise contact for countercurrent and crosscurrent extraction. Constructional details of equipment like mixer-settler, packed columns, pulsed extractor, sieve-tray extractor and centrifugal extractor.

*Leaching*: Preparation of solid, countercurrent and crosscurrent multistage contact Shank’s system. Constructional details of equipment like Rotocel extractor, Hildebrandt extractor, Bollman extractor, Kennedy Extractor & Beet-Sugar Diffusion battery extractor.

*Adsorption*: Types of adsorption, nature of adsorbents, equilibria for adsorption systems. Brief manufacture and commercial applications and characteristics for common adsorbents. Stagewise & continuous contacting of fluid and solid phase. Description of contact filtration adsorption system. Hypersorber Ion-exchange system.


**Books Recommended:**


**Paper Title: Open Elective-II (Theory)**

**Paper Code**: CHE 603  
**Max. Marks**: 50  
**Credits**: 4  
**Time**: 3 hours

**Course Duration**: 45 Lectures of one hour each.

**Note for the Paper setter**: The question paper should be divided into Section A and Section B. Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

1. **RESEARCH METHODOLOGY**

   **SECTION-A**

   **Introduction**: Meaning, Features, Objectives/Motives & types of Research; Attributes of good Research,
Research Methods and Research Methodology; Research Process, Significance of Research in Managerial decision making.

**Research Design:** Meaning, Characteristics and various concepts relating to research design and classification of research design, Importance.

**Measurement and Scaling:** Data Types Nominal, Ordinal and Ratio scale; scaling techniques.

**Formulation of Hypothesis:** Meaning, Characteristics and concepts relating to testing of Hypothesis (Parameter and statistic, Standard error, Level of significance, type-I and Type-II errors, Critical region, one tail and two tail tests); Procedure of testing Hypothesis. Numerical problems based on chi-square test and Ftest (variance ratio test only).

**SECTION – B**

**Data Collection:** Sources of Data-Primary/Secondary Methods of collecting data; direct personal interview, indirect oral interview, information through local agencies, mailed questionnaire method, schedule sent through enumerators; questionnaire and its designing and characteristics of a good questionnaire.

**Sampling Design:** Meaning and need of Sampling, Probability and non-probability sampling design, simple random sampling, systematic sampling, stratified sampling, cluster sampling and convenience, judgement and quota sampling (non-probability), determination of sample size.

**Data Analysis & Interpretation:** Introduction to Multivariate analysis- Multiple and partial correlation, multiple regression analysis (with two independent variables), specification of regression models and estimation of parameters, interpretation of results. Analysis of Variance (ANOVA)-One way and Two way ANOVA. Introduction to discriminant analysis and Factor Analysis (Numerical not to be asked)

**Report writing:** Style/format, contents and essential steps for report writing.

**Suggested Readings:**
2. Ranjit Kumar: Research Methodology, Pearson Education 2009-02-20
3. Donald R. Cooper, Pamela S. Schindler: Business Research Methods, Tata McGraw Hill
5. R. Pannerselvam: Research Methodology, Parentice Hall of India Limited.
7. William G. Zikmund: Business Research Methods, Thomson South Western Publication

**2. INTRODUCTION TO BIOCHEMICAL ENGINEERING**

Scope and principles of Biochemical Engineering, micro-organisms and their control, heat and mass transfer in biochemical systems. Sterilisation of equipment and environment. Anaerobic

**Books Recommended:**


**3. MEMBRANE SEPARATION PROCESSES (Theory)**

Paper Code : CHE 603  Max. Marks: 100  Time: 3 hours

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**

Fundamental, Mechanism of Membrane Transport, gaseous diffusion, separation in liquid phase, dialysis, reverse osmosis, ultra filtration liquid membrane.

**SECTION-B**


**Books Recommended:**


**Paper Title: CHEMICAL TECHNOLOGY (ORGANIC) (Theory)**

Paper Code : CHE 604  Max. Marks 50  Credits : 4  Time: 3 hours

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**


*Soaps and Detergents*: Introduction, Raw materials, Manufacture of soap, Classification of detergents, finishing of detergents.

*Water*: Sources and Constraints, Consumption patterns; Impurities: dissolved, suspended, colloidal; Hardness of water; Water softening; Lime soda, Ion exchange.

*Desalination*: Classification of processes; Evaporative processes, Multieffect evaporation, multistage flash, vapour compression; Membrane processes, Reverse osmosis, electrodialysis.

**SECTION-B**


*Sugar*: Introduction; Sugar extraction, defacation, sulphitation, carbonation, concentration, crystallization, drying, refining; Uses of molasses and bagasse.
**Carbon Technology:** Introduction, Classification of activated carbons, raw materials and manufacture of activated carbons, precursors for carbon fibres, manufacture of carbon fibres from polyacrylonitrile, manufacture of carbon black by furnace black process, applications.

**Nanotechnology:** Introduction and synthesis of nano particles by RF plasma process.

**Books Recommended**

**Paper Title:** TRANSPORT PHENOMENA (Theory)
**Paper Code:** CHE 605  Max. Marks 50  Credits : 4  Time: 3 hours
**Course Duration:** 45 Lectures of one hour each.
**Note for the Paper setter:** The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**
Transport of momentum, heat and mass by molecular motion-Newton’s law of Viscosity, Fourier’s law of heat conduction, Fick’s law of diffusion.
Transport properties – Viscosity, thermal conductivity and mass diffusivity.
Emphasis on the analogy between momentum, heat and mass transfer with respect to transport mechanism and governing equations.
Development of mathematical models of transfer process through shell momentum balance, shell energy balance and shell mass balance for solving specific problems of transport of momentum, heat and mass in laminar flow or in solids in one dimension.

**SECTION-B**
Development of general differential equations of fluid flow, heat transfer and mass transfer and their applications in solving one-dimensional steady state and unsteady state problems of momentum, heat and mass transfer.
Interphase transport of momentum, heat and mass and dimensionless correlation for each one of them.
Momentum, heat and mass transfer analysis.

**Books Recommended:**
Paper Title: HEAT TRANSFER LAB. (Practical)

Paper Code CHE 651  Max. Marks 50  Credits : 2

1. Determination of heat transfer coefficient for different types of heat transfer equipment. Wilson plots.
2. Unsteady state heat transfer in jacketed vessels. (Open pan evaporator)
3. Correlation of instantaneous heat transfer coefficients with time study deposition of scale on a heating surface.
4. Determination of heat losses for insulated pipes
5. Study of double pipe heat exchanger and to determine overall heat transfer coefficient
6. Study the performance characteristics of a 1,2 - shell and tube heat exchanger
7. Study and operation of long tube, forced circulation and multiple effect evaporators.
8. Duhring plot for solutions involving nonvolatile solutes.

Paper Title: REACTION ENGINEERING LAB. (Practical)

Paper Code CHE 652  Max. Marks 50  Credits : 2

1. Kinetic studies in a batch reactor.
2. Kinetic studies in a plug flow reactor.
3. Kinetic studies in a CSTR.
4. Kinetic studies in a semi batch reactor.
5. RTD studies in CSTR.
6. Dispersion number for packed bed reactor.
7. Adiabatic batch reactor.

CHE 653  PROCESS PLANT DESIGN–II

1. Process design and specifications of double pipe heat exchanger, shell and tube heat exchanger, plate type heat exchanger, condensor and reboiler.
2. Equilibrium procurement techniques – experimental and use of thermodynamics for its evaluation and then use in design height of distillation column. Calculations using McCabe Thiele, Plate-to-Plate calculation methods for fractionators, design of batch fractionating columns, design of fractionator internals for sieve-tray.
3. Absorber/Stripper design of stage-wise and continuous contact equipment (packed column), height of column and diameter calculation, design of various internals of absorber/stripper.
4. Process flow sheets, material and energy balance flow sheeting analysis.

Books Recommended:

1. **Oils & Fats**: Determination of Acid value, Iodine value, Saponification value.
2. **Carbohydrates**: Reducing and non-reducing sugars by (i) Fehlings method (ii) Pavy’s method.
3. **Soaps**: Determination of free and combined alkali, total fatty matter, moisture and insoluble.
SYLLABUS FOR
BACHELOR OF ENGINEERING (CHEMICAL)
SEVENTH SEMESTER

Paper Title: PROCESS ENGINEERING ECONOMICS (Theory)

Paper Code: CHE 701  Max. Marks 100  Time: 3 hours

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B. Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A


Interest and Investment Costs: Simple and compound interest. Nominal and effective rates of interest. Continuous interest ordinary annuity. Perpetuities and capitalized costs.

Taxes and Insurance: Types of taxes and tax returns, types of insurance and legal responsibility.

Depreciation: Types of depreciation. service life salvage value, present value and methods of determining depreciation, single unit and group depreciation.

SECTION-B


Optimum Design: Procedure with one variable, optimum reflux ratio in distillation and other examples.

Preliminary Steps in Plant Design: Plant design factors. project organization, plant location, preliminary data collection, process engineering

Books Recommended:

Paper Title: PROCESS INSTRUMENTATION (Theory)
Paper Code: CHE 702  Max. Marks: 100  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

General Concept: Need and classification of measurements and instruments, Basic and auxiliary functional elements of a measurement system.
Static and Dynamic Characteristics of Instruments:
Static Characteristics: Range and span, accuracy and static error, reproducibility and drift, sensitivity and dead zone.
Dynamic Characteristics: Speed of response and lag, fidelity and dynamic error, dead time.
Temperature measurement:
Thermocouples, metal resistance thermometers and thermistors, optical and radiation pyrometers, radiation receiving elements.
Pressure measurement:
Use of manometers, Bourdon gauge, bellows type gauge. Vacuum measurement–Mcleod gauge, thermoionic type ionization gauge, pirani vacuum gauge. Measurement of pressure in corrosive fluids: Diaphragm seal, liquid seal and purge system.

SECTION-B

Liquid level measurement:
Direct measurement of liquid level – Float & tape liquid level gauge, float and shaft liquid level unit, hydraulic remote transmission of liquid level.
Level measurement in open vessels: Bubbler system, diaphragm box system, air trap system.
Level measurement in pressure vessels – Differential pressure manometer, use of liquid seals with a manometer, displacement float liquid level gauge.
(6 Hrs.)
Measurement of viscosity, conductivity, humidity and pH.
Density measurement – liquid level method, displacement meter and hydrometer.
Measurement of weight – spring scale, pneumatic force meter and hydrostatic force meter.
Process Instrumentation–Recording instruments, indicating and signaling instruments, control centre, transmission of instrument reading, instrumentation diagrams.

Books Recommended:
1. Eckman, Donald P.: Industrial Instrumentation, CBS Publisher and Distributors, Indian Reprint 2004.
1. ANALYTICAL TECHNIQUES (Theory)

Section A

2. Solvent Extraction: Distribution law, extraction process, factors effecting extraction, technique for extraction, quantitative treatment of solvent extraction equilibria, classification of solvent extraction systems. Advantages and applications of solvent extraction.

Section B

7. NMR: Principle, chemical shift, spin-spin coupling shift reagents, instrumentation, spectra and molecular structure, identification of organic compounds on the basis of NMR.

Books Recommended:


2. POLYMER SCIENCE AND ENGINEERING (Theory)

SECTION A

Chemistry of polymers:
Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness, Polymerization methods: addition and condensation; their kinetics, copolymerization, monomer reactivity ratios and its significance, kinetics, different copolymers, random, alternating,
azeotropic copolymerization, block and graft copolymers, techniques for copolymerization-bulk, solution, suspension, emulsion.

**Polymer Characterization:**
Solubility and swelling, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights, polymer crystallinity, analysis of polymers using IR, XRD, thermal (DSC, DMTA, TGA), microscopic (optical and electronic) techniques.

**SECTION-B**

**Polymer Technology:**
Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, crosslinking and vulcanization

**Polymer processing:**
Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill, internal mixer.

**Books Recommended:**

**Paper Title: Department Elective -I (Theory)**
**Paper Code:** CHE 703  **Max. Marks:** 100  **Time:** 3 hours

**Course Duration:** 45 Lectures of one hour each.

**Note for the Paper setter:** The question paper should be divided into Section A and Section B. Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

1. **Alternate Energy Technology**

   **SECTION-A**

Solar Energy Fundamentals, Solar Radiation Characteristics and Measurements. Low temperature energy collection, high temperature energy collection, solar thermal power generation systems, Domestic industrial and agricultural applications of solar energy.
SECTION-B


Books:
Energy Technology, S. Rao, Dr. B.B. Parulekar, Khanna Publisher, 2000.
Non Conventional Energy Sources, G.D. Rai, Khanna Publisher, 1997

2. LOW TEMPERATURE ENGINEERING

SECTION-A


SECTION-B


Books Recommended:
3. PLANT UTILITIES (Theory)

SECTION-A

Importance of Process utilities in Chemical Plant.
Compressed air and Vacuum: Reciprocating air compressors, vacuum pumps, air receivers, piping systems.
Steam: Boiler, steam handling and distribution steam nozzles.

SECTION-B

Refrigeration: Air refrigeration cycle, vapour compression cycle, liquification processes.
Power Generation: Internal Combustion engines. Gas turbines, steam power plants.

Books Recommended:

Paper Title: PROCESS PLANT DESIGN-III (Practical)

Paper Code CHE 751 Max. Marks 50

1. Design of liquid-liquid and liquid-solid extraction equipment (stagewise and continuous contact).
2. Design of Heterogeneous catalytic Reactors.
   2.1 Fixed-bed reactors
      (i) Isothermal and adiabatic
      (ii) Non-isothermal non-adiabatic
   2.2 Fluidized-bed reactors
      (i) Two-phase fluidized bed model
      (ii) Slurry reactors and
      (iii) Trickle-bed reactors.
3. Layout of chemical plant equipment, safety and hazard aspects of layout.

Books Recommended:

**Paper Title : MASS TRANSFER LAB. (Practical)**

**Paper Code CHE 752**

<table>
<thead>
<tr>
<th>Max. Marks 50</th>
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</thead>
<tbody>
<tr>
<td>1. Determination of mass transfer coefficients for naphthalene-air system.</td>
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<tr>
<td>2. To determine drying rate curves for different wet solids in a batch drier under constant drying conditions</td>
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<tr>
<td>3. Fractional approach to equilibrium for liquid-liquid extraction from single drop.</td>
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<tr>
<td>4. Verification of Rayleigh’s equation for differential distillation.</td>
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<tr>
<td>5. Determination of flooding velocities in packed columns.</td>
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<tr>
<td>6. Determination of HETP for packed distillation columns.</td>
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<tr>
<td>7. Study and operation of a pilot sized distillation column under total reflux.</td>
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<tr>
<td>8. Study of different mass transfer equipments.</td>
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</table>

**Paper Title : PROJECT WORK**

**Paper Code CHE 851**

Each student is required to submit a project report on the design of a chemical plant, selecting the best process with optimum equipment size and operating conditions. The object is to test the ability of the student to apply his entire knowledge of Chemical Engineering principles to conceptualize, analyze and solve the problems. To judge his knowledge and originality and capacity for application of laboratory data in designing chemical plants and to determine the level of his proficiency at the end of the course.
SYLLABUS FOR
BACHELOR OF ENGINEERING (CHEMICAL)
EIGHTH SEMESTER

Paper Title: INDUSTRIAL SAFETY & HAZARDS (Theory)
Paper Code : CHE 801 Max. Marks 100 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Definition, identification, classification and assessment of various types of hazards in work-place environment, protective and preventive measures in hazard control.
Toxic Chemicals: maximum allowable concentrations and other standards. Biological threshold limit values.

SECTION-B

Case Studies of typical hazardous industries.

Books Recommended:

Paper Title: PROCESS DYNAMICS & CONTROL (Theory)
Paper Code : CHE 802 Max. Marks 100 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Incentives for chemical process control, design aspects of a process control system.
Difference between feedback and feed forward control configuration. Hardware elements of a control system, Block Diagrams.

Laplace transform and transfer functions. Difference between lumped and distributed parameter systems, Dynamic behaviour of first and higher order systems, interacting and non-interacting systems, dead time.
Different modes of control actions and their basic characteristics, controllers and their characteristics, control valve.

SECTION-B

Closed-loop transfer functions, transient response of simple control systems, Routh stability criterion, Root Locus.

Introduction to frequency response: Bode diagrams, control system design by frequency response: Ziegler-Nichols controller settings, stability using frequency response, gain margin and phase margin.

Introduction to advanced control techniques such as cascade control, feed forward control, ratio control, inferential control.

Books Recommended


Paper Title: Open Elective-III (Theory)
Paper Code : CHE 803 Max. Marks 100 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B
Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set.
The students will be required to attempt 5 questions selecting at least 2 from each section.

1. PROJECT MANAGEMENT

SECTION-A

Project Management: concept of project management, project management systems, responsibilities and qualities of a project manager, project management team-composition, functions and responsibilities, co-ordination procedures. Manpower planning; recruitment and selection job description, specification and evaluation, performance appraisal, basis of remuneration and incentives. Project Identification: Principles of project identification, importance of capital investment, decision making industrial policy resolution, industrial development and regulation act, supply and demand analysis, incentives for industrially backward areas and small scale industries, foreign collaboration and foreign exchange regulations. Appraisal criteria and selection of investment: Non discounting criteria, discounting criteria, appraisal and selection in practice.
SECTION-B

Books Recommended:

2. FINANCIAL MANAGEMENT

SECTION-A
Introduction to Financial Management: Meaning; Scope; Finance Function; Financial Goals; Agency Problem; Relationship of Finance with Accounts and Economics.
Sources of Finance: Features; Advantages and Limitations of Equity Shares; Preference Shares; Debentures; Term-Loans; Right Issue, Venture Capital, Private Equity GDR, ADR.
Cost of Capital: Meaning; Calculation of Cost of Debt Capital; Equity Capital; Preference Capital; Retained Earnings; Weighted Average Cost of Capital.
Capital Structure: Meaning; Determinants; Assumptions; Net Income and Operating Income Approach; Traditional Position; M-M Position; EBIT and EPS Analysis; Capital Structure and Taxation.
Leverage Analysis: Meaning; Types; Estimation of Financial; Operating and Combined Leverage; Relation of Financial Leverage with Risk and Return.
Management of Working Capital: Meaning of WC; Need of WC Management; Determinants of WC; Operating Cycle; Estimation of WC; Working Capital Financing; Trade Credit, Bank finance, commercial paper, factoring, money market instruments.

SECTION-B
Cash Management: Meaning; Facets of Cash Management; Motives for Holding Cash; Optimal Cash Balance; Short-term and Long-Term Cash Forecasting.
Receivable Management: Meaning; Credit Policy Variable; Credit Evaluation; Credit Decisions; Control of Account Receivable.
Inventory Management: Meaning; Need to hold Inventory; Objective of Inventory Management; Inventory Investment Analysis; Inventory Control System.
Capital Budgeting: Meaning; Basic Principles of Costs and Benefits; Investment Criteria; Pay back Method; Accounting Rate of Return method; Net Present Value Method; Benefit-Cost Ratio; Internal Rate of Return; Capital Rationing; Introduction to Basic Techniques of Risk Analysis in Capital Budgeting.
Dividend Decisions: Meaning and Types of Dividend; Issues in Dividend Policy; Traditional Model; Walter Model; Gordon Model; Miller and Modigliani Model; Bonus Shares and Stock Splits.
Corporate Restructuring: Meaning and forms of corporate restructuring, merger and amalgamation, takeover and acquisition, types or forms of mergers and takeovers, their benefits and motives.

Suggested Readings:

3. HUMAN RESOURCE MANAGEMENT (Theory)
   
   SECTION-A
   
   Introduction: Meaning, scope, objectives and functions of HRM; Importance of Human Resource Management; HRM & HRD a comparative analysis;
   
   Environment of HRM: Role of government, internal and external forces; Human Resource Management practices in India.
   
   Human Resource Planning: Definition, objectives, process and importance; Job analysis, description, specification & job evaluation; Recruitment, selection, placement and induction process;
   
   Human Resource Development: Concept, Employee training & development; Career Planning & development; Promotions, demotions, transfers, separation, absenteeism & turnover;
   
   SECTION-B
   
   Job Compensation: Wage & salary administration, incentive plans & fringe benefits.
   
   Performance Management: Concept & process, performance appraisal, Potential appraisal;
   
   Quality of work life (QWL): Meaning, techniques for improving QWL.
   
   Industrial Relations: Concept and theories, trade unions; Health, Safety & Employee welfare measures; Employee grievances and discipline, participation & empowerment; Introduction to collective bargaining.

   Books Recommended:

4. INDUSTRIAL RELATIONS AND LABOUR LAWS

   SECTION – A
   
   Overview of Industrial Relations: Concept of IR, Nature of IR, Objectives of IR, Evolution of IR in India, Theories of IR, Systems approach to IR.
Trade Unionism: Concept of Trade Unions, Functions of Trade Unions, Approaches, Structures of Trade Unions.

The Trade Unions Act, 1926: Trade Union, Registration of Trade Unions, Rights and Liabilities of registered trade unions.

Grievance Handling: Grievance, Causes/Sources of Grievances, Grievance Redressal Machinery, Legislative Aspects of the Grievance Redressal Procedure in India, Domestic enquiry.


SECTION – B

The Workmen's Compensation Act, 1923: Workman, employer’s liability to pay compensation, disablement, amount of compensation.

Tripartite and bipartite bodies: Workers Participation in Management.


Industrial Relations and emerging scenario: Industrial Relations and technological change, International Labour Organisation (ILO): Objectives and Structure, Future of Industrial Relations

Standing Orders Act, 1948: Standing orders, certification of draft standing orders, duration and modification of certified orders.

Employee’s State Insurance Act, 1948: Contribution, principle employer, immediate employer, different benefits.

Suggested Readings:
6. S.N. Dhayani: Industrial Relations System, Sultan Chand and Sons
1. PETROCHEMICAL TECHNOLOGY

SECTION-A

General Introduction: Definition, history and economic perspective of petrochemical industry, raw materials for petrochemical industry-petroleum, natural gas, coal, bio-mass, agro-residues, etc.

First Generation Petrochemicals: Petrochemicals based on aliphatic, olefinic, acetylene, aromatics, etc. Hydrocarbons-processing and applications.


SECTION-B

Nylon Monomers, Polyester Monomers, Styrene, Other Monomers - Bisphenol A, Epichlorophydrin, diisocyanates, Pentaerythritol, etc. - properties, process technologies and applications.

Third Generation Petrochemicals: Important Polymers such as Polyethylene, Polypropylene and their Copolymers and other Derivatives Rubbers, Diene Polymers, Styrene Polymers, Vinyl Polymers and Condensation Polymers - properties, process technologies and applications.

Books Recommended:

2. NANO TECHNOLOGY (Theory)

SECTION-A

Introduction: Plenty of room at the bottom—Feynman’s concept, evolution of ultra-fine materials, the missing link between conventional laws in physics and chemistry and new theories.
**Building Blocks of Nanotechnology:** covalent architecture, coordinated architecture and weakly bound aggregates, Interactions and topology

**Chemical Properties:** The effect of nanoscale metals on chemical reactivity, effect of nanostructure on mass transport, metal nanocrystallites support on oxides, supported nanoscale catalysts.

**General principles for synthesis** of monodispersed nanoparticles, metals and intermetallics, Ceramics, composites, nanoparticles, colloids/Micelles/vesicles/Polymers/glasses, Crystalline, and zeolite hosts.

**Review of fundamental behaviour** of 0-D(nanoclusters), 1-D(nanowires), 2-D(thin film multilayers), and 3-D(bulk nanostructures) materials. Introduction to size dependent phenomenon in nanostructure for various applications, specific production techniques like chemical vapor deposition, arc ignition etc. Formation of clusters and nanoparticles from supersaturated vapor and selected properties, sputtering and thermal evaporation and laser methods. Synthesis of nanoparticles by chemical routes.

SECTION-B

**Approaches to production:** Top down and bottom up, Mechanical attrition, high energy ball milling, and mechanical attrition, nanocomposites by mechano-chemistry, mechanism of grain size reduction, property of microstructure relationships.

**Characterization techniques:** Tools in nanotechnology: Scanning electron microscopy(SEM), Transmission electron microscopy and high resolution(TEM), energy dispersive spectroscopy(EDX), Atomic force microscopy(AFM), Magnetic force microscopy(MFM), Chemical Force Microscopy(CFM), Focused ion beam, nanolithography, powder x-ray diffractometry, UV visible.

**Nanomaterials:** CNTs, Polymer Nanocomposites nanoceramics, nanometals, nanopolymers, structures-properties-applications, Quantum dots. Concepts Bio-Nanotechnology.

**Applications:** Nanotherapeutics, Molecular diagnostics, tissue engineering, nanopumps, nanorobotoics cells, molecular motors, nanomembranes, Organic molecular based computers, bionanodevices (sensors & actuators).

**Books Recommended**
2. *Nanotechnology – An introduction to nanostructure of technique* by Michel Kohler and Wolfgang Fritzsche 2004- Wiley VCH
3. *Springer Handbook of Nanotechnology* by Bharat Bhushan
5. *Nanostructures and Nanomaterials* by G. Cao, Imperial College Press, 2004
6. *Introduction to Nanotechnology* by Owen and Poole, Wiley
7. *Nano-materials* by A. K. Bandopadhyay, New Age International
4. **Complex Flow Hydrodynamics**

**Section-A**

Shell balance for momentum transfer: Velocity profiles; Residence time distribution measurement techniques; RTD for single phase flow in tubes, coils, packed beds, stirred vessels;

Rheology of Fluids and Suspensions.

Motion of particles, drops and bubbles through quiescent Newtonian and non-Newtonian fluids.

Drop/Bubble shapes characterization. Drag and terminal velocity of particles, bubbles and drops.

**Section-B**

Operational hydrodynamic characteristics of: Packed beds, fluidised beds, Trickle beds, Bubble columns, spray columns, plate columns.

Prediction of pressure drop; Friction factor; drag coefficient, single phase flow, multiphase flow; Lockhart Martinelli approach.

**Reference Books**

4. Fluidization Engineering

SECTION-A

Introduction to fluidisation, Industrial applications, Behaviour of fluidised beds----classification of particles, regimes of fluidization, minimum fluidization velocity, particulate and aggregative fluidization, Bubbling fluidization, Bubbling bed models for catalytic reactions.

SECTION-B

Turbulent and fast fluidization, dilute and dense phase transport, cyclone, stand pipes, circulating fluidized beds, spouted beds, three phase fluidization, performance modeling of multiphase fluidized systems.

Reference Books:

1. Fluidisation Engineering by D.Kunii and Octave Levenspiel, Butterworth-Heinemann;
   2nd edition


5. POLYMER SYNTHESIS AND CHARACTERIZATION

Section A

Step reaction (condensation) polymerization – Mechanism of step reaction polymerization, carbonyl addition elimination, carbonyl addition – substitution, nucleophilic substitution, and aromatic electrophilic substitution. Kinetics of step reaction polymerization, reactivity and molecular size. Kinetic expressions for polymerization in absence and in presence of a catalyst. Statistics of linear step reaction polymerization – number distribution and weight distribution functions, molecular weight control, Polyfunctional step reaction polymerization, prediction of gel point, its experimental observation, molecular wt. distribution

Free radical vinyl polymerization: free radical initiators, techniques for free radical polymerization (bulk, suspension, solution, and emulsion), kinetics and mechanism of polymerization, monomer reactivity, and copolymerization, Controlled/"living” radical vinyl polymerization: ATRP (Atom Transfer Radical Polymerization) and RAFT (reversible addition-fragmentaion chain transfer radical polymerization)

Vinyl polymerization with ionic initiators: cationic polymerization and anionic polymerization, Vinyl polymerization with complex coordination catalysts: Ziegler-Natta catalysts
Copolymerization – types of copolymerization- the copolymer composition equation, monomer reactivity rations, rate of copolymerization, composition of copolymers, variation of copolymer composition with conversion, mechanisms of copolymerization, block and graft copolymers.

Section B
Chemical analysis: Introduction, Physical tests, burning characteristics, Density, refractive index, chemical tests. Qualitative and quantitative elementary analysis, Solubility and acid numbers, acetyl number, iodine number end group analysis
Other Polymer Characterization Techniques; Differential Scanning Calorimetry, Dynamic Mechanical Analysis, Thermogravimetric Analysis, Gel Permeation Chromatography Viscosity, Nuclear Magnetic Resonance spectroscopy, Infrared spectroscopy,

5. Polymer Characterization, E. Schröder, G. Müller, K. F. Arnt, Hanser Publishers

Paper Title: PROCESS MODELING & SIMULATION LAB. (Practical)
Paper Code CHE 852 Max. Marks 25
Functional design, property estimate as inputs for design. System concepts for computer aided design, computer aided flow sheet design. Process analysis. Process variables selection, equipment design through the selection of free parameters subject to constraints and other parameters, modular design. Simulation optimality. Dynamic design including control stability. Typical equipments to be considered: heat exchangers, distillations columns, reactor and process equipments.

Books Recommended:

Paper Title: PROCESS CONTROL LAB. (Practical)
Paper Code CHE 853 Max. Marks 50
1. U-Tube manometer
   (a) To plot the response curve for a given input to a U-tube manometer.
   (b) To determine the transfer function from the response curve obtained in part (a).
2. Time constant of a mercury thermometer
   To study the dynamics of the given thermometer and compare the theoretical value of its time constant with the experimental value.
3. Analysis of valve
Develop a block diagram representing the dynamic behaviour of the given globe valve.

4. (a) Liquid level measurement
   With the given Bubbler System for Liquid Level Measurement, evaluate liquid height in the tank and compare it with actual values.
   (b) Calibration of Pressure Gauge
   Calibrate a pressure gauge in the range 0 psi to 60 psi.

5. Temperature control system
   To maintain the temperature of the fluid at the set point value.

6. Time constant of liquid level tank
   To study the dynamics of liquid level in a tank and compare the analytical value of the time constant with the experimental value.

7. Liquid level control
   (a) To carry out the closed loop experiment on the given liquid level control system and record its response for step change in the inlet flow.
   (b) To plot the experimental response curve and comment on the response obtained.

8. Compurec
   Pressure control simulation with step input and sinusoidal input.

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**Paper Title:** LITERATURE SURVEY, REPORT WRITING AND SEMINAR  
**Paper Code:** CHE 854  
**Max. Marks:** 50

Forms of technical reports: aims and forms according to type of readership and extent of circulation. Abstracts, extended abstracts, tables, graphs. Visual representation of data: slides, microfilms, others techniques including those of audio-visual representation. Correct use of audio equipment.

Research papers and their presentation and publication. Information retrieve direct and through abstracts.

Practical training in writing and presentation of technical reports through audio-visual means.

Technique of effective public speaking organized and imprompt discussions.

Preparation of technical report on an assigned topic after survey of scientific, technical and commercial literature, using card indexes, microfilms and other information retrieval methods.

Use of Computer softwares for report writing.

**Books Recommended:**

2. Sottle, R.T. : The Use of Chemical Literature, Butter Worths.

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**Paper Title:** VIVA VOCE-II (COMPREHENSIVE)  
**Paper Code:** CHE 855  
**Max. Marks:** 50

The viva-voce examinations will be comprehensive and covering mainly chemical engineering and technology subjects covered during all the semester including the Eight Semester.