**SYLLABI FOR BACHELOR OF ENGINEERING (CHEMICAL)**
**EXAMINATIONS 2010 – 2011**
**SCHEME OF TEACHING AND EXAMINATION**

| Paper | Subject | Teaching Hours per Week | | | | Exam. Marks | Sessional Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **FIRST SEMESTER** | | L | T | P | C | | | |
| CHE 101 | Mathematics-I | 3 | 1 | - | 4 | 50 | 50 | 100 |
| CHE 102 | Applied Physics | 3 | 1 | - | 4 | 50 | 50 | 100 |
| CHE 103 | Chemistry (Inorganic) | 3 | 1 | - | 4 | 50 | 50 | 100 |
| CHE 104 | Engineering Mechanics | 3 | 1 | - | 4 | 50 | 50 | 100 |
| CHE 105 | Introduction to Chemical Engineering | 3 | 1 | - | 4 | 50 | 50 | 100 |
| **Practicals** | | | | | | | | |
| CHE 151 | Physics | - | - | 2 | 1 | 25 | 25 | 50 |
| CHE 152 | Inorganic Chemistry | - | - | 3 | 2 | 25 | 25 | 50 |
| CHE 153 | Engineering Graphics | - | - | 3 | 2 | 25 | 25 | 50 |
| CHE 154 | Communication Skills | - | - | 2 | NC | | Qualifying | |
| | **Total** | **15** | **5** | **10** | **25** | **325** | **325** | **650** |

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

## SCHEME OF TEACHING AND EXAMINATION

| Paper | Subject | Teaching Hours per Week | | | | Exam. Marks | Sessional Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **SECOND SEMESTER** | | L | T | P | C | | | |
| CHE 201 | Mathematics-II | 3 | 1 | - | 4 | 50 | 50 | 100 |
| CHE 202 | Strength of Materials | 3 | 1 | - | 4 | 50 | 50 | 100 |
| CHE 203 | Chemistry (Organic) | 3 | 1 | - | 4 | 50 | 50 | 100 |
| CHE 204 | Process Plant Material & Energy Balances | 3 | 1 | - | 4 | 50 | 50 | 100 |
| CHE 205 | Physical Chemistry | 3 | 1 | - | 4 | 50 | 50 | 100 |
| CHE 206 | Environmental Studies | 2 | - | - | NC | | Qualifying | |
| **Practicals** | | | | | | | | |
| CHE 251 | Computer Aided Drafting | - | - | 3 | 2 | 25 | 25 | 50 |
| CHE 252 | **Basic Workshop Techniques | - | - | 3 | 2 | 25 | 25 | 50 |
| CHE 253 | Organic Chemistry | - | - | 3 | 2 | 25 | 25 | 50 |
| CHE 254 | Mechanical Engineering Lab. | - | - | 2 | 1 | 25 | 25 | 50 |
| CHE 255 | Physical Chemistry | - | - | 3 | 2 | 25 | 25 | 50 |
| | **Total** | **17** | **5** | **14** | **29** | **375** | **375** | **750** |

** There will be 4 weeks' training in Basic Workshop Techniques during the summer vacations.

**SCHEME OF TEACHING AND EXAMINATION**

| Paper | Subject | Teaching Hours per Week | | | Exam. Marks | Sessi-onal Marks | Total Marks |
|---|---|---|---|---|---|---|---|
| **THIRD SEMESTER** | | L | T | P | | | |
| CHE 301 | Physical Chemistry | 3 | 1 | - | 100 | 50 | 150 |
| CHE 302 | Mechanical Operations | 3 | 1 | - | 100 | 50 | 150 |
| CHE 303 | Electronics | 3 | 1 | - | 100 | 50 | 150 |
| CHE 304 | Fluid Flow | 3 | 1 | - | 100 | 50 | 150 |
| CHE 305 | Introduction to Bio-Technology | 3 | 1 | - | 100 | 50 | 150 |
| **Practicals** | | | | | | | |
| CHE 351 | Physical Chemistry | - | - | 3 | 50 | 50 | 100 |
| CHE 352 | Computer Programming | - | - | 3 | 50 | 50 | 100 |
| CHE 353 | Electronics Engineering Lab | - | - | 3 | 50 | 50 | 100 |
| CHE 354 | Computer Aided Drafting | - | - | 3 | 50 | 50 | 100 |
| | **Total** | **15** | **5** | **12** | **700** | **450** | **1150** |

**SCHEME OF TEACHING AND EXAMINATION**

| Paper | Subject | Teaching Hours per Week | | | Exam. Marks | Sessi-onal Marks | Total Marks |
|---|---|---|---|---|---|---|---|
| **FOURTH SEMESTER** | | L | T | P | | | |
| CHE 401 | Mathematics-III | 3 | 1 | - | 100 | 50 | 150 |
| CHE 402 | Electrical Engineering | 3 | 1 | - | 100 | 50 | 150 |
| CHE 403 | Chemical Engineering Thermodynamics | 3 | 1 | - | 100 | 50 | 150 |
| CHE 404 | Heat Transfer | 3 | 1 | - | 100 | 50 | 150 |
| CHE 405 | Engineering Materials | 3 | 1 | - | 100 | 50 | 150 |
| **Practicals** | | | | | | | |
| CHE 451 | Electrical Engineering Lab | - | - | 3 | 50 | 50 | 100 |
| CHE 452 | Process Equipment Design | - | - | 3 | 50 | 50 | 100 |
| CHE 453 | Process Plant Design-I | - | - | 3 | 50 | 50 | 100 |
| CHE 454 | Analytical Techniques | - | - | 3 | 50 | 50 | 100 |
| CHE 455* | Comprehensive Viva-Voce-I | - | - | - | 100 | - | 100 |
| | Total | 15 | 5 | 12 | 800 | 450 | 1250 |

* The Comprehensive Viva-Voce –I Examination (Paper CHE 455 will cover the subjects taught during the First, Second, Third and Fourth Semesters).

## SCHEME OF TEACHING AND EXAMINATION

| Paper | Subject | Teaching Hours per Week | Exam. Marks | Sessional Marks | Total Marks |
|---|---|---|---|---|---|

| **FIFTH SEMESTER** | | L | T | P | | | |
|---|---|---|---|---|---|---|---|
| CHE 501 | Mathematics-IV | 3 | 1 | - | 100 | 50 | 150 |
| CHE 502 | Petroleum Processing Engineering | 3 | 1 | - | 100 | 50 | 150 |
| CHE 503 | Chemical Reaction Engineering- I | 3 | 1 | - | 100 | 50 | 150 |
| CHE 504 | Mass Transfer-I | 3 | 1 | - | 100 | 50 | 150 |
| CHE 505 | Environmental Engineering | 3 | 1 | - | 100 | 50 | 150 |
| CHE 506 | Chemical Technology (Inorganic) | 3 | 1 | - | 100 | 50 | 150 |
| **Practicals** | | | | | | | |
| CHE 551 | Environmental Engineering Lab | - | - | 3 | 50 | 50 | 100 |
| CHE 552 | Chemical Technology Lab (Inorganic) | - | - | 3 | 50 | 50 | 100 |
| CHE 553 | Petroleum Processing Engineering Lab | - | - | 3 | 50 | 50 | 100 |
| CHE 554 | Fluid Mechanics Lab | - | - | 3 | 50 | 50 | 100 |
| | **Total** | **18** | **6** | **12** | **800** | **500** | **1300** |

## SCHEME OF TEACHING AND EXAMINATION

| Paper | Subject | Teaching Hours per Week | | | Exam. Marks | Sessional Marks | Total Marks |
|---|---|---|---|---|---|---|---|
| **SIXTH SEMESTER** | | L | T | P | | | |
| CHE 601 | Chemical Reaction Engineering -II | 3 | 1 | - | 100 | 50 | 150 |
| CHE 602 | Mass Transfer-II | 3 | 1 | - | 100 | 50 | 150 |
| CHE 603 | Energy Technology | 3 | 1 | - | 100 | 50 | 150 |
| CHE 604 | Chemical Technology (Organic) | 3 | 1 | - | 100 | 50 | 150 |
| CHE 605 | Transport Phenomena | 3 | 1 | - | 100 | 50 | 150 |
| **Practicals** | | | | | | | |
| CHE 651 | Particle Mechanics Lab | - | - | 3 | 50 | 50 | 100 |
| CHE 652 | Chemical Engineering Computation | - | - | 3 | 50 | 50 | 100 |
| CHE 653 | Process Plant Design-II | - | - | 3 | 50 | 50 | 100 |
| CHE 654 | Chemical Technology Lab (Organic) | - | - | 3 | 50 | 50 | 100 |
| | **Total** | **15** | **5** | **12** | **700** | **450** | **1150** |

## SCHEME OF TEACHING AND EXAMINATION

| Paper | Subject | Teaching Hours per Week | | | Exam. Marks | Sessional Marks | Total Marks |
|---|---|---|---|---|---|---|---|
| **SEVENTH SEMESTER** | | L | T | P | | | |
| CHE 701 | Chemical Reaction Engineering-II | 3 | 1 | - | 100 | 50 | 150 |
| CHE 702 | Process Dynamics & Control | 3 | 1 | - | 100 | 50 | 150 |
| CHE 703 | Process Engineering Economics | 3 | 1 | - | 100 | 50 | 150 |
| CHE 704 | Plant Utilities | 3 | 1 | - | 100 | 50 | 150 |
| **Elective Subjects** | | | | | | | |
| CHE 705 | Petrochemical Technology | | | | | | |
| CHE 706 | Polymer Science & Engineering | | | | | | |
| CHE 707 | Food Technology | | | | | | |
| CHE 708 | Industrial Safety & Hazards | 3 | 1 | - | 100 | 50 | 150 |
| CHE 709 | Optimization Techniques in Chemical Engineering | | | | | | |
| CHE 710 | Project Management | | | | | | |
| **Practicals** | | | | | | | |
| CHE 751 | Chemical Engineering Computation | - | - | 3 | 50 | 50 | 100 |
| CHE 752 | Process Plant Design-III | - | - | 3 | 50 | 50 | 100 |
| CHE 851 | Heat & Mass Transfer | - | - | 3 | - | - | - |
| CHE 852 | Process Control & Reaction Engineering Lab | - | - | 3 | - | - | - |
| CHE 855 | Seminar | - | 2 | - | - | - | - |
| CHE 856 | Project Work | - | 3 | - | - | - | - |
| | **Total** | **15** | **10** | **12** | **600** | **350** | **950** |

## SCHEME OF TEACHING AND EXAMINATION

| Paper | Subject | Teaching Hours per Week | | | Exam. Marks | Sessional Marks | Total Marks |
|---|---|---|---|---|---|---|---|
| **EIGHTH SEMESTER** | | L | T | P | | | |
| CHE 801 | Industrial Management | 3 | 1 | - | 100 | 50 | 150 |
| **Elective Subjects-II** | | | | | | | |
| CHE 810 | Membrane Separation Process | | | | | | |
| CHE 811 | Petroleum Processing Engineering | | | | | | |
| CHE 812 | Polymer Processing | | | | | | |
| CHE 813 | Low Temperature Engineering | 3 | 1 | - | 100 | 50 | 150 |
| CHE 814 | Biochemical Engineering | | | | | | |
| CHE 815 | Alternate Engineering Technologies | | | | | | |
| CHE 816 | Computer Programming & its Applications | | | | | | |
| **Practicals** | | | | | | | |
| CHE 851 | Heat & Mass Transfer | - | - | 3 | 75 | 75 | 150 |
| CHE 852 | Process Control & Reaction Engineering Lab | - | - | 3 | 75 | 75 | 150 |
| CHE 853 | Process Modelling & Simulation | - | - | 3 | 50 | 50 | 100 |
| CHE 854 | Elective Lab. | - | - | 3 | 50 | 50 | 100 |
| CHE 855 | Seminar | - | - | 2 | - | 100 | 100 |
| CHE 856 | Project Work | - | 3 | - | 50 | 100 | 150 |
| CHE 857 | Factory Training & Tour Report | - | - | - | - | 100 | 100 |
| CHE 858 | Viva Voce-II (Comprehensive) | - | - | - | 100 | - | 100 |
| | **Total** | **6** | **5** | **14** | **600** | **650** | **1250** |

**SYLLABUS FOR**
**BACHELOR OF ENGINEERING (CHEMICAL)**
**FIRST SEMESTER**

## CHE 101 MATHEMATICS-I

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.

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*:**


1. Prasad, G. : Differential Calculus, 17th Edition, Pothishala Private Ltd. Allahabad.
2. Prasad, G. : Integral Calculus, 19th Edition, Pothishala Private Ltd., Allabahad.
3. Shanti Narayan : Differential Calculus, 14th Edition, S. Chand and Co., New Delhi.
4. Shanti Narayan : Integral Calculus, 10th Edition, S. Chand And Co., New Delhi.
5. Grewal, B. S. : Higher Engineering Mathematics, 41st Edition, Khanna Pub., New Delhi.
6. Kreyszig, Erwin : Advanced Engineering Mathematics, 8th Edition, John Wiley and Sons.
7. Jain, R. K. & Iyengar, S. : Advanced Engg. Mathematics, 2nd Edition, Narosa Publishing House, New Delhi, 2003.


## CHE 102 APPLIED PHYSICS

1. *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.

2. *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, Bernoulie's equation and its applications: venturimeter and pitot tube.

3. *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.

4. *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.

5. *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.

***Books Recommended:***


1. Halliday, D. & Resnick, R. : Physics, 3rd Edition.
2. D. S. Mathur : Elements of Properties of Matter, 10th Edition.
3. Arthur Beiser : Perspectives of Modern Physics.
4. Theraja, B. L. : Modern Physics for Engineers, 1st Edition.
5. M. Ali Omar : Elementary Solid State Physics, 1st Edition.


**CHE 103 CHEMISTRY (INORGANIC)**

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.
(3 Hrs.)
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 Hrs.)

3. *The Solid State*: A recapitulation of close packing of spheres, structures of NaCl, CsCl, ZnS, $CaF_2$, crystal defects and applications of defect structures (transistors, rectifiers, photovoltaic cells and computer chips).
(3 Hrs.)

4. *Coordination Compounds*: Werner's theory, effective atomic number, bonding of transition metal complexes: valence bond theory, crystal field theory, crystal field splitting 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). Kinetic aspects of coordination compounds (substitution reactions in complexes with coordination number 4 and 6 and their mechanism - $SN^1$, $SN^2$). Magnetic behaviour of complexes – Para magnetism, diamagnetism, ferromagnetism and antiferromagnetism and measurement of magnetic susceptibility of complexes by Guoy's method.
(12 Hrs.)

5. *Organometallic Compounds*: Nomenclature, types of ligands and bonding in organometallic compounds, use of organometallics in industry.
(4 Hrs.)

6. *Inorganic polymers*: Types of inorganic polymers, polyphosphazenes, polysiloxanes – their structures and properties.
(4 Hrs.)

7. *Role of Metals in Biological Systems*: Bio-inorganic Chemistry of Iron – Heme proteins & Non-Heme iron proteins; bioinorganic chemistry of cobalt-vitamin $B_{12}$ and metalloenzymes.
(4 Hrs.)

8. *Metal toxicology*: Toxic effects of heavy metals with special reference to Cd, Pb, Hg and As.
(4 Hrs.)

9. Theory of quantitative inorganic analysis. (3 Hrs.)

***Books Recommended*:**


1. Sharpe, A. G. : Inorganic Chemistry, 3rd Edition, Longman Publishers ELBS, 1992.
2. Lee, J. D. : Concise: Inorganic Chemistry, 5th Edition, Chapman and Hall Publishers, 1996.
3. Cotton, F. A. & Wilkinson, G. : Advanced Inorganic Chemistry, 3rd Edition, Wiley Eastern Ltd., 1982.
4. Cotton, F. A. & Wilkinson, G. : Basic Inorganic Chemistry, Wiley Eastern Ltd., 1987.
5. Mark, J., West, R. & Allcock, H. : Inorganic Polymer, Prentice Hall, New Jersey

Publishers, 1982.

6. Basola, F. & Pearson, R. G. : Inorganic Reaction Mechanism, 2nd Edition, Wiley Eastern Publishers, 1984.
7. Amdur, Doull & Klaasen (Eds.) : Casarett and Doulls Toxicology, Pergamon Press, New York, 1991.
8. William & Burson (Eds.) : Industrial Toxicology: Safety and Health applications in the work place, Van Nostrand – Reinhold, New York, 1985.

**CHE 104 ENGINEERING MECHANICS**

1. *Force System*: Introduction, force, principle of transmissibility of a force, resultant of a force system, resolution of a force, moment of force about a line. Varigon's theorem, couple, resolution of force into force and a couple, properties of couple and their application to engineering problems.
2. *Equipments*: Force body diagram, equations of equilibrium and their applications to engineering problems, equilibrium of two forces and three-force member.
3. *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.
4. *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 n $T_1/T_2 = \mu_c A$ and its application.
5. *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.
6. *Dynamics*: Rectilinear motion, plane curvilinear motion-rectangular co-ordinates, normal and tangential coordinates.
7. *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.
8. *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.
9. *Kinematics of Rigid Bodies*: Equation of motion, translatory motion and fixed axis rotation, application of work energy, principles to rigid bodies conservation of energy.

10. *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. : Statics, 3rd Edition, John Wiley & Sons.
2. Meriam, J. L. & Kraige, L. G. : Dynamics, 3rd Edition, John Wiley & Sons.
3. Hidgen, Stiles : Statics and Dynamics, Longman


## CHE 105 INTRODUCTION TO CHEMICAL ENGINEERING

1. What is chemical Engineering? A.I.Ch.E. Definition of Chemical Engineering. Brief history of chemical engineering. General aspects of Chemical Engineering like communications, human relations, technical reading and professional bodies. Engineering 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.
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.
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.
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.

***Books Recommended*:**


| | | | |
|---|---|---|---|
| 1. | Littlejohn, C. E. & Meenagham, C. M. | : | Introduction to Chemical Engineering, 1st Edition, McGraw Hill. |
| 2. | Anderson, L. B. | : | Introduction to Chemical Engineering, 1st Edition, McGraw Hill. |
| 3. | Shaheen, E. I. | : | Basic Practices of Chemical Engineering, Houghton Miftlin Company, Boston, 1975. |
| 4. | Felder, R. M. & Fousseau, R.W. | : | Elementary Principles of Chemical Processes, 2nd Edition, John Wiley & Sons. |
| 5. | Himmelbleau, D. M. | : | Basic Principles and Calculations of Chemical Engg., 6th Edition, Prentice Hall. |


## CHE 151 PHYSICS (PRACTICALS)

- 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*:**


| | | | |
|---|---|---|---|
| 1. | Workshop, B. L. & Flint, H. T. | : | Advance Practical Physics, 1st Edition, Metheun and Co. London. |
| 2. | Arora, C. L. | : | B.Sc. Practical Physics, 20th Edition, S. Chand and Co. |

3. Khanna & Gulati : Practical Physics, 11th Edition,

## CHE 152 INORGANIC CHEMISTRY (PRACTICALS)

1. Volumetric Analysis
   (i) Redox Titrations:-
      Titrations involving
      (a) $KMnO_4$ (Estimation of $C_2O_4^{-2}$)
      (b) $K_2Cr_2O_7$ (Estimation of $Fe^{+2}/Fe^{+3}$)
      (c) Iodine [Iodometry & Iodimetry] (Estimation of $Cu^{+2}$, $AsO_3^{-3}$ and $Sb^{+3}$)
   (ii) Complexometric Titrations- Determination of Zn by EDTA titration.
2. Gravimetric Analysis
      (a) Estimation of $Ba^{+2}/SO_4^{-2}$ as $BaSO_4$
      (b) Estimation of $Fe^{+2}/Fe^{+3}$ as $Fe_2O_3$

## CHE 153 ENGINEERING GRAPHICS (PRACTICALS)

Introduction to engineering graphics, lettering, types of lines and their use, dimensioning aligned and undirectional system. Orthographic projections, reference planes, auxiliary planes, first angle and third angle method of projection. Conversion of pictorial view into orthographics views, isometric projection.

Fastners-permanent fastners and temporary fastners, rivet, shapes of rivet heads, riveted joints, caulking and fullering, screw thread, thread terms and nomenclature, thread profiles, conventional representation of threads, drawing of hexagonal nuts and square nut; nut bolt assembly; sketches of foundation bolts, locking devices for nut.

Engineering curves-cycloid, epycycloid, hypocycloid involute of a circle, involute of polygon, Archimedian spiral and logarithmic spiral, drawing tangents and normals to these curves.

***Books Recommended***:


1. Luzadduer : Engineering Drawing, Prentice Hall of India Pvt. Ltd.
2. Levens, A. S. : Graphics for Engineers, John Wiley.
3. Gill, P. S. : Machine Drawing, 17th Edition, B. D. Kataria & Sons, Ludhiana, 2006.
4. Bhatt, N. D. : Machine Drawing, 22nd Edition, Character Book Staff, Anand.
5. Shah, P. J. : Engineering Drawing, C. Jamandas & Co., Bombay.


## CHE 154 COMMUNICATION SKILLS (PRACTICALS)

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.

2. 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***:

1. Mohan, K. and Banerji, M. : Developing Communication Skills, Macmillan

**SYLLABUS FOR**
**BACHELOR OF ENGINEERING (CHEMICAL)**
**SECOND SEMESTER**

## CHE 201 MATHEMATICS-II

*Relationship between cartesian, cylindrical polar and spherical polar co-ordinate systems*: standard forms of equation of sphere, cone, cylinder.

*Solution of simultaneous linear equation*: Gauss elimination scheme, Gauss-Jorden Method, Gauss-Seidel; interaction method, Solution of algebraic and transcendental equations, Graphical method, bisection method, Regular-False-position, iteration method, Newton-Raphson method, Curve-fitting: Graphical method, method of least squares.

*Matrices*: Rank of matrix, elementary transformation, Eigen-values, Eigen-vectors, Cayley-Hamilton Theorem.

*Finite differences*: Forward, Backward and Central differences, Interpolation Formulas: Lagrange's formula for unequal Intervals, inverse interpolation, Numerical differentiation and integration.

*Statistics*: Binomial Poisson and normal distributions, $chi^2$-t distribution. Test of significance with applications.

***Books Recommended*:**


1. Kreyszig Erwin : Advanced Engineering Mathematics, 7th Edition, John Wiley and Sons.
2. Hilderband, F. B. : Introduction to Numerical Analysis, Tata McGraw Hill.
3. Sastry, S. S. : Introductory Methods of Numerical Analysis, 4th Edition, Prentice Hall.
4. Grewal, B. S. : Higher Engineering Mathematics, 41st Edition, Khanna Publishers, Delhi.
5. Bajpai, A. C. : Numerical Methods for Engineers and Scientists, 1st Edition, John Wiley.

6. Jain, R. K. & Iyengar, S. : Advanced Engg. Mathematics, 2nd Edition, Narosa Publishing House, New Delhi, 2003.

## CHE 202 STRENGTH OF MATERIALS

1. *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.

2. *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.

3. *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.

4. *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.

5. *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.

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

7. *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.

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

9. *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.

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

11. *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:***


1. Ryder, G. H. : Strength of Materials, 3rd Edition S.I. Units Macmillan, 1969.
2. John Case & Chilver, A. H. : Strength of Material and Structures, 2nd Edition, 1971.
3. Timoshenko, S. : Strength of Materials Part-I, 3rd Edition, Cbs Publishers, 1986.
4. Bedi, D. S. : Strength of Materials, 2nd Edition, S. Chand & Company Ltd., 1984.


**CHE 203 CHEMISTRY (ORGANIC)**

1. *Classification of organic compounds*: IUPAC nomenclature, Structural isomerism, Cis-trans isomerism. Shapes and Molecular orbital structures of compounds containing C, N and O. Conformations of alkanes. Structures of dienes, pyridine, pyrrole, aromatic compounds.
2. *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.
3. *Chemistry of hydrocarbons*: House synthesis, halogenation of alkanes, free radical mechanism, cracking, effect of structure on physical properties of compounds. Alkenes, catalytic hydrogenation, dehydration of alcohols, dehydrohalogenation, Saytzeff rule, electrophillic 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 electrophillic substitution reactions, Friedel-Crafts reactions.
4. *Chemistry of functional groups*: Alkyl and aryl halides, nucleophilic substitution, synthetic utility of Grignard reagents and alkyllithiums, 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*:**


1. Bahl, B. S. & Bahl, Arun : Text-book of Organic Chemistry, 16th Edition, S. Chand and Company Ltd., New Delhi.

2. Solomons, T. W. G. : Fundamentals of Organic Chemistry, John Wiley and Sons, Inc., New York, 1994.

## CHE 204 PROCESS PLANT MATERIAL AND ENERGY BALANCES

1. Review: Stoichiometric and composition relationship gas laws; Gaseous mixtures, vapor pressure, humidity, etc.
2. Material Balances for Non-reaction systems including balances involving recycle and by-pass streams.
3. Material Balances for Reacting systems including balances involving recycle and purge streams.
4. Combustion Calculations.
5. Energy balances on nonreactive and reactive systems.

***Books Recommended*:**

1. Bhatt, V. I. & Vora, S. M. : Stiochiometry, 3rd Edition, Tata McGraw Hill, 1984.
2. Himmelbleau, D. M. : Basic Principles and Calculations in Chemical Engineering, 6th Edition, Prentice Hall, 1977.
3. Felder, R. M. & Rousseau R.W. : Elementary Principles of Chemical Processes, 3rd Edition, John Wiley and Sons, 1986.
4. Reklaithis, G. V. : Introduction of Material and Energy balances, John Wiley, 1983.
5. Lubyben, L.W. & Winzel, L. A. : Chemical Process Analysis, 2nd Edition, Prentice Hall, 1988.

## CHE 205 PHYSICAL CHEMISTRY

1. *Solutions*: Ideal and non-ideal solutions, Raoults's law, change of free energy, enthalpy, and entropy on mixing of liquids, distillation of binary solutions. Partially miscible liquids such as Phenol- water, triethylamine- water, and Nicotine- water systems. Henry's law, Nernst distribution law, Colligative properties of dilute solutions. Abnormal molar mass, degree of dissociation and association of solutes.
(9 Hrs.)

2. *Chemical Kinetics*: Rate equation of reactions of various orders, rate mechanism, kinetics of complex reactions. Concept of energy barrier and energy of activation. Theories of reaction rates, measurement of extent of reaction, zero order reactions. Rates of flow systems. Lindemann theory of unimolecular reactions.
(8 Hrs.)

3. *Surface Phenomena*: Adsorption of gases by solids. Types of adsorption, adsorption isotherms, Langmuir's adsorption equation, B.E.T. equation for determination of surface

area of adsorbents, applications of adsorption, catalysis, kinetics of surface reactions. Introduction to micelles, emulsions and gels.

(5 Hrs.)

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

(3 Hrs.)

5. *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. Ionizaton of water, ionization constants of weak acids and weak bases, hydrolysis, pH, commonion effect, solubility product and salt effect.

(8 Hrs.)

6. *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.

(7 Hrs.)

***Books recommended*:**


| | | | |
|---|---|---|---|
| 1. | Maron, Samuel H. Prutton, Carl F. | : | Principles of Physical Chemistry, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi. |
| 2. | Glasstone, Samuel | : | Textbook of Physical Chemistry, MacMillan and Co. Ltd. London |
| 3. | Barrow, M. Gorden | : | Physical Chemistry, McGraw Hill, N.Y. |
| 4. | Rose, J. | : | Dynamics of Physical Chemistry, Lond Pitman |
| 5. | Puri, B.R., Sharma, L.R. and Pathania, Madan, S. | : | Principles of Physical Chemistry, S. Nagin &Co Jalandhar. |
| 6. | Negi, A.S. and Anand, S.C. | : | A Text Book of Physical Chemistry, Wiley Eastern Ltd. New Delhi. |
| 7. | Laidler, Keith J. | : | Chemical Kinetics, Tata McGraw-Hill Co. Ltd., New Delhi. |
| 8. | Moore, W.J. | : | Basic Physical Chemistry, Prentice-Hall of India, New Delhi. |
| 9. | Atkin, P.W. | : | A Text Book of Physical Chemistry, Oxford University Press. |


**CHE 206 ENVIRONMENTAL STUDIES**

Unit –I : The Multi-disciplinary nature of Environmental Studies: Definition, scope and

importance; need for public awareness.

Unit –II : 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).

Unit –III : 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.

Unit –IV : 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.

Unit –V : 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.

Unit – VI : 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.

Unit –VII : 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.

**CHE 251 COMPUTER AIDED DRAFTING (PRACTICALS)**

1. Traditional drafting of various assemblies, pipe joints, sectional views and valves.
2. Introduction to various Computer Softwares and Computer Aided Drafting. Study and use of various commands from Menus, Command Tool Box and Command prompt area.
3. Applications of Auto – CAD
    - Drawing of Process and Flow Sheets.
    - X-Y Graphs, Heat Exchangers.
    - Columns: Packed Columns, Plate Columns.
    - Jacketed vessels, Boiler parts like spring loaded steam stop valve.
    - Cut View of Centrifugal pump and rotary compressor to show internal details.

***Books Recommended:***


1. Rakar, A. : Inside Auto Cad, B.P.B. Publications, New Delhi.
2. Omura, G. : Mastering Auto Cad, P.B.S. Publications, New Delhi.
3. Voisinet, D.D. : Computer Aided Drafting & Design.
4. Rogers, D.F. : Procedural Elements for Computer Graphics, McGraw Hill, N.Y.


**CHE 252 BASIC WORKSHOP TECHNIQUES (PRACTICALS)**

*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.

*Machine Shop*: Classification of fabrication processes, machine tools and materials, introduction to working of lathe, shaper, 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.

**CHE 253 ORGANIC CHEMISTRY (PRACTICALS)**

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.

**CHE 254 MECHANICAL ENGINEERING LABORATORY (PRACTICALS)**

Experimental determination of Young's modulus (from Searls apparatus) and Moment of inertia of a flywheel, experimental verification of the laws of friction and determination of efficiencies of various lifting machines.

Experiments for determining tensile, compressive, shear and bending strengths of materials on Universal Testing Machine, Brinell Hardness test, Izod Impact strength test.

***Books Recommended***:


1. Ryder, G. H. : Strength of Materials, 3rd Edition, Macmillan.
2. Chaudhary, H. R. : Practical Applied Mechanics, Mohindra Capital Publishers, Chandigarh.

## CHE 255 PHYSICAL CHEMISTRY (PRACTICALS)

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 $KMnO_4/K_2Cr_2O_7$.
    - Determination of composition of Fe-Salicylic Acid Complex by Job's Method.

***Books Recommended*:**

1. Lavitt, B.P. : Findlay's Practical Physical Chemistry, Longman Group Ltd.

**SYLLABUS FOR**
**BACHELOR OF ENGINEERING (CHEMICAL)**
**THIRD SEMESTER**

## CHE 301 PHYSICAL CHEMISTRY

7. *Solutions*: Ideal and non-ideal solutions, Raoults's law, change of free energy, enthalpy, and entropy on mixing of liquids, distillation of binary solutions. Partially miscible liquids such as Phenol- water, triethylamine- water, and Nicotine- water systems. Henry's law, Nernst distribution law, Colligative properties of dilute solutions. Abnormal molar mass, degree of dissociation and association of solutes.
(9 Hrs.)

8. *Chemical Kinetics*: Rate equation of reactions of various orders, rate mechanism, kinetics of complex reactions. Concept of energy barrier and energy of activation. Theories of reaction rates, measurement of extent of reaction, zero order reactions. Rates of flow systems. Lindemann theory of unimolecular reactions.
(8 Hrs.)

9. *Surface Phenomena*: Adsorption of gases by solids. Types of adsorption, adsorption isotherms, Langmuir's adsorption equation, B.E.T. equation for determination of surface area of adsorbents, applications of adsorption, catalysis, kinetics of surface reactions. Introduction to micelles, emulsions and gels.
(5 Hrs.)

10. *Photochemistry*: Laws of photochemistry, principles of photochemical excitation, quantum efficiency, Kinetics of photochemical reactions.
(3 Hrs.)

11. *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. Ionizaton of water, ionization constants of weak acids and weak bases, hydrolysis, pH, commonion effect, solubility product and salt effect.
(8 Hrs.)

12. *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.
(7 Hrs.)

***Books recommended*:**

1. Maron, Samuel H. Prutton, : Principles of Physical Chemistry, Oxford & IBH

| | | | |
|---|---|---|---|
| | Carl F. | | Publishing Co. Pvt. Ltd, New Delhi. |
| 2. | Glasstone, Samuel | : | Textbook of Physical Chemistry, MacMillan and Co. Ltd. London |
| 3. | Barrow, M. Gorden | : | Physical Chemistry, McGraw Hill, N.Y. |
| 4. | Rose, J. | : | Dynamics of Physical Chemistry, Lond Pitman |
| 5. | Puri, B.R., Sharma, L.R. and Pathania, Madan, S. | : | Principles of Physical Chemistry, S. Nagin &Co Jalandhar. |
| 6. | Negi, A.S. and Anand, S.C. | : | A Text Book of Physical Chemistry, Wiley Eastern Ltd. New Delhi. |
| 7. | Laidler, Keith J. | : | Chemical Kinetics, Tata McGraw-Hill Co. Ltd., New Delhi. |
| 8. | Moore, W.J. | : | Basic Physical Chemistry, Prentice-Hall of India, New Delhi. |
| 9. | Atkin, P.W. | : | A Text Book of Physical Chemistry, Oxford University Press. |


**CHE 302 MECHANICAL OPERATIONS**

1. *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. (6 Hrs.)
2. *Mechanical Separation*: Screening: Stationery screens, Grizzlies, Trommel and Vibrating screens. International Standard Screens & Indian Standard Screens. Screening Analysis-differential and cumulative.

- 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. (17 Hrs.)

3. *Filtration*: Plate and frame filter press, continuous rotary vacuum filter, filter aids, theory of filtration for non-compressible cakes. (5 Hrs.)
4. *Centrifugation*: Tubular bowl centrifuge, disk centrifuge and batch basket centrifuge. (2 Hrs.)
5. *Fluidization*: Conditions for fluidization: Aggregate and particulate fluidization. Ergun's and Carman-Kozeny equations. (4 Hrs.)
6. *Mixing and Agitation*: Basic ideas and characteristics of mixing equipment power consumptions scale-up. (4 Hrs.)
7. *Conveying*: Mechanical and pneumatic conveying systems, storage & handling of materials. (2 Hrs.)

***Books Recommended*:**


| | | | |
|---|---|---|---|
| 1. | Mc Cabe, Warren L., Smith, Juluain C. and Harroit, Peter | : | Unit Operations of Chemical Engineering, 5th Edition, Mc Graw Hill Int. ed (Chemical Engineering Series) Mc Graw Hill Book Company, New York, 1993. |
| 2. | Foust, Alan S., Wenseli, Leonard A., Clump, Curtis W., mans, Louis and Anersen, L. Bryce | : | Principles of Unit Operations, Wiley International Edition, John Wiley & Sons Inc., New York. |
| 3. | Coulson, J.M. and Richardson, J.F. | : | Unit Operations (Volume 2 of Chemical Engineering) New York: Mc Graw – Hill Book Co;, Inc. |
| 4. | Gupta, Santosh K. | : | Momentum Transfer Operations, Tata McGraw-Hill, New Delhi. |
| 5. | Badger, Walter L. and Banchero, Julius T. | : | Introduction to Chemical Engineering, Mc Graw-Hill, Kogakusha Ltd., New Delhi. |
| 6. | Brown, C.G. | : | Unit Operations, John Wiley & Sons, Inc., New York. |
| 7. | Chattopadhyay, P. | : | Unit Operations of Chemical Engineering, Vol. I, Khanna Publishers, New Delhi. |


**CHE 303 ELECTRONICS**

*Semiconductor Diodes*: General introduction to Electronics. Concept of stiff Voltage and Current Source. PN Junction, Depletion layer, Barrier Potential, Forward and Reverse Bias, Breakdown voltage, load lines of diode, V-I characteristics, Half wave and full wave rectifiers, RC LC filters, Zener diode, Varactor Diode, Light emitting diodes.

*Bipolar Junction Transistor*: Introduction, Junction transistor Structure, Operation, Transistor amplifying action, CB, CE, CC-configuration characteristics, applications of transistor as an amplifier, Biasing of Transistor. Introduction to FET's, JFET's.

*Amplifiers*: Class-A power amplifier, AC Load line, Voltage, current, power gain maximum AC load power, stage efficiency in Class-A operation. Introduction to Class-B and Class- C amplifiers.

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

*Oscillators*: Block diagram of feedback circuit used as an oscillator, concept of RC oscillators.

*Boolean Algebra And Logic Gates*: 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, SOP and POS Method. Reduction of Boolean expression.

*Flip Flops And Counters*: Concept of flip-flops, RS Latches, RS,D, JK, T types, Triggered and Clocked, master slave flip flops, Shift registers, Buffer register, Concept of synchronous and asynchronous counters, Ripple counters, Half adder and full adder, subtractor**.**

***Books Recommended*:**


1. Bhargava : Basic electronics and Linear circuits, Tata McGraw Hill.
2. Millman, J. : Integrated Electronics.
3. Malvino : Digital Principles and Applications, Tata McGraw Hill.


**CHE 304 FLUID FLOW**

*Fluid Statics*: Normal forces in fluids, Pressure Measurements, Forces on Submerged bodies, Buoyancy and Stability. (4 Hrs.)

*Fluid Properties*: Newtonian and non-Newtonian Fluids, Nature of Turbulence, Eddy Viscosity, Flow in Boundary Layers, Basic Equation of Fluid Flow. Bernoulli's Equation. (8 Hrs.)

*Navier stokes equation*: Applications of Dimensional analysis to Fluid Flow. Problems. (4 Hrs.)

*Flow of Incompressible Fluids*: Laminar and Turbulent flow in pipes, Velocity Distribution in Pipes, Frictional Losses in Pipes and Fittings, Fanning equation, Estimation of economic pipe diameter. Derivation of HAGEN-POISEULLI and f=16/Re equations. (10 Hrs.)

*Flow of compressible fluids*: Compressible flow and flow through nozzles. (4 Hrs.)

*Flow Measurements*: Pilot tube, Orifice, Venturi, Rotameter and Notches, wet gas metre etc. (4 Hrs.)

*Fluid Machinery*: Classification and Performance of Pumps, Turbines, Compressors, and Blowers, Selection and Specification, Net positive Suction Head. (6 Hrs.)

***Books Recommended*:**


1. Mc Cabe, W.L. and Smith, J.C. : Unit Operation of Chemical Engineering, McGraw Hill.
2. Coulson, J.M. and Richardson, J.F. : Chemical Engineering, Vol. I, Pergamon
3. Foust, A.S., Wensel, L.A., Clump, C.W., Maus, L. and Anderson, L. : Principles of Unit Operations, John Wiley.
4. Badger, W.L. and Banchero, J.T. : Introduction to Chemical Engineering, Tata McGraw Hill Pub. Co. Ltd., 1997.
5. Fox, R.W. and McDonald, A.T. : Introduction of Fluid Mechanics (SI Version) 4th ed. John Wiley and Sons, 1996.
6. Chattopadhya, P. : Unit Operations of Chemical Engineering, Vol. I,

Khanna Publishers, Delhi, 1997.

## CHE 305 INTRODUCTION TO BIO-TECHNOLOGY

*Overview of Biotechnology*: To make students conversant with the current developments and further prospects of biotechnology.

*Introduction to Life*: The origin of life: Oparin's hypothesis, generation of organic molecules as building blocks for the synthesis of complex biomolecules, the cellular basis of life; correlation between the various structures and functions.

*Matter*: The basic unit of life – the cell, various organelles, their structure and function.

*Macromolecules* - their structure and functions: Configuration and Conformation, Carbohydrates, Amino acids, Proteins, Lipids, Purines, Pyrimidines, Porphyrins, Vitamins and Nucleic acids.

*Environment*: The concept of recalcitrance and the role of biotechnology in dealing with these types of compounds.

*Bioinstrumentation*: Biosensors – concept and construction, construction and application of ECG, EEG, ultrasound, MRI etc; artificial limbs, microsurgical operations – role of bioengineer, Bioreactor design and operation.

***Books Recommended*:**


1. Neil A. Cambell : Biology, Benjamin Cummings Company.
2. Smith and Wood : Biological Molecules, Latest Edition, Chapman and Hall.
3. Smith and Wood : Molecular Biology and Biotechnology, Chapman and Hall.
4. Hart, D.L. and Jones, E.W. : Genetics, 5th Edition, Jones & Barlett Publications.
5. Kendal : Biology, Prentice Hall, 5th Edition, 2001.


## CHE 351 PHYSICAL CHEMISTRY (PRACTICALS)

9. Surface tension of liquids using Stalagmometer and calculation of Parachor values.
10. Distribution of Iodine between water and carbon tetrachloride.
11. Kinetics of the hydrolysis of methyl acetate in the presence of hydrochloric acid.
12. Adsorption of acetic acid on activated charcoal.
13. Viscosity of liquids and composition of a binary solution.
14. 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.

15. Potentiometric titration of HCl vs NaOH and acetic acid vs NaOH and determination of dissociation constant of acetic acid.
16. Colorimetry

- Verification of Lambert-Beer Law.
- Determination of concentration of solution of $KMnO_4/K_2Cr_2O_7$.
- Determination of composition of Fe-Salicylic Acid Complex by Job's Method.

***Books Recommended*:**


1. Lavitt, B.P. : Findlay's Practical Physical Chemistry, Longman Group Ltd.


**CHE 352 COMPUTER PROGRAMMING (PRACTICALS)**

**<u>$C^{++}$ fundamentals</u>**

- $C^{++}$Programming Basics: $C^{++}$ Program Structure, Variables, Input /Output statements, Arithmetic Operators, Assignment and Increment Operators.
- 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*:**


1. Lafore, R. : Object Oriented Programming in Turbo $C^{++}$, Galgotia Publications.
2. Kanetkar,Y. : Let Us $C^{++}$, BPB Publications

## CHE 353 ELECTRONICS ENGINEERING LAB (PRACTICALS)

NOTE: Minimum eight experiments are to be done.

1 Study the forward and reverse biased diode characterstics.

2 Study the CB, CE, CC transistor characterstics.

3 To obtain the waveforms of half wave rectifier circuit on CRO with and without L and C filter.

4 To obtain the waveforms of full wave rectifier circuit on CRO with and without L and C filter.

5 To study the OP-AMP as an Inverting amplifier.

6 To study the OP-AMP as a Phase shifter.

7 To study the OP-AMP as an Adder.

8 To study the OP-AMP as a Difference amplifier.

9 To study the OP-AMP as a Differentiator.

10 To study the OP-AMP as an Integrator.

11 Verification of basic and universal gates.

12 Verification of counters and seven segment display.

13 Study of pulse triggered and edge triggered RS, JK, Master salve segment display.

## CHE 354 COMPUTER AIDED DRAFTING (PRACTICALS)

1. Traditional drafting of various assemblies, pipe joints, sectional views and valves.

2. Introduction to various Computer Softwares and Computer Aided Drafting. Study and use of various commands from Menus, Command Tool Box and Command prompt area.

3. Applications of Auto – CAD

- Drawing of Process and Flow Sheets.
- X-Y Graphs, Heat Exchangers.
- Columns: Packed Columns, Plate Columns.
- Jacketed vessels, Boiler parts like spring loaded steam stop valve.
- Cut View of Centrifugal pump and rotary compressor to show internal details.

***Books Recommended*:**

1. Rakar, A. : Inside Auto Cad, B.P.B. Publications, New Delhi.

2. Omura, G. : Mastering Auto Cad, P.B.S. Publications, New Delhi.
3. Voisinet, D.D. : Computer Aided Drafting & Design.
4. Rogers, D.F. : Procedural Elements for Computer Graphics, McGraw Hill, N.Y.

**SYLLABUS FOR**
**BACHELOR OF ENGINEERING (CHEMICAL)**
**FOURTH SEMESTER**

## CHE 401 MATHEMATICS – III

Fourier Series: Euler's Formulae, Dirchiel's Conditions for Expansion, Change of interval, Odd and Even Functions, Expansion of Odd and Even Periodic Functions, Introduction to Harmonic Analysis. (8 Hrs.)

Vectors: Gardient, Divergence, Curl, Statement of Green's Gauss and Stoke's Theorem and their simple applications. (6 Hrs.)

Linear Differential Equations with constant Coefficients, Homogeneous Linear Equations, method of variation of Parameters, Simultaneous Liner Differential Equations with Constants Coefficients. (8 Hrs.)

Laplace transform: Definition, Transforms of Elementary functions, Properties of Transforms, Inverse Transforms, Transform of Derivative Unit. Unit Step Function, Dirac Della Function & Unit Impulse function. Period Functions, Application of Transform to the solution of ordinary Differential equations. (8 Hrs.)

Function of complex variable, analytic functions, Cauchy's theorem, Cauchy's integral formula, introduction to Tayler's series and Laurent's series, Residues, theorem and its simple applications. (10 Hrs.)

***Books Recommended*:**


1. Kreyszig, Erwin : Advanced Engineering Mathematics, 7th Edition, John Wiley & Sons.
2. Grewal, B.S. : Higher Engineering Mathematics, 41st Edition, Khanna Publishers, Delhi.
3. Jain, R. K. and Eyengar, S. R.K. : Advanced Engg. Mathematics, 2nd Edition, Narosa Publishing House, New Delhi, 2003.


## CHE 402 ELECTRICAL ENGINEERING

*DC Circuits*: General introduction to Electrical Engineering, Kirchoff's Law and network solution, network analysis by Mesh and Node analysis, Superposition theorem, Thevenin Theorem, Norton Theorem, Maximum power transfer theorem, delta-star transformation and vie-versa, energy storage elements, step response to RL, RC and RLC circuits.

*Single Phase AC Fundamentals*: Generation of alternating voltages and alternating 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, AC through pure resistance,

inductance and capacitance, series and parallel combination of R-L-C circuits, resonance in series and parallel 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**.**

*Transformers*: 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, voltage regulation, open circuit and short circuit test on single phase transformers.

*AC Machines*: Operating principle and construction of three phase induction motors, production of rotating field, concept of slip, frequency etc. Torque under starting conditions and running conditions, condition for maximum torque, slip-torque characteristics (qualitative treatment) Various power stages in motor, relation between torque, mechanical power and rotor output , starting of induction motor. Operating principle and construction of single phase induction motors( Split phase and capacitor motor).

*DC Machines*: Operating principle and construction of DC generators, types of DC Generators, E.M.F equations, various losses in DC Generators and efficiency, Armature reaction, commutation in DC Generators. Principle of DC Motors, significance of Back E.M.F and voltage equation , calculation of Amature and shaft torque, Applications of DC motors.

***Books Recommended*:**


1. Edward Hughes : Electrical and Electronic Technology, Pearson Education Publication, Asia, 2003.
2. Nagsarkar, T.K. and Sukhija M.S. : Basic Electrical Engg., Oxford University Press, 2004.
3. Nagrath, I.J. and Kothari, D.P. Basic Electrical Engg., TMH, New Delhi.


## CHE 403 CHEMICAL ENGINEERING THERMODYNAMICS

Brief review of the terms: state functions, types of systems, internal energy, heat and work and reversible and irreversible processes. First Law of Thermodynamics and its Engineering Applications i.e. constant volume processes, constant pressure processes, isothermal and adiabatic processes, pumps, turbines, compressors, nozzles, heat exchangers, pitot tube, venturimeter and orifice meter. Throttling Processes, Joule-Thomson Coefficient, liquefication of gases, thermochemistry includes a brief review of heat capacities and their measurement, standard heat of reaction, standard heat of formation, standard heat of combustion, flame temperature, H-x diagrams, heat of solution, partial, molar enthalpies, enthalpy for phase change

etc. Equation of state for real gases and their mixtures. Principle of corresponding states and generalized compressibility factor.

Review of Second law of thermodynamics, entropy concept, Entropy and lost work calculations. Microscopic interpretation of entropy. Third Law of thermodynamics and its applications. Free energy functions and their significance in phase and chemical equilibria, Clapeyron's equation and some important correlations for estimating vapor pressures. Estimation of thermodynamic properties by using graphs and tables.

*Phase Equilibria:*

Partial molar properties, partial molar Gibbs free energy, Chemical potential and its dependence on temperature and pressure Ideal solutions (Lewis-Randel Rule).

Fugacity and its calculations. Dependence of fugacity of temperatures and pressure

Solution behaviour of real liquids and solids. Activity and activity coefficients. Variation of activity co-efficient with temperature and composition. Activity coefficients of electrolytes standard states. Properties of mixing. Excess Properties, Gibbs-Duhem equation and its application to vapour-liquid equilibria.

*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*:**


1. Smith, J.M., Van Ness, H.C. and Abbott, M.M. : Introduction to Chemical Engineering Thermodynamics, 7th Edition, McGraw Hill Professional, 2005
2. Elliott, J.R and Lira, C.T. : Introductory Chemical Engineering Thermodynamic, Prentice Hall PTR., 1999.
3. Rao, Y.V.C. : Chemical Engg. Thermodynamics, Orient Blackswan, 1997.
4. Dodge, B.F. : Chemical Engg. Thermodynamics, McGraw Hill, 1944, Original from the University of Michigan, 2007.
5. Narayanan, K.V. : A Textbook of Chemical Engineering Thermodynamics, PHI Learning Pvt. Ltd., 2004.


**CHE 404 HEAT TRANSFER**

*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.

*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.

*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.

***Books Recommended*:**


1. Mc Cabe, W.L., Smith, J.C. : Unit Operations of Chemical Engineering McGraw Hill.
2. Holman, J.P. : Heat Transfer, McGraw Hill Book Co.
3. Mc Adams, W.H. : Heat Transmission, McGraw Hill Book Co.
4. Chapmann, A.J. : Heat Transfer, Mc Millan Publishing Co.
5. Kern, D.Q. : Process heat Transfer, McGraw Hill Book Co.
6. Kreith, F. : Principles of Heat Transfer, Harper & Row Pub., London.
7. Geankoplis, C.J. : Transport Processes and Unit Operations, Prentice Hall of India Pvt. Ltd., 3rd Edition, 1999.


## CHE 405 ENGINEERING MATERIALS

1. *Atomic Structure*: Review of bonding in solids, structure –property-processing relationship. (2 Hrs.)
2. *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. (6 Hrs.)
3. *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. (8 Hrs.)

4. *Phase Diagrams and phase transformation*: binary phase diagrams – Fe-$Fe_3C$, Cu-Ni, Pb-Sn. microstructure development, TTT diagrams, heat treatment processes-hot and cold working, hardening and softening processes. (8 Hrs.)
5. *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. (8 Hrs.)
6. Corrosion: Types and mechanism of corrosion, factors influencing corrosion, combating corrosion, selection of materials of construction for handling different chemicals. (8 Hrs.)

***Books Recommended*:**


1. Askelland, Donald R. : The Science & Engineering of Materials, PWSKENT.
2. Shackleford, J.F. : Introduction to Material Science for Engineers, Mc Millan.
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


**CHE 451 ELECTRICAL ENGINEERING LAB (PRACTICALS)**

NOTE: Minimum eight experiments 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. Calibration of Energy meter with help of standard wattmeter method.

10. To study speed control of DC Shunt Motor. To draw the speed variation with respect to:

    i) Change of field current.

    ii) Change of armature resistance.

**CHE 452 PROCESS EQUIPMENT DESIGN (PRACTICALS)**

1. Mechanical design of Process Equipment: Introduction, classification of pressure vessels, pressure vessel codes and standards. Fundamental principles and equations.
2. 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.
3. 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.
4. Design of vessels subject to external pressure: Cylindrical shells, design of stiffening rings, vessels heads.
5. Design of vessels subject to combined loading: Weight loads, wind loads (tall vessels), torque.
6. Design of Foundation and supports.
7. Design of Bolted flanged joints and welded joints.

***Books Recommended*:**


1. Battacharyya, B.C. : Introduction to Chemical Equipment Design Mechanical aspects, Chemical Engineering Education Development Centre.
2. Joshi, M.V. : Process Equipment Design, Macmillan India.
3. Coulson, J.M. and Richardson, J.F. : Chemical Engineering, Volume 6, Pergamon Press.


**CHE 453 PROCESS PLANT DESIGN – I (PRACTICALS)**

1. Design of piping & Piping networks.

2. Selection, specification & power requirements of process pumps, fans and blowers.
3. Design of settling equipments like Dor Thickeners, Dust Chambers, Cyclone Separator & Centrifuges.
4. Design of agitated vessels using various types of impellers.
5. Design of Conveyor system for solids.

***Books Recommended*:**


| | | | |
|---|---|---|---|
| 1. | Luding, E.E. | : | Applied Process Design in Chemical in Petrochemical Plants, Gulf Publishing Company. |
| 2. | Perry, J.H. | : | Chemical Engineers Handbook, McGraw Hill. |
| 3. | Joshi, M.V. | : | Process Equipment Design, MacMillan Indian. |
| 4. | Peters, M.S. and Timmerhaus, K.D. | | Plant Design and Economics for Chemical Engineers, McGraw Hill. |


**CHE 454 ANALYTICAL TECHNIQUES (PRACTICALS)**

1. *Solvent Extraction*: Distribution law, extraction process, factors effecting extraction, technique for extraction, Advantages and applications of solvent extraction. Extraction of caffeine from tea leaves.
2. *Chromatography*: Introduction to chromatography, principles, classification of chromatographic techniques, thin layer and paper chromatography – principle and technique. TLC of common compounds.
3. *Column Chromatography*: Factors affecting column efficiency and applications. Separation of a mixture of cations by column chromatography.
4. *IR Spectroscopy*: Origin, principle, modes of vibrations of atoms in polyatomic molecules, instrumentation, selection rules, identification of organic compounds on the basis of infrared spectra.
5. *UV-Vis Spectroscopy*: Selection rules, identification of organic compounds using UV-VIS spectroscopy.
6. *NMR Spectroscopy*: Principle, chemical shift, spin-spin coupling shift reagents, instrumentation, spectra and molecular structure, identification of organic compounds on the basis of NMR.
7. *Thermoanalytical methods*: Principle, classification of methods.

   TGA – Instrumentation, factors affecting results and analysis of data. Applications.

   DTG – Instrumentation, analysis of data and applications.

   DTA – Principle, Instrumentation and applications. Thermal analysis of representative samples e.g. Calcium oxalate.

***Books Recommended*:**


| | | | |
|---|---|---|---|
| 1. | Skoog, D. A. & West, D. M. | : | Principles of Instrumental Analysis, 5th Edition, Saunders College Publishers, USA. |
| 2. | Skoog, D. A. & West, D. M. | : | Fundamentals of Analytical Chemistry, 7th Edition, Saunders College Publishers, USA. |
| 3. | Willard, Meritt, Dean & Sattle | : | Industrial Methods of Analysis, 7th Edition. |
| 4. | Galen W. Ewing | : | Industrial Methods of Chemical Analysis, 5th Edition. |
| 5. | Silverstein R. M. & Webster, F.X. | : | Spectrometric Identification of Organic Compounds, 6th Edition, John Wiley and Sons, Inc., USA. |

**SYLLABUS FOR**
**BACHELOR OF ENGINEERING (CHEMICAL)**
**FIFTH SEMESTER**

## CHE 501 MATHEMATICS-IV

Solution of differential equations in series with reference to Bessel and Legendre equations, elementary properties of Bessel and Legendre functions. (6 Hrs.)

Solution of differential equations by numerical methods, Picard's method, Euler's method, Runge-Kutta method, Milne's method. (4 Hrs.)

Solution of difference equation with constant coefficients. (3 Hrs.)

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. (8 Hrs.)

Different methods for parabolic equations, hyperbolic equations and elliptic equations. (6 Hrs.)

Solution of partial differential equations of engineering interest by method of separation of variables. (7 Hrs.)

Z-transforms: Introduction, standard Z – transforms, properties of z-transforms, initial value and final value theorems, Inverse – Z-transforms, Inverse Z-transforms by power series method, partial fractions method and integral method, application to difference equations. (6 Hrs.)

***.Books Recommended*:**


1. Kreyszig, Erwin : Advanced Engineering Mathematics, 8th Edition, Wiley-Eastern, New Delhi, 2002.
2. Grewal, B.S. : Higher Engineering Mathematics, 40th Edition, Khanna Publishers, Delhi, 2008.
3. Jain, R. K. & Iyengar, S. : Advanced Engg. Mathematics, 2nd Edition, Narosa Publishing House, New Delhi, 2003.
4. Jain, R.K. : Numerical Solutions of Differential Equations, 2nd Edition, Prentice Hall, 1987.


## CHE 502 PETROLEUM PROCESSING ENGINEERING

Introduction to petroleum industry, world petroleum resources, petroleum industry in India. Origin, exploration & drilling of petroleum crude. Transportation of crude and products. ( 4 Hrs.)

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. (12 Hrs.)

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. (12 Hrs.)

Conversion Processes: Thermal cracking: visbreaking and coking processes, catalytic cracking, thermal reforming and catalytic reforming, alkylation, polymerization, isomerisation and hydroprocessing. (10 Hrs.)

Safety and pollution considerations in refineries. (2 Hrs.)

***Books Recommended*:**

**TEXT BOOKS**


1. Nelson, W.L. : Petroleum Refinery Engineering, 5th Edition, McGraw Hill, 1985.
2. Rao, B.K. : Modern Petroleum Refining Processes, 5th Edition, Oxford & IBH Publishing Co., 2009.


**REFERENCE BOOKS**


1. Guthrie, V.B. : Petroleum Products Handbook, McGraw Hill, 1960.
2. Hobson, G.D., Pohl. W. : Modern Petroleum Technology, 5th Edition, John Wiley, 1984.


**CHE 503 CHEMICAL REACTION ENGINEERING–I**

Introduction and a brief review of the kinetics of homogeneous reactions. (4 Hrs.)

Interpretation of rate data from constant volume and constant pressure systems. (8 Hrs.)

Single Ideal reactors. (6 Hrs.)

Design for single reactions. (5 Hrs.)

Design for multiple reactions. (5 Hrs.)

Thermal characteristics of reactors: temperature and pressure effects. (7 Hrs.)

Non-ideality in reactors and its effects on chemical conversion. One parameter models to represent the behaviour of chemical reactors. (5 Hrs.)

***Books Recommended*:**


1. Levenspiel, O. : Chemical Reaction Engineering, 3rd Edition, John Wiley and Sons, 2004.
2. Smith, J.M. : Chemical Engineering, Kinetics, 3rd Edition, and McGraw Hill, 1981.
4. Dinbigh, K. and Turner, K.G. : Chemical Reactor Theory – An Introduction, Cambridge Univ. Press.
5. Scott Fogler, H. : Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall, 2007.

## CHE 504 MASS TRANSFER – I

Mass transfer operations, classification of mass transfer operations, choice of separation methods, methods of conducting mass transfer operations, design principles. (3 Hrs.)

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. (7 Hrs.)

Mass transfer coefficients, types of mass transfer coefficients, mass transfer coefficients in laminar flow, theories of mass transfer. (5 Hrs.)

Interphase mass transfer, concept of overall mass transfer coefficient. (6 Hrs.)

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. (8 Hrs.)

Humidification operations, psychometric chart, adiabatic saturation temperatures, wet bulb temperature, adiabatic operations, types of cooling towers. (6 Hrs.)

Principle of drying, batch drying, drying curve, constructional details and working of different dryers. (5 Hrs.)

***Books Recommended*:**


1. Treybal, Robert E. : Mass Transfer Operations, 3rd Edition. McGraw-Hill, 1981.
2. Sherwood, T.K., Pifford, Robert L. and Wilke, Charles R. : Mass Transfer, McGraw-Hill.
3. Sharma, K.R. : Principles of Mass Transfer, Prentice Hall of India Pvt. Ltd., 2007.
4. McCabe, Warren L., Smith Juliam C. and Harriott, Peter : Unit Operations of Chemical Engg., 7th Edition, McGraw-Hill, 2005.
5. Coulson & Richardson : Chemical Engineering, Vol.I (6th Edition, 2009) and Vol. II. (5th Edition, 2006).


## CHE 505 ENVIRONMENTAL ENGINEERING

Ambient air and water standards. Principal sources of pollution. (3 Hrs.)

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. (7 Hrs.)

*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. (12 Hrs.)

*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. (12 Hrs.)

*Solid wastes:* Control and disposal, sanitary landfill, incineration, pyrolysis gasification and recycling. (6 Hrs.)

***Books Recommended*:**


| | | | |
|---|---|---|---|
| 1. | Perkins, H.C. | : | Air Pollution, McGraw Hill, N.Y. |
| 2. | Rao, C.S. | : | Environmental Pollution Control Engineering, 2nd Edition, New Age International Pvt. Ltd., 2006. |
| 3. | Williamson, S.J. | : | Fundamental of Air Pollution, Addison Wesley Co. N.Y. |
| 4. | Numerow, N.L. | : | Liquid Wastes of Industry, Addison Wesley Co., N.Y. |
| 5. | Sincero, A.P. and Sincero, G.A. | : | Environmental Engineering, Prentice-Hall of India, 1999. |
| 6. | Hammer, M.J. and Jr. Hammer, M.J. | : | Water and Wastewater Technology, 6th Edition, Prentice-Hall of India, 2008. |
| 7. | Mahajan, S.P. | : | Pollution Control of Process Industries, Tata McGraw Hill. |
| 8. | Metcalf and Eddy | : | Waste-Water Engineering, 4th Edition, Tata McGraw Hill, 2007. |


## CHE 506 CHEMICAL TECHNOLOGY (INORGANIC)

*Chlor-Alkali Industry*: Manufacture of Soda Ash by Solvay and modified Solvay process, manufacture of caustic soda. (5 Hrs.)

*Sulphuric Acid*: Introduction, manufacture of sulphuric acid. (5 Hrs.)

*Cement & Glass*: Cement- types and manufacture of Portland cement. Glass- manufacture of glass, application of special glasses. (5 Hrs.)

*Ceramics- Refractories*: Introduction, properties of ceramics, classification of refractories, important steps involved in the manufacture of refractories. (5 Hrs.)

*Industrial gases*: Manufacture and uses of carbondioxide, oxygen, nitrogen and acetylene. (6 Hrs.)

*Paints*: Introduction, classification of paints, manufacture of paints. (4 Hrs.)

*Fertilizers*: Nitrogeneous fertilizers- Manufacture of Ammonia, Nitric acid, Urea, CAN, Ammonium Sulphate. Phosphatic fertilizers- superphosphate and triple superphosphate. Potassic fertilizers- Potassium Chloride and Potassium Sulphate. (10 Hrs.)

***Books Recommended*:**


1. Shreev, R.N. & Brink, J.A. : Chemical Process Industries, 5th Edition, McGraw Hill, 1987.
2. Austine, G.T. : Shreeves Chemicals Process Industries, 5th Edition, Mc Graw Hill, 1984.
3. Dryden, C.E., Rao M.G. & Silting, M. : Outlines of Chemical Technology, 3rd Edition, Affiliated East West Press Pvt. Ltd., N. Delhi, 2008.
4. Pandey, G.N. : Chemical Technology, Volume-I, Lion Press, Kanpur.
5. Bansal, R.C. and Goyal, M. : Activated Carbon Adsorption, Taylor & Francis CRC Group, N.Y., USA, 2005.


## CHE 551 ENVIRONMENTAL ENGINEERING LABORATORY (PRACTICALS)

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 552 CHEMICAL TECHNOLOGY LAB (INORGANIC)

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

## CHE 553 PETROLEUM PROCESSING ENGINEERING LAB. (PRACTICALS)

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.

## CHE 554 FLUID MECHANICS LAB (PRACTICALS)

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.

**SYLLABUS FOR**
**BACHELOR OF ENGINEERING (CHEMICAL)**
**SIXTH SEMESTER**

## CHE 601 CHEMICAL REACTION ENGINEERING-II

Heterogeneous catalyses: A brief review of catalyses catalytic specificity. Preparation testing and characterisation of catalysts, catalyst poisoning and catalyst regeneration. (10 Hrs.)

Fluid Solid catalytic reaction: Kinetics; external transport processes, Reaction -and diffusion within porous catalysts. Effective diffusivity, thermal conductivity and effectiveness factors. Analysis of rate data design outline and selection of fixed bed, fluid bed and slurry reactions. (15 Hrs.)

Fluid - fluid reactions rate equations and their application to the design of reactors. (8 Hrs.)

Fluid Solid non-catalytic reactors rate equations and their application to the design of reactors. (7 Hrs.)

***Books Recommended*:**


1. Levenspiel, O : Chemical Reaction Engg., John Wiley
2. Walas, S.M. : Reaction Kinetics for Chemical Engg., McGraw Hill.
3. Smith, J.M. : Chemical Engineering Kinetics, McGraw Hill.
4. Fogler, H.S. : The elements of Chemical Kinetics, McGraw Hill.
5. Hills, C.J. : An Introduction to Chem. Engg., Kinetics and Reactor Design.
6. Satterfield, C.N. : Mass Transfer in Heterogenous catalysis, MIT Press, Cambridge Mass.
7. Butt, J.K. : Chemical Reaction Engineering Advance in Chemistry Series, 109, American Chemical Society.


## CHE 602 MASS TRANSFER-II

*Absorption*: Equilibria for absorption systems – use of Raoult's law, Henry's law for solubility predictions, Selection of absorbent, limiting liquid gas ratios, absorption factor use in design of plate absorbers. Kremser equation for ideal plates and translation of ideal plates to real plates using various efficiencies. Concept of transfer units for the design of packed absorbers. (7 Hrs.)

*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 method and enthalpy concentration method (Ponchon and Savarit method). Packed distillation columns. Azeotropic & extractive distillation preliminaries and molecular distillation. (13 Hrs.)

*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. (7 Hrs.)

*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. (7 Hrs.)

*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. (3 Hrs.)

*Crystallization*: Growth and properties of crystals saturation, nucleation, growth of crystals, effect of impurities on crystal formation, effect of temperature on solubility, fractional crystallization, yield of crystals, crystal purity, yield calculation using phase diagram, energy requirements using enthalpy-concentration diagram. Methods of creating super saturation-Meirs supersolubility curve. Mechanism and methods for nucleation. Derivation for ideal growth of crystals and discussion of actual growth. Swanson-Walker and various vacuum crystallizers. (3 Hrs.)

***Books Recommended*:**


1. Treybal, Robert E. : Mass Transfer Operations, 3rd Edition, McGraw-Hill, 1981.
2. Sherwood,T.K., Pigford, R.L & Wilke,C.R. : Mass Transfer, McGraw-Hill, Chemical Engineering Series, 1975.
3. Skelland, A.H.P. : Diffusion Mass Transfer, John Wiley & Sons., New York, 1974.
4. McCabe, Warren L., Smith Julian C. and Harriot, H.P. : Unit-Operations of Chemical Engg., 7th Edition, McGraw-Hill, 2005.
5. King, C.J. : Separation Processes, Tata McGraw Hill Publishing Co. Ltd., New Delhi , 1982.
6. Geankoplis, C.J. : Transport Process and Separation Processes, 4th Edition, Prentice Hall Inc., New Delhi, 2003.


## CHE 603 ENERGY TECHNOLOGY

*Fuels*: Types of conventional fuels, their merits and demerits. Non-conventional/renewable energy sources, their importance for sustainable development and environmental protection. (2 Hrs.)

*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. (8 Hrs.)

*Liquid fuels*: Origin of petroleum, refining and distillation of crude oil, uses of petroleum products. (2 Hrs.)

*Gaseous fuels:* Natural gas, manufacture of water gas and producer gas, gas cleaning methods. (4 Hrs.)

*Principles of combustion*: Combustion calculations, waste heat utilization. (4 Hrs.)

*Furnaces*: Classification of furnaces, draught, furnace atmosphere, Portland cement continuous rotary kiln, blast furnace, glass melting furnace. (6 Hrs.)

*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.
- Wind Energy: Nature of wind and wind turbine performance.
- Other renewable energy sources such as geothermal, tidal, ocean and wave. (14 Hrs.)

***Books Recommended*:**

**TEXT BOOKS**


1. Gupta, O.P. : Elements of Fuels, Furnaces & Refractions, 5th Edition, Khanna Publishers, 2007.
2. Rao, S. and Parulekar, B.B. : Energy Technology – Non-conventional, Renewable & Conventional, 3rd Edition, Khanna Publishers, 2007.


**REFERENCE BOOKS**


1. Dayal, M. : Renewable Energy – Environment and Development, Konark Publishers Pvt. Ltd., 1989.
2. Sukhatme, S.P. : Solar Energy – Principles of Thermal Collection and Storage, 2nd Edition, Tata McGraw – Hill Publishing Company Ltd., 2006.
3. Sharma, S.P. and Mohan, C. : Fuels and Combustion, Tata Mc-Graw Hill Publishing Company Ltd., 1984.


## CHE 604 CHEMICAL TECHNOLOGY (ORGANIC)

*Pulp & Paper*: Raw materials, types of pulp, manufacture of paper. (5 Hrs.)

*Sugar*: Introduction, juice extraction, defacation, sulphonation, carbonation, concentration, refining. (5 Hrs.)

*Fermentation*: Production of ethyl alcohol from molasses, citric acid and antibiotics like pencillin. (5 Hrs.)

*Oils & Fats*: Extraction of oils from vegetable oils, refining of oils and fats, hydrogenation of oils. (5 Hrs.)

*Soaps and Detergents*: Introduction, raw materials, manufacture of soap, classification of detergents, finishing of detergents. (5 Hrs.)

*Carbon Technology*: Introduction, classification of activated carbons, raw materials and manufacture of activated carbons, classification of carbon fibres, precursors for carbon fibres, manufacture of carbon fibres from polyacrylonitrile, manufacture of carbon black by furnace black process, applications. (8 Hrs.)

*Nanotechnolgy*: Introduction, properties of nano particles like optical properties, reactivity, synthesis of nano particles by RF plasma process.

Carbon nanotubes: Introduction, structure and properties of carbon nanotubes and fabrication of carbon nanotubes, applications. (7 Hrs.)

***Books Recommended*:**


1. Shreev, R.N. & Brink, J.A. : Chemical Process Industries, 5th Edition, McGraw Hill, 1987.
2. Austine, G.T. : Shreeves Chemicals Process Industries, 5th Edition, Mc Graw Hill, 1984.
3. Dryden, C.E., Rao M.G. & Silting, M. : Outlines of Chemical Technology, 3rd Edition, Affiliated East West Press Pvt. Ltd., N. Delhi, 2008.
4. Pandey, G.N. : Chemical Technology, Volume-I, Lion Press, Kanpur.
5. Bansal, R.C. and Goyal, M. : Activated Carbon Adsorption, Taylor & Francis CRC Group, N.Y., USA, 2005.
6. Bansal, R.C., Donnet, J.B. and Stoeckli, F. : Active Carbon, Marcel Dekker, N.Y.
7. Charles, P.P. and Frank, J.O. : Introduction to Nanotechnology, Wiley India Edition.


## CHE 605 TRANSPORT PHENOMENA

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. (2 Hrs.)

Transport properties – Viscosity, thermal conductivity and mass diffusivity. (4 Hrs.)

Emphasis on the analogy between momentum, heat and mass transfer with respect to transport mechanism and governing equations. (6 Hrs.)

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. (12 Hrs.)

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. (12 Hrs.)

Interphase transport of momentum, heat and mass and dimensionless correlation for each one of them. (2 Hrs.)

Momentum, heat and mass transfer analysis. (2 Hrs.)

***Books Recommended*:**


1. Bird, R.B., Stewart, W.E. and Lightfoot, E.N. : Transport Phenomena, 2nd Edition, John Wiley & Sons, 2005.
2. Weity, J.R. Wilson, R.E. and Wicks, C.E. : Fundamentals of Momentum Heat and Mass Transfer, 4th Edition, John Wiley & Sons, 2001.
3. Bennett.C.O. and Myres J.E. : Momentum, Heat and Mass Transfer, McGraw Hill.


## CHE 651 PARTICLE MECHANICS LAB. (PRACTICALS)

1. Pressure drop and two phase flow characteristics in packed and fluidized beds.
2. Measurement of drag force.
3. Batch settling of slurries.
4. Constant pressure filtration.
5. Mixing, crushing, grinding, screening and particle size analysis.

## CHE 652 CHEMICAL ENGINEERING COMPUTATION (PRACTICALS)

Errors analysis, Solution of linear and non-linear algebric 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*:**


1. Grewal, B.S. : Numerical Methods in Engineering and Science, Khanna Publishers, N. Delhi, 2001.
2. Sastry, S.S. : Introductory Methods of Numerical Analysis, Prentice Hall of India.

## 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. | Coulson, Richardson & Sinnott, R.K. | : | Chemical Engineering, Volume 6 – An Introduction to Chemical Engineering Design, 4th Edition, Pergamon Press, 2007. |
| 2. | Ludwig, E.E. | : | Applied Process Design in Chemical and Petrochemical Plants, 2nd Edition, 1977. |
| 3. | Perry, J.H. | : | Chemical Engineers Handbook, 8th Edition, McGraw Hill, 2007. |
| 4. | Kern, D.Q. | : | Process Heat Transfer, McGraw Hill, 1965. |
| 5. | Joshi , M.V. | : | Process Equipment Design, 3rd Edition, Macmillan India, 2007. |
| 6. | Shell and Tube Type Heat Exchangers, Indian Standards. | : | Instt., IS: 43-197. |
| 7. | Peters, M.S. and Timmerhaus, K.D. | : | Plant Design and Economics for Chemical Engineers, 5th Edition, McGraw Hill, 2004. |


## CHE 654 CHEMICAL TECHNOLOGY LAB (ORGANIC)

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**

## CHE 701 CHEMICAL REACTION ENGINEERING-II

*Heterogeneous catalyses*: A brief review of catalyses catalytic specificity. Preparation, testing and characterisation of catalysts, catalyst poisoning and catalyst regeneration. (10 Hrs.)

*Fluid Solid Catalytic Reaction*: Kinetics; external transport processes, reaction and diffusion within porous catalysts. Effective diffusivity, thermal conductivity and effectiveness factors. Analysis of rate data design outline and selection of fixed bed, fluidised bed and slurry reactions. (15 Hrs.)

Fluid - fluid reactions rate equations and their application to the design of reactors. (8 Hrs.)

Fluid Solid non-catalytic reactors rate equations and their application to the design of reactors.

(7 Hrs.)

***Books Recommended*:**


1. Levenspiel, O. : Chemical Reaction Engineering, 3rd Edition, John Wiley and Sons, 2004.
2. Walas, S.M. : Reaction Kinetics for Chemical Engg., McGraw Hill.
3. Smith, J.M. : Chemical Engineering, Kinetics, 3rd Edition, and McGraw Hill, 1981.
4. Scott Fogler, H. : Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall, 2007.
5. Hills, C.J. : An Introduction to Chem. Engineering Kinetics and Reactor Design.
6. Satterfield, C.N. : Mass Transfer in Heterogeneous catalysis, MIT Press, Cambridge Mass.
7. Butt, J.K. : Chemical Reaction Engineering Advances in Chemistry Series, 109, American Chemical Society.


## CHE 702 PROCESS DYNAMICS & CONTROL

Incentives for chemical process control, design aspects of a process control system. Difference between feedback and feedforward control configuration. Hardware elements of a control system, Block Diagrams. (5 Hrs.)

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. (10 Hrs.)

Different modes of control actions and their basic characteristics, controllers and their characteristics, control valve. (4 Hrs.)

Closed-loop transfer functions, transient response of simple control systems, Routh stability criterion, Root Locus. (10 Hrs.)

Introduction to frequency response, control system design by frequency response. (7 Hrs.)

Introduction to advanced control techniques such as cascade control, ratio control, feedforward-feedback control, inferential control, adaptive control and digital computer control. (4 Hrs.)

***Books Recommended*:**


1. Coughanowr, D.R. : Process Systems Analysis and Control, 2nd Ed. Mc Graw Hill, 1991.
2. Stephanopolous : Chemical Process Control - An Introduction to Theory and Practice, Prentice Hall of India, 1990.
3. Harriott, P. : Process Control, TMH Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1972.


## CHE 703 PROCESS ENGINEERING ECONOMICS

*Cost estimation*: Factors affecting investment and production costs. Capital investments, fixed investments and working capital. Cost indices. Estimating equipment costs by scaling 6/10 factor rule. Methods for estimating capital investment. Estimation of total product cost. Different costs involved in the total product costs. Different cost involved in the total product for a typical chemical process plant. (6-8 Hrs.)

*Interest and Investment Costs*: Simple and compound interest. Nominal and effective rates of interest. Continuous interest ordinary annuity. Perpetuities and capitalized costs. (4-5 Hrs.)

*Taxes and Insurance*: Types of taxes and tax returns, types of insurance and legal responsibility. (2–4 Hrs.)

*Depreciation*: Types of depreciation. service life salvage value, present value and methods of determining depreciation, single unit and group depreciation. (5-6 Hrs.)

*Profitability, Alternative Investments and Replacements*: Mathematical methods of profitability evaluation. Cash flow diagrams. Determination of acceptable investments. Alternatives when 'an investment must be made and analysis with small increment investment, replacement. Breakeven analysis. Balance sheet and income statement. (9-10 hrs.)

*Optimum Design*: Procedure with one variable, optimum reflux ratio in distillation and other examples. (5-6 Hrs.)

*Preliminary Steps in Plant Design*: Plant design factors. project organization, plant location, preliminary data collection, process engineering (3-4 Hrs.)

***Books Recommended*:**


1. Peters, M.S. & Timmerhaus, K.D. : Plant Design and Economics of Chemical Engineers, Mc Graw Hill, New York, 4th Edition, 1991.
2. Ulrich, G.D. : A Guide to Chemical Engineering Process Design & Economics, John Wiley, 1984.
3. Guthrie, K.M. : Process Plant Estimating, Evaluation & Control, Craftsman Solano Beach, Calif, 1947.

4. Jelen, F.C. : Cost and Optimisation Engineering, McGraw Hill, New York, 1970.
5. Holland, F.A. & Wastson, F.A. : Introduction to Process Economics, 2nd Edition, Wiley, 1983.
6. Bassel, W.D. Preliminary Chemical Engineering Plant Design, Elsevier, New York, 1976.

**CHE 704 PLANT UTILITIES**

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.

*Refrigeration*: Air refrigeration cycle, vapour compression cycle, liquification processes.

*Power Generation*: Internal Combustion engines. Gas turbines, steam power plants.

*Water*: Water Resources, storage & distribution of water reuse & conservation of water.

***Books Recommended*:**

1. Jouganson, R. : Fan Engineering, Buffalo Rorge Co., 1970.
2. Wangham, D.A. : Theory and Practice of Heat Engines, ELBS Cambridge University Press, 1960.
3. Lyle, O. : Efficient Use of Steam, HMSO, 1963.
4. Stoccker, W.F. : Refrigeration and Air Conditioning, Mc-Graw Hill, 1950.
5. Kurl, W.F. J.H.M. : Reuse of Water in Industry, Butterworth, London.

**ELECTIVE SUBJECTS**

**CHE 705 PETROCHEMICAL TECHNOLOGY**

1. *General Introduction:* Definition, history and economic perspective of petrochemical industry, raw materials for petrochemical industry-petroleum, natural gas, coal, bio-mass, agro-residues, etc.
2. *First Generation Petrochemicals*: Petrochemicals based on aliphatic, olefinic, acetylene, aromatics, etc. Hydrocarbons-processing and applications.
3. *Second Generation Petrochemicals*: Products based on Synthesis Gas, Method, Ethanol, Ethylene Oxide, Vinyl Chloride, Propylene Oxide, Isopropyl Alcohol, Acetone, Allyl Alcohol, Glycerol, Phenol, Aniline, Nylon Monomers, Polyester Monomers, Styrene, Other Monomers - Bisphenol A, Epichlorophydrin, diisocyanates, Pentaerythritol, etc. - properties, process technologies and applications. .

4. *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*:**


1. Steiner, H. : Introduction to Petroleum Chemicals, Pergamon Press.
2. Waddane, A.L. : Chemicals from Petroleum, John Murry.
3. Topchiev, A.V. : Synthetic Materials from Petroleum, Pergamon Press.
4. Astle, M.J. : The Chemistry of Petrochemicals, Reinhold.
5. Maiti, S. : Introduction to Petrochemicals, Oxford and IBH Pub. Co. Ltd., New Delhi, 1992.
6. Frank, H.G. & Stadelhofer, J.W. : Industrial Aromatic Chemistry, Springer Verlag Berlin, 1987.


## CHE 706 POLYMER SCIENCE AND ENGINEERING

Basic structures and fundamentals of polymers, Industrially important polymers. Polymerization Reaction Kinetics. Gelation Phenomena, Morphology and Transitions in Polymers. Solution thermodynamics of polymers, Experimental techniques in polymer characterization. Introduction to Rheology and Viscoelasticity of Polymers. Fundamentals of polymer processing.

***Books Recommended*:**


1. Williams, D.J. : Polymer Science and Engineering, Prentice Hall Inc.
2. Rodriguez, F. : Principles of Polymer Systems, Tata McGraw Hill Pub.
3. Odian,G. : Principles of Polymerization, McGraw Hill.
4. Collins, E.A., Bares, J. & Billmeryer, F.W. : Experiments in Polymer Science, Wiley Inter Science.
5. Kumar, A. & Gupta, S.K. : Fundamental of Polymer Science and Engineering, Tata McGraw Hill Pub.
6. Middleman, S. : Fundamentals of Polymer Processing, McGraw Hill, New York.


## CHE 707 FOOD TECHNOLOGY

Classification of foods. Nutritional aspects of foods, causes of food spoilage, Principles of food preservations.

*High and Low Temperature Preservation of Foods*: Thermal death of bacteria. Thermal Process evaluation. Batch and continuous sterilization, pasteurization, blanching, canning, metabolism as a function of temperature, refrigeration, storage of foods. Freezing methods and equipment.

*Drying and Dehydration of Foods*: Principles of drying and dehydration of foods: drying methods and equipment, sun drying, freeze drying, Diffusion pervapouration.

*Radiation-Preservation of Foods*: Various types of radiations and their classifications, physical and chemical reactions induced by radiations, interaction of radiation with living micro-organism, food irradiation and microwave heating.

*Food Preservation by Chemicals* Food additives, autooxidants, surface active agents, stablizers, bleaching and maturing agents. Pickling and fermentation of foods.

*Preservation and Processing of Food*: Preservation and processing of food materials such as fruits, vegetables, bread, dairy products, fish, meat, alcoholic and soft drinks etc.

***Books Recommended*:**


1. Charm, S.C. : The Fundamentals of Food Engineering, A.V.I. Publishing Co., 1971.
2. Warnel, J.N. : Principles of Dairy Processing, Wilelesy Eastern, 1976.


## CHE 708 INDUSTRIAL SAFETY AND HAZARDS

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.

Mechanical and electrical hazards. Personal protective equipments. Explosives and inflammable substances. Radioactive hazards. Fire prevention. Good house keeping in industrial environment.

Standard safety procedures and disaster control. Indian Legislation on safety and prevention of hazards and safety code: ISO 14000. Environmental impact assessment. Control strategies for hazardous wastes.

Case Studies of typical hazardous industries.

***Books Recommended*:**


1. Wills, G.L. : Safety in Process Plant Design.
2. Less, F.P. : Loss Prevention in Process Industries.
3. Chanleft, E.T. : Environmental Protection.
4. Berhowex, P.M. & Rudd, D.F : Strategy of Pollution Control.
5. Safety for Chemical Engineers : A.I.Ch.E. Publications, 1976-77.


## CHE 709 OPTIMIZATION TECHNIQUES IN CHEMICAL ENGINEERING

1. Introduction to system analysis and modelling, with reference to Chemical Engineering problems.

2. Differential method for solving one and two variable problems, with and without constraints.
   - Case studies.
   - Application of Langrangian multiplier method.
3. Linear Programming
   - Modelling.
   - Graphical method.
   - Single Phase Simplex method.
   - Two Phase Simplex method.
   - Quality.
   - Sensitivity Analysis.
4. Geometric Programming
   - As applied to Chemical Engineering Problems with degree of difficulty equal to zero and one.
   - With and without constants.
5. Search Methods
   - Sequential Search methods.
   - Golden Section method.
   - Dichotomous Search Method.
6. Introduction to Dynamic Programming as applied to discrete multistage problems like cascade of CSTR, train of heat exchangers etc.
7. Computer programming techniques applied to optimization.

***Books Recommended*:**


1. Baveridge and Schecheter : Optimization Theory and Practice.
2. Asghar Hussian : Optimization Techniques for Chemical Engineers.
3. Hadley : Linear Programming.
4. Hadley : Non Linear Programming.
5. Rao : Optimization.


**CHE 710 PROJECT MANAGEMENT**

*Project Management*: Concept of project management, project management systems, responsibilities and qualities of a project manager, Project management team - composition, functions, responsibilities and coordination procedures.

*Manpower Planning*: Recruitment and selection job description, specification and evaluation, performance appraisal, basis of remuneration and incentives.

*Identification*: Principles of project identification, importance of capital investment decision, phase of capital expenditure management, objective of 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 collaborations and foreign exchange regulations.

*Appraisal Criteria and Selection of Investment*: Non-discounting criteria, discounting criteria appraisal and selection in practice.

*Feasibility Studies*: Preparation of techno-economic feasibility report, feasibility analysis technical economic, commercial and financial.

*Planning*: Network analysis, PERT/CPM Bar Chart, preconstruction planning.

*Project Scheduling, Control and Monitoring*: Resource Scheduling manpower scheduling, multi project scheduling, cost scheduling, PERT/Cost Scheduling Optimisation. Crash costing and updating and levelling of resources, implementation of project schedules.

*Financial Control*: Budgeting and cost control, sources of long term and short term funds for business planning and capital structure problems of working capital management and liquidity.

***Books Recommended*:**


1. Chandra, P. : Project Preparation Appraisal Implementation, 3rd Edition, IIM, Bangalore, McGraw Hill, 1987.
2. Kharbanda, O.P. : Total Project Management, Gower Publishing Co. Ltd., England.
3. Choudhury, S. : Project Management, Tata McGraw Hill, New Delhi, 1988.
4. Rao Ramesh, K.S. : Fundamentals of Financial Management, Macmillan Publishing Co., New York, 1989.
5. Bansal, J.C. & Ghosh, B. : Project Management of Process Plants, Panjab University, 1985.


**CHE 751 CHEMICAL ENGINEERING COMPUTATION (PRACTICALS)**

Errors analysis, Solution of linear and non-linear algebric equations.

Numerical differential & integration.

Interpolation.

Least squares approximation.

Ordinary, partial differential equations.

Development of computer programmes based on the above topics using Matlab and their applications in chemical process computations.

***Books Recommended*:**


1. Grewal, B.S. : Numerical Methods in Engineering and Science, Khanna Publishers, N. Delhi, 2001.
2. Sastry, S.S. : Introductory Methods of Numerical Analysis, Prentice Hall of India.

**CHE 752 PROCESS PLANT DESIGN-III (PRACTICALS)**

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*:**


| | | | |
|---|---|---|---|
| 1. | Ludwig, E.E. | : | Applied Process Design in Chemical and Petrochemical Plants, 2nd Edition, 1977. |
| 2. | Perry, J.H. | : | Chemical Engineers Handbook, 8th Edition, McGraw Hill, 2007. |
| 3. | Peters, M.S. and Timmerhaus, K.D. | : | Plant Design and Economics for Chemical Engineers, 5th Edition, McGraw Hill, 2004. |
| 4. | Coulson, Richardson & Sinnott, R.K. | : | Chemical Engineering, Volume 6 – An Introduction to Chemical Engineering Design, 4th Edition, Pergamon Press, 2007. |
| 5. | Treybal, Robert E. | : | Mass Transfer Operations, 3rd Edition, McGraw-Hill, 1981. |
| 6. | Levenspiel, O. | : | Chemical Reaction Engineering, 3rd Edition, John Wiley and Sons, 2004. |
| 7. | Walas, S.M. | : | Reaction Kinetics for Chemical Engg., McGraw Hill. |
| 8. | Scott Fogler, H. | : | Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall, 2007. |
| 9. | Satterfield, C.N. | : | Mass Transfer in Heterogeneous Catalysis MIT Press Cambridge, Mass. |

**SYLLABUS FOR**
**BACHELOR OF ENGINEERING (CHEMICAL)**
**EIGHTH SEMESTER**

## CHE 801 INDUSTRIAL MANAGEMENT

Process of decision making, elements in decision making nature and framework of planning short and long range planning policy formulation organisation structure and behaviour, decentralisation and delegation. line-staff relationship motivation and morale, communication, inter-personal and group behaviour, coordination and direction.

Purpose, processes and areas of control; control standards, control reports, budget as control device.

Economic planning and policy in India, industrial policy, industrial development in India. Position and problems of chemical industries in India.

***Books Recommended*:**


1. Koontz & O'Donnel : Essentials of Management, New York, McGraw Hill Publishing Company, 1990.
2. Newman & Summer : Process of Management.
3. Terry, George, R. : Principles of Management Homewood Richards, D. Irwin INC, 1990
4. Davar, R.S. : The Management Process, Bombay, Progressive Corporation, 1980.
5. Rathermund, Dietimar : An Economic History of India from precolonical Times to 1986, Manohar Press, New Delhi, 1988.


## CHE 810 MEMBRANE SEPARATION PROCESS

Fundamental, Mechanism of Membrane Transport, gaseous diffusion, separation in liquid phase, dialysis, reverse osmosis, ultra filtration liquid membrane. Electromembrane process. Transfer coefficients and their determination. Engineering aspects of membrane separation and industrial applications.

***Practicals***

1. Preparation of membranes.
2. Study of separation characteristics of membranes.
3. Study of the effective life span of membranes.
4. Liquid membranes (i) emulsion type (ii) supported liquid membrane.
5. Emulsion membrane: Design of liquid surfactant membrane system to treat industrial effluent.

***Books Recommended*:**


1. Wang, H., Sun-Tak & Kammermeyer, K. : Membranes in Separation, Wiley Interscience.
2. Baum B., Halley, W. & White, R.A. : Membrane Separation Process, Elsevier Scientific Publication.


## CHE 811 PETROLEUM PROCESSING ENGINEERING

Introduction to petroleum industry, world petroleum resources petroleum industry in India. Origin, exploration, drilling and production of petroleum crudes. Transportation of crudes and products.

*Crude pretreatment*: Composition and classification of crudes, methods of evaluation: ASTM, TBP and EFV distillation. Properties and specifications of petroleum products such as LPG, gasoline, naphtha, kerosene, diesel oils, lubricating oils, waxes and the like.

*Separation Processes*: Design and operation of topping and vacuum distillation units. Tube still furnaces. Solvent extraction processes for lube oil base stock and for aromatics from naphtha and kerosene steams, solvent dewaxing.

*Conversion Process*: Thermal cracking, visbreaking and coking processes. Catalytic cracking, reforming, hydroprocessing, alkylation, polymerization and isomerisation.

Safety and pollution considerations in refineries.

***Books Recommended*:**


1. Nelson, W.L. : Petroleum Refinery Engineering, 5th Edition, McGraw Hill, 1985.
2. Hobson, G.D., Pohl. W. : Modern Petroleum Technology, 5th Edition, John Wiley, 1984.
3. Guthrie, V.B. : Petroleum Products Handbook, McGraw Hill, 1960.
4. Rao, B.K. : Modern Petroleum Refining Processes, 5th Edition, Oxford & IBH Publishing Co., 2009.


## CHE 812 POLYMER PROCESSING

Fundamentals of rheology and visco-elasticity of polymer solution and metal; Master curve and its use for design of polymer parts: polymer fabrication by techniques such as compression, molding, extrusion, calendaring, thermoforming, injunction molding, reaction injection molding (RIM), blow molding etc. Compounding of plastics and role of additives in processing.

***Books Recommended*:**


1. Middleman, S. : Fundamental of Polymer Processing, McGraw Hill, New York, 1977.
2. Tadmor, Z. and : Principles of Polymer Processing, John Wiley & Sons, 1979.

Gogos, C.G.

3. McKalvey, J.M. : Polymer Processing, Wiley.
4. Bein Hardt, E.C. : Processing of thermoplastic Materials, Reinhold, N.Y.
5. Throne, J.L. : Plastics Process Engineering, Marcelekker Inc.

## CHE 813 LOW TEMPERATURE ENGINEERING

Basic concept of refrigeration cycles: elementary vapour-compression cycles with reciprocating, rotary and centrifugal compression system. Elementary air cycle, ejector cycle and absorption cycle. Thermodynamics of vapour refrigeration. Reversed Carnot cycle and C.O.P. theoretical vapour compression cycle and the departure in actual practice, its mathematical analysis. Refrigerants and their selection. Multiple evaporation and compressor system, Controls, absorption-refrigerator cycle and its mathematical analysis. Cryogenic concept and its purpose. Various methods of production of low temperatures and their mathematical analysis. Methods of liquefaction of nitrogen, hydrogen, oxygen, helium. Application of low temperatures in industry and research.

***Books Recommended*:**

1. Jordan, R.C. & Priester, G.B. : Refrigeration and Air Conditioning, Prentice-Hall of India Pvt. Ltd; New Delhi.
2. Dossat, Roy J. : Principles of Refrigeration, John Wiley & Sons Inc., New York & London.

## CHE 814 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 and aerobic fermentations, kinetics of biochemical reactions. Principles of design of equipment for biochemical processes. Study of important processes involving biochemical reactions.

***Books Recommended*:**

1. Steel, R. : Biochemical Engineering, Heywood & Co., London.
2. Webb, F.C. : Biochemical Engineering, D. Van Nostrand Co., London.

## CHE 815 ALTERNATE ENERGY TECHNOLOGIES

Nature and availability of solar energy collection and storage, solar water and space heating solar, cooling and drying, solar evaporation and distillation, Photo-synthesis and photo-chemistry, biomass applications, wind energy, geothermal energy, refrigeration.

*Practicals:*

1. To study performance of thermo-syphon solar water heater.
2. Energy flow in a solar still.

3. Energy balance on a solar cooker.
4. To study the charging and discharging characteristics of a solar unit.
5. To study the performance of a wood gassifier.
6. To study the performance of a solar air drier.
7. To study the performance of a home made pyranometer.
8. Effect of forced convection in a solar still.
9. To study the performance of hot box cooker.
10. To study the charging and discharging characteristics of a solar accumulator.
11. To study the effect of wind velocity on the performance of solar appliances.

***Books Recommended*:**


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|---|---|---|---|
| 1. | Beckman, W.A., Klein S.A. and Duffie, J.A. | : | Solar Heating Design, John Wiley & Sons. |
| 2. | Kreider, Jan F. | : | The Solar Heating Design Process, Mc Graw-Hill Book Co. |
| 3. | Charles E. Backus | : | Solar cells. |
| 4. | Sayigh, A.A.M. | : | Solar Energy Engineering. |
| 5. | Messel, M. & Butter, S.I. | : | Solar Energy. |
| 6. | Hagglund | : | Chemistry of wood. |
| 7. | Putnam | : | Wind Power. |
| 8. | Wise John | : | Wood Chemistry. |


## CHE 816 COMPUTER PROGRAMMING & ITS APPLICATIONS

- Programming in Pascal.
- Use of standard mathematical and statistical libraries.
- Computer aided drafting. Use of Auto lisp.
- Diagnostic and debugging techniques.
- Application packages such as word processors, management related standard packages.

*Practicals*:

1. Writing, debugging and execution of programs involving operations on series, determinants, matrices, interpolation, extrapolation, solution and algebraic equations, numerical integration, chi square values, regression, correlation.
2. Use of Auto lisp in drawing of two or three dimensional objects, Layers, Manipulation of Attributes.
3. Practical use of word processors.

***Books Recommended*:**

Standard Manuals on Pascal, AutoCAD, Autoslip, Word Processors and other application packages.

## CHE 851 HEAT & MASS TRANSFER (PRACTICALS)

Determination of heat transfer coefficient for different types of heat transfer equipment. Wilson plots. Unsteady state heat transfer in jacketed vessels. Correlation of instantaneous heat transfer coefficients with time study deposition of scale on a heating surface. Heat losses for insulated pipes, performance characteristics of a shell and tube heat exchanger and induced draft cooling tower. Study and operation of long tube, forced circulation and multiple effect evaporators. Durhing plot for solutions involving nonvolatile solutes.

Mass transfer coefficients for naphthalene-air system. Drying rate curves for different wet materials. Fractional approach to equilibrium for liquid-liquid extraction from single drop. Study of different mass transfer equipments.

Verification of Rayleigh's equation for differential distillation. Flooding velocities in packed columns. Determination of HETP for packed distillation columns. Study and operation of a pilot sized distillation column under total reflux.

## CHE 852 PROCESS CONTROL & REACTION ENGINEERING (PRACTICALS)

Calibration of temperature, pressure, flow and composition measuring instruments. Study of process characteristics. Investigation of the operation of pneumatic and electronic controller with proportional, integral and derivative action. To determine the best setting of a controller with controlling an actual process. To solve first order or higher order differential equations with the help of an analog computer and to study control problems by analog simulation.

Selected experiments on isothermal, homogeneous batch and continuous reactors, stirred tank and tubular reactors. Residence time distribution.

## CHE 853 PROCESS MODELLING & SIMULATION (PRACTICALS)

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*:**


1. Luyben, W.L. : Process Modeling, Simulation & Control, Mc Graw-Hill Book Co.
2. Franks, R.G. E. : Modeling and Simulation in Chemical Engineering, Wiley Interscience.

3. Mischke, C. : Computer Aided Design, Prentice Hall.

**CHE 854 ELECTIVE LAB. (PRACTICALS )**

Based on theory.

**CHE 855 SEMINAR**

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*:**

1. Mikdran, A.M. : Use of Engineering Literature, Butter Worths.
2. Sottle, R.T. : The Use of Chemical Literature, Butter Worths.
3. Hoover, H. : Essentials For TheTechnical Writer, John Wiley.
4. Robertson, W.S. & Siddle, W.D. : Technical Writing and Presentation, Pergamon.

**CHE 856 PROJECT WORK (PRACTICALS)**

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.

**CHE 857 FACTORY TRAINING & TOUR REPORT**

Each student will be required to submit a report after each factory visit/training programme throughout the entire course. The reports will be assessed by teachers in charge of the programme.

**CHE 858 VIVA VOCE-II COMPREHENSIVE (PRACTICALS )**

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