Rashtrasant Tukadoji Maharaj Nagpur University

Faculty of Engineering & Technology

Syllabus for

Third Semester B.Tech. Chemical Technology

Subject : BTCHT 301T (BCHT) **Chemical Process Calculations (Theory)**

Lecture : 3 Hours Tutorial : 1 Hour No. of Credits : 4

University : 80 Marks College Assessment: 20 Marks

Duration of Examination : 3 Hours

Unit I Basic principles, the concept of gram atom and gram mole, conversion of units from one system to another, concept of excess reactant, conversion and yield, Selectivity and degree of completion of reaction.

Unit II Ideal gases, partial pressure, vapor pressure, application of ideal gas laws, volume changes with changes of composition, dissociating gases, humidity and saturation, solubility and crystallization.

Unit III Material balance without chemical reaction, recycle, purge and bypass calculations, material balance with chemical reaction.

Unit IV Energy balance without chemical reaction, combined material and energy balances.

Unit V Energy balance with chemical reaction, combined material and energy balances.

Unit VI Fuels and combustion, types of fuels, heating values of fuels, theoretical and excess air, heat and combustion problems

Books Recommended :

1. Stoichiometry and Process Calculation by Narayana K.V., Laxmikutty B. , Prentice Hall of India 2006.
2. Basic Principles and Calculations in Chemical Engineering by Himmalblau D.M. & Riggs, J.B. Prentice Hall of India 6th Edition (2011)
3. Stoichiometry by Bhatt B.I. , Vora S.M. Tata-McGraw-Hill 4th Edition 2004
4. Chemical Process Calculation by Hougen A., Watson, M. John Wiley & Sons, Third Edition 2000

Subject : BTCHT 302T (BGE) **Organic Process Technology (Theory)**

Lecture : 3 Hours No. of Credits : 3

University : 80 Marks College Assessment: 20 Marks

Duration of Examination : 3 Hours

Unit I Amination by Reduction, concept, examples. Commercial production of aniline from nitrobenzene using reducer house, catalytic reduction of nitrobenzene, technical preparationof P-phenylenediamine. Amination by ammonolysis, concept of aqueous and liquid ammonia, factors affecting the process, continuous ammonolysis of chlorobenzene.

Unit II Alkylation: introduction and type of alkylation, alkylating agents, equipments for alkylation. Technical preparation of Anisole, Tetraethyl Lead, Dimethyl Aniline.

Unit III Oxidation liquid and vapor phase oxidation, thermo chemistry of oxidation, Technical preparation of citric acid,oxalic acid, vanillin from eugenol, adipic acid mgf. from cyclohexane using green route.

Unit IV Esterification mechanism of esterification, types of esterification, technical preparation of Bio-diesel(methylesters of higher fatty acid), vinyl acetate, methyl methacrylate.

Unit V Hydrogenation, types of hydrogenation reaction, production of hydrogen from various sources, scope of hydrogenation reaction. Technical hydrogenation processes, petroleum hydrogenation, Tar hydrogenation, coal hydrogenation.

Unit VI Polymers. General introduction, types of polymerization. Study of bio-degradable polymers like polylactic acid, polyvinyl esters, polybutyric hydride. Conducting polymers like poly(acetlynes), poly(phenylenes)

Books Recommended :

1. P.H.Groggins "Unit Processes In Organic Synthesis"
2. Industrial Chemistry by B.K.Sharma,
3. Drydens "Outlines Of Chemical Technology"(edited and revised by M.Gopal Rao and Sittig) east west press New Delhi
4. Polymer Science by V. Gowarikar and Vishwanathan
5. Text book of Engineering chemistry by Khan and Khan
6. A Text book of Engineering chemistry by S. S. Dara, S. Chand Publication ,New Delhi
7. Material Chemistry by V.K. Walekar and A. Bharti, Tech-Max Publication, Pune.

Subject : BTCHT 303T (BGE) **Engineering Mathematics III (Theory)**

Lecture : 4 Hours Tutorial: 1 Hour No. of Credits : 5

University : 80 Marks College Assessment: 20 Marks

Duration of Examination : 3 Hours

Unit I Laplace Transforms: Important Formulae, Properties of Laplace Transforms, Laplace Transform of Unit Step Function, Impulse Function, Periodic Function, Dirac Delta Function, Bessel Function, Error Function, Inverse Laplace Transforms, Important

Formulae of Inverse Laplace Transforms, Properties of Inverse Laplace Transforms, Partial fraction method for Inverse Laplace Transforms, Convolution Theorem, Solutions of ordinary differential equations, simultaneous ordinary differential equations, partial differential equations and evaluation of Integrals using Laplace Transform method.

Unit II Z-Transforms: Properties of Z-Transforms, Inverse Z-Transforms, , Convolution, Convolution property of casual sequence, Transforms of important sequences, Inverse of Z-Transforms by division, solutions of difference equations.

Unit III Partial Differential Equations**:** Solution of first order linear and non-linear Partial Differential Equations, Solution of higher order linear homogeneous Partial Differential Equations and linear non-homogeneous Partial Differential Equations.

Unit IV Applications of Partial Differential Equations: Method of separation of variables for Partial Differential Equations and its use in solving the Partial Differential Equations representing (i) One dimensional wave equation, (ii) One dimensional heat conduction equation in Cartesian co-ordinates and polar co-ordinates and (iii) Two dimensional steady state heat conduction equation.

Unit V Numerical solution of Partial Differential Equations**:** Numerical solution of parabolic, elliptic and hyperbolic Partial Differential Equations using finite difference technique.

Unit VI Calculus of Functions of Complex variables **:** Analytic functions, Cauchy –Riemann conditions in Cartesian co-ordinates and polar co-ordinates, methods for finding conjugate functions, Integration of function of complex variables, Cauchy's integral theorem and integral formula, Residue theorem and its use for evaluating Integrals of function of complex variables, evaluation real definite integrals by contour integration; conformal transformations and bilinear transformations.

Books Recommended:

1. Advanced Engineering Mathematics by H.K. Dass
2. A T Book of Engineering Mathematics by N.P. Bali, Manish Goyal
3. Higher Engineering Mathematics by B.S. Grewal
4. Higher Engineering Mathematics by B.V. Ramana

Subject : BTCHT 304T (BGE) **Electronics & Instrumentation (Theory)**

Lecture : 3 Hours No. of Credits : 3

University : 80 Marks College Assessment: 20 Marks

Duration of Examination : 3 Hours

Unit I Engineering materials: Classification & requirement of engineering materials and their applications, Selection of materials, Physical and mechanical properties of ceramic & composite materials, Polymers, Addition & Condensation polymerization, Copolymerization, Structure & properties of polymers, Plastic.

Unit II Magnetic materials: Classification of magnetic materials, Magnetic dipole, Dipole moment, Magnetic field strength, Magnetization, Magnetic permeability, Magnetic domains, B-H curve, Hard and Soft magnetic materials, Ferrites and its applications.

Unit III Band theory of solids: Energy gap in solids, Classification of solids, Intrinsic and extrinsic semiconductors, Conductivity of semiconductor materials and its temperature dependence, semiconductor devices: photo diodes, LED, Photo Cell.

Unit IV Dielectric and Ferroelectric materials**:** Dipole moment, Dielectric polarization, Dielectric constant, Types of polarization, Temperature and frequency dependence of dielectric constant, Dielectric loss, Dielectric strength, Dielectric breakdown, Ferroelectric properties of materials, Ferroelectric domains, P-E curve, Applications of dielectric and ferroelectric materials.

Unit V Conducting materials: Resistivity & Conductivity of metals, Physical and Mechanical properties of metals, Corrosion, Superconductivity, Types of superconductor, Applications of superconductivity.

Unit VI Measuring Instruments: Number systems, Logic gates, D to A and A to D converters. Working and uses of CRO, Cyclotron, Bain bridge mass spectrograph, Binocular and Research microscopes, Transducers: LVDT, Strain gauge, Thermistor, Thermocouple.

Books Recommended :

1. Material science & Engineering: V. Raghavan (Prentice-Hall of India Pub., 4th edition)
2. Advances in Material Science: R. K. Dogra & A. K. Sharma (S. K. Kataria & Sons)
3. Material Science: Khurmi and Sedha (S. Chand Pub.)
4. Science and Engineering Materials: C. M. Srivastava and C. Srinivasan (New Age International, New Delhi)
5. Material Science: I. P. Singh (New Age International, New Delhi)
6. Digital Electronics: Millman & Halkias
7. Electrical & Electronics Measurements and Instrumentation: A. K. Sawney (Dhapat Rai Pub.)

Subject : BTCHT 305T (BCHT) **Special Technology I (Theory)**

Lecture : 3 Hours Tutorial : 1 Hour No. of Credits : 4

University : 80 Marks College Assessment: 20 Marks

Duration of Examination : 3 Hours

BTCHT 305T/1 **Food Technology I**
(Chemistry of Foods)

Unit I: Development of Food Chemistry: History of Food Chemistry, Nature and Origin of Life, Basic activities of animals and plants and their relations. Water and Ice: Importance of water in foods. Structure of water and ice. Concept of bound and free water, their implications. Water Activity and its influence on shelf life of foods.

Unit II: Chemistry of Carbohydrates: Nomenclature, Classification and Structure of carbohydrates. Chemical Reactions of Carbohydrates. Physical and Chemical properties of sugars, starch, pectic substances, gums and other polysaccharides. Functional properties of carbohydrate in food.

Unit III: Chemistry of Lipids: Definition and classification of lipids, Chemistry of fatty acids and glycerides. Chemistry of processing of fats and oils, hydrogenation of fats, shortening confectionery fat etc. Rancidity of fats and oils, its prevention and antioxidants. Functional properties of lipids in foods.

Unit IV: Chemistry of Proteins: Importance of proteins. Nomenclature, classification, structure and chemistry of amino acids, peptides and proteins. Sources and distribution of proteins isolation, identification and purity of proteins. Denaturation, Physical, Chemical and Biochemical characterization of proteins.

Unit V: Enzymes: Introduction, classification and nomenclature of enzymes, specificity. Assay of enzymes such as amylase, protease, lipase. Isolation and purification of enzymes and their industrial applications.

Unit VI: Analytical Techniques: Techniques of food analysis such as chromatography, electrophoresis, light and electron microscopy, spectrophotometry, tracer techniques etc. Physical Properties of Food Systems. Colloidal Properties of food, Sensory perception of tastes, flavour, aroma and texture. Sensory analysis of foods.

Books Recommended:

1. Food Chemistry : L H Meyer, Van Nostrand Reinhold Co New York 1960
2. Principles of Food Science, Ed. Owen R Fennema Part I, Food Chemistry, Marcel Dekker Inc New York
3. The Chemical analysis of foods and food products : Morris B Jacob, 3rd Edition, Vam Nostrand Co, Princeston, New Jersey
4. Instrumental Methods of Analysis: Peksock and Shields

BTCHT 305T/2 **Technology of Oils, Fats and Surfactants I**

Unit I Natural Fats and Oils: Their sources and classification. Constitutents of natural fats Glycerides. Phospholipids, fatty acids, non glyceride constituents, toxic constituents and detoxification. Nutritional functions of fats.

Unit II Glycerides and fatty acids: Nomenclature, structure, occurrence in oils and fats. Physical properties of fats and fatty acids their properties, solution properties and spectral properties.

Unit III Physical and Chemical characteristics of Oils and Fats. Elementary methods of analysis of oils, fats and fatty acids.

Unit IV Identification of fats and oils. Detection of adulteration in fats. Indian Standards for fats and oils.

Unit V Chemical reaction of fats and their fatty acids. Chemistry of hydrogenation, polymerization, autooxidation and importance of these reactions. Antioxidants and synergists.

Unit VI Chemical reactions of fats and their fatty acids. Dehydration, sulphation and sulphonation. Esterification, interesterification and hydrolysis, hydrazinolysis. Their significance and importance.

BOOKS RECOMMENDED

1. Industrrial Oils and Fat Products : Ed A E Bailey Vol I
2. Fatty acids : K.S. Markely, InterScience Publishers, 2nd Edition, New York
3. Analysis of Fats and Oils : V.C. Mehlan Bacher
4. Inhibition of fat oxidation processes : K.A. Allen
5. An introduction to the Chemistry and BioChemistry of Fatty acids : Gunstone
6. Industrial Chemistry of Fats and Waxes : T Hilditch
7. B S I Methods of Analysis of Fats and Oils
8. Rancidity of Edible Fats : C H Lea
9. ISI Methods of analysis of oils and fats IS 548 (1964)
10. AOCS Methods of Analysis of Oils and Fats

BTCHT 305T /3 **Petroleum Refining and Petrochemical Technology I**
(Geology, Exploration and Production of Gas and Oil)

Unit 1: Introduction to the subject: Outline of the gas and oil industry with main sub divisions, comparative study of various conventional and non conventional energy sources. Fuels and sources of synthetic organic chemicals.

Unit 2: History of petroleum, elements of petroleum geology, types and ages of rocks, lithography and classification of rocks, structure and stratiography of rock formation, sedimentary rocks, traps for oils and gas and their structural details.

Unit 3: Theories and origin andd accumulation of oil and gas. Kerogen composition, classification, isolation, Properties of petroleum and gas in rocks, porosity, permeability, connate water, electrical resistivity, compressibility of rocks, phase behaviour, shrinkage, viscosity, compressibility, permeability, mobility, interfacial tension, wetting capillary pressure and forces of oil and flows.

Unit 4: Methods of surface and subsurface exploration (geolotical, geophysical and geochemical) cable tool, rotary and turbo drilling, drilling of wells (vertical, deviated and horizontal). Drilling, fluids,composition and functions, rates, coring, cementing, acidization, fracturing, completion and testing of wells, logging, methods of primary recovery.

Unit 5: Well testing and control, free flow and gas lifting, mechanical pumping, work over jobs, treatment of wter for injection, enhanced oil recovery, secondary and tertiary.

Unit 6: Separation of Oil and Gas, gathering, stabilization, dehydration, desalting, sortingand mixing, transportation and storage of oil and gas, metering systems, group gathering stations and tank firms.

Books recommended:

1. An introduction to Physics and Chemistry of Petroleum : R R F Kinghorn
2. Composition and properties of Petroleum : H J Neumann, B P Lahme and B Severin
3. Fundamental Aspects of Petroleum geochemistry : Negi and Colombo
4. Modern Petroleum Technology : G D Hobson and W Pohl

BTCHT 305T /4 **Pulp and Paper Technology I**
(Chemistry of Paper Making Raw Material)

Unit I: Species, anatomy and physical properties of wood – classification of woods, plants used in pulp and paper. Gross structure of trunk, structural elements of wood, fibre dimensions.

Unit II: Water conducting system, food conducting syste, wood, bark and its structural elements, decay of wood physical properties of wood.

Unit III: Fibre morphology – Cell formation and growth, fibre structure, chemicalcomposition of wood, non weedy fibres used in pulping – bast, fruits, grass, leaf, animal, mineral and synthetic fibres.

Unit IV: Cellulose – Chemistry and location in the cell, isolation, molecular constitution, microfibrils, crystalline and amorphous cellulose, biogenesis of cell wall, polysaccharides, sorption, swelling and solution of cellulose.

Unit V: Degradation reaction of cellulose, hemicelluloses, structure and properties of hemicelluloses. Lignin – lignification in wood, biological and biochemical aspects of lignin formation, chemical aspects of lignin formation.

Unit VI: Structure and properties of lignin, separation of lignin from woody tissues and laboratory separation, commercial separation, analysis of lignin and utilization of lignin.

Books Recommended:

1. The Chemistry of Cellulose : Emil Hauser, John Wiley and Sons, New YOrk
2. The methods of cellulose Chemistry : Charles Dorre, Chapman and Hall Ltd.
3. High Polymers Vol V (Part I to V) Ed. Emil Ott et al, Interscience Publishers
4. Pulping Process by S.A. Rydholm, John Wiley and Sons, New York
5. Pulp and Paper Chemistry and Chemical Technology : James P Casey, John Wiley and Sons, New York.

BTCHT 305T /5 **Plastics and Polymer Technology I**
(Polymer Technology)

Unit I: Basic Principles of Aromaticity, Types and Mechanism of Aromatic substitution. Manufacture of monomers, ethylene, acetylene, butadiene, styrene, formaldehyde and its properties.

Unit II: Manufacture of Vinyl Acetate, Vinyl Chloride, Dibasic acids viz Succinic, Maleic, Adipic acids and their properties. Acrylic acid, MMA, Butylacrylate and similar compounds with their properties.

Unit III: Natural polymers viz Cellulose, Lemin, Rubber, their properties and uses. Preparation and properties of cellulose acetate, carboxymethyl cellulose. Regenerate Cellulose and other Cellulose derivatives.

Unit IV: Chemistry of Polymerisation: Introduction to types of polymerization, emulsion, solution, Bulk with typical examples of PG, PVC, PS etc. Mechanism of polymerization, detailed use of Zeigler Natta Catalyst used in Polymerisation.

Unit V: Copolymerisation: Introduction, Free Radical, Ionic and Co Polycondensation, copolymerization. Kinetics of Polym,erisation, introduction, free radical chain polymerization, cationic polymerization, anionic polymerization.

Unit VI: Experimental Methods: Polymer Synthesis, Isolation and Purification of Polymers, Polymer fractionation, Molecular weight determination, Molecular weight distribution and glass transition temperature.

Books Recommended:

1. Organic Chemistry: I L Finar Vol I, Longman Group Ltd. ELBAS, London 6th Edition
2. Polymer Science: V R Gowarikar et al, Wiley Eastern Ltd, Mumbai
3. Unit Processes in Organic Synthesis: P H Groggins, Mc Graw Huill Co, New York.

BTCHT 305T /6 **Surface Coating Technology I**
(Chemistry of Drying Oils and Polymerisation)

Unit I: Introduction to Surface Coatings, classification, definition of paints, varnishes, lacquer, pigment, extender. General composition of surface coatings, function of pigments, extenders, binders, driers, additives in surface coatings. History of developments of surface coatings, Global scenario and past, present and future of Indian Coating Industry.

Unit II: Film Formation : Fundamental of film formation. Chemical Composition, functionality and degree polymerization and film properties. Concept of functionality. Types of coatings, convertible and non convertible.

Unit III: Polymeriation, additive, condensation, auto-oxidative, copolymerization and heteropolymerisation. Degree of polymerization.

Unit IV: Vegetable and marine Oils for surface coatings. Classification of oils, fats and waxes. Non drying, drying and semidrying oils. Sources and composition. Methods of extraction and refining of drying oils from vegetable and marine origin.

Unit V: Polymerisation of drying oils, thermal and oxidative. Formation of stand, blown and boiled oils. Limed oils, Treated Oils. Dehydrated oils, DCO, Copolymerised oils, film formation and deterioration.

Unit VI: Deries, mechanism of drying action. Composition of dries, drier metals, drierabsorption. Analysis of metal content. Preliminary analysis of Paints, Indian Standards specifications for paints.

Books Recommended:

1. Organic Coating Technology : H F Payne, Vol I, John Wiley and Sons, New York
2. Paint Technology Manual : Vol I, Oil and Colour Chemists Association
3. Paint Technology Manual : Vol II, Oil and Colour Chemists Association
4. The Chemical Constitution of Natural Fats : T P Hilditch, 2nd Edition, John Wiley and Sons, 1947
5. Protective and Decorative Coatings : J J Matellio, Vol I, John Wiley and Sons
6. Surface Coatings : Vol I, Raw Materials and their useage, Oil and Colour Chemists Association, Australia
7. Text Book of Polymer Science : W Billmeyer, Interscience Publishers Inc, New York 1962
8. An Introduction to Polymer Chemistry : W R Moore, Aldine Publishing Co. Chicago, 1963
9. Paints and Varnishes : A.S. Khanna, Indian Central Iolsee Committee, 1959

Subject : BTCHT 306P (BGE) **Organic Process Technology (Practical)**

Practical : 3 Hours No. of Credits : 2

University : 25 Marks College Assessment: 25 Marks

Duration of Examination : 4 Hours

Synthetic Preparation of Important Organic Compounds and calculation of Theoretical and Percent yield

1. Preparation of Methyl Esters of Fatty Acids from Soybean Oil (Bio-Diesel) using Unit Process Esterification.
2. Preparation of Oxalic Acid from Cane Sugar using Unit Process Oxidation.
3. Preparation of Urea Formaldehyde Resin using Unit Process Polymerisation.
4. Preparation of Phenol Formaldehyde Resin (PF Resin) using Acid Catalyst using Unit Process Polymerisation.
5. Preparation of P-bromo Acetanilide from Acetanilide using Unit Process Halogenation.
6. Preparation of m-Dinitrobenzene from Nitrobenzene using Unit Process Nitration.
7. Preparation of Acetanilide from Crude Aniline using Unit Process Acetylation.
8. Preparation of Pthalamide from Pthalic Anhydride using Unit Process Amination By Ammonolysis.

9. Preparation of Nerolin from β-Napthol using Unit Process Alkylation.

Subject : BTCHT 307P (BGE) **Electronics & Instrumentation (Practical)**

Practical : 3 Hours
University : 25 Marks
Duration of Examination : 4 Hours

No. of Credits : 2
College Assessment: 25 Marks

LIST OF EXPERIMENTS

1. Measurement of Magnetic susceptibility.
2. Measurement of resistivity and conductivity.
3. To determine the cut-in-voltage of LED.
4. A study of P-E curve on CRO.
5. A study of basic & universal logic gates.
6. A study of A to D & D to A convertor.
7. Determination of activation energy of a thermistor
8. A study of cathode ray oscilloscope.
9. To study the characteristic of a photo cell.
10. Measurement of displacement by LVDT.

Subject : BTCHT 308P (BCHT) **Special Technology I (Practical)**

Practical : 3 Hours
University : 25 Marks
Duration of Examination : 4 Hours

No. of Credits : 2
College Assessment: 25 Marks

BTCHT 308P /1 Food Technology Practical I

1. Estimation of reducing sugar by Lane Eynon's method
2. Estimation of nonreducing sugar by lane eynon's method
3. Estimation of amino acid (glycine) by Sorenson formal titration method
4. Estimation of glucose by iodometry titration (Wills Statter method)
5. Determination of acid value of oil or fat
6. Determination of saponification value of oil or fat
7. Determination of iodine value of oil or fat
8. Peroxide value of oils
9. Estimation of ascorbic acid (vitamin c) by titration method
10. To determine the unknow sugar by paper chromatography
11. Qualitative analysis of carbohydrate

BTCHT 308P/2 Technology of Oils, Fats & Surfactants Practical I

1. Determination of Moisture Content of Oil and Fat
2. Determination of Acid Value of Oil and Fat
3. Determination of Free Fatty Acid content of Oil and Fat
4. Determination of Saponification Value of Oil and Fat
5. Determination of Iodine Value of Oil and Fat
6. Determination of Peroxide Value of Oil and Fat

7. Determination of Refractive Index of Oil and Fat
8. Estimation of Sedimentation present in Oil / Fat
9. Estimation of Adulteration in cotton seed oil using Halphens Test
10. Estimation of Adulteration in Sesame oil using Baudin's Test
11. Determination Melting point of Fats by thels tube Method
12. Determination Smoke And Flash Point Of Oil And Fat

BTCHT 308P /3 Petroleum Refining and Petrochemical Technology I

List of Experiments

1. API gravity,
2. Aniline point ,
3. Diesel Index,
4. Cloud and Pour point,
5. Smoke point,
6. Flash point by Abel,
7. Penskey Martin and Cleaveland Open cup,
8. Sapnofication Value,
9. Dropping point of grease,
10. melting point of wax,
11. Drop melting point.

BTCHT 308P /4 Pulp & Paper Technology Practical I
(Proximate Analysis of Paper Making Materials)

1. Preparation of sample (40 + 60 mesh) of wood
2. Determination of moisture content of the sample of wood
3. Determination of ash content of the wood sample
4. Determination of cold water solubles in wood sample
5. Determination of hot water solubles in wood sample
6. Determination of 1% NaOH solubles in wood sample
7. Determination of the extractives in ethanol-benzene mixture
8. Determination of holocellulose in extract free sample of wood
9. Determination of acid soluble lignin in the sample of wood
10. Preparation of 40 + 60 mesh samples from agricultural residues.

BTCHT 308P /5 Plastics & Polymer Technology Practical I
(Polymer synthesis and Characterisation)
List of Experiments:

Part: I **Preparation of common polymers.**

1. Preparation of Polystyrene by free radical polymerisation.
2. Preparation of Polystyrene by ionic polymerisation.
3. Preparation of phenol formaldehyde resin by acid catalyst.
4. Preparation of phenol formaldehyde resin by alkali catalyst.
5. Preparation of urea formaldehyde resin by acid catalyst.
6. Preparation of alkyd resin.
7. Preparation of polymethylmethacrylate (PMMA).
8. Preparation of nylon.

Part: II **Characterization of following polymers.**

9. Polystyrene.

10. Phenol formaldehyde resin.
11. Urea formaldehyde.
12. Alkyd resin.
13. Nylon.
14. PMMA.
15. PVC.
16. Polyacrylates.

Recommended Books/References:

1. Handbook of Polymer Synthesis, Characterization, and Processing by Enrique Saldívar-Guerra, Eduardo Vivaldo-Lima. Wiley.
2. Polymer Synthesis and Characterization: Laboratory Manual by **Sandler** , **Karo** , **Bonesteel** & **Pearce**. Elsevier.
3. Laboratory experiments in polymer synthesis and characterization by Eli M. Pearce, Carl E. Wright, Binoy K. Bordoli. (Article).

BTCHT 308P /6 Surface Coating Technology Practical I

List of Experiments

1. Determination Oil Absorption of Pigment.
2. Determination of Bulk density of pigment.
3. Determination of Hiding power of pigment.
4. Determination of Tinting Strength/Reducing power of pigment.
5. Determination of Moisture content in pigment
6. Determination of Acid value of oil/oleoresins/rosin.
7. Determination of Iodine value of oil/oleoresins/rosin.
8. Determination of Saponification value of oil/oleoresins.
9. Determination of Hydroxyl value of oil/oleoresins.
10. Determination of Density of solvent.
11. Determination of Boiling Range of solvent
12. Determination of rate of evaporation of solvent
13. Determination of %residue in solvent
14. Determination of aromatic hydrocarbon content in solvent.
15. Determination of Flash point of solvent.

Rashtrasant Tukadoji Maharaj Nagpur University

Faculty of Engineering & Technology

Syllabus for

Fourth Semester B.Tech. Chemical Technology

Subject : BTCHT 401T (BGE) **Strength of Materials (Theory)**

Lecture : 3 Hours Tutorial: 1Hour No. of Credits : 4

University : 80 Marks College Assessment: 20 Marks

Duration of Examination : 3 Hours

Unit I Simple Stresses and Strains**:** Introduction; Definition of stress and strain; tensile and compressive stresses; shear stress, Elastic limit, Hooke's law, poission's ratio, modulus of Elasticity, modulus of Rigidity, Bulk Modulus; stresses in composite sections; Volumetric strain; Temperature stresses. Strain Energy Stresses due to different types of axial loading; Gradually applied loads, Suddenly applied loads, Impact loads.

Unit II Shear Forces and Bending moments Definitions; Concept of Shear force and Bending moment; Sign conventions; Shear force and Bending moment diagrams for cantilevers, simply supported beams and beams with overhang; point of contra flexure; member subjected to couples. **Stresses in Beams** Definition; Pure or simple bending, theory of simple bending; Neutral layer, Neutral axis, Moment of resistance, assumptions in the theory of simple bending; Section modulus for rectangular, circular, I section and T section. Flitched Beams Definition; Equivalent section, modular ratio, moment of resistance in flitched beams. Shear stress distribution in Beams sections Shear stress distribution on rectangular, circular, I section and T section.

Unit III Deflection of Beams Member bending into a circular arc; Slope, deflection and radius of curvature; Cantilevers and simply supported beams. Macaulay's method for slope and deflection in cantilevers, simply supported beams and beams with overhang.

Unit IV **Direct and Bending Stresses** Stress distribution of the section of an eccentrically loaded rectangular column; Core of Kern of the section, Circular and hollow sections. **Columns and Struts** Introduction; axially loaded compression members; crushing load; Buckling or critical load, Euler's theory of long columns, assumptions made in Euler's theory; Empirical formulae; Rankine's formula.

Unit V Torsion of Shafts Pure Torsion; Theory of pure torsion; Torsional moment of resistance; assumptions in the theory of pure torsion; Polar modulus; Power transmitted by circular and hollow shafts; Torsional rigidity. Close coiled helical springs Stiffness, deflection, shear stress and Strain energy.

Unit VI Thin Cylinders and Spheres Thin cylinders; Circumferential and Longitudinal stresses; Thin spherical shells. Riveted Connections Types of joints; Lap and Butt joints; Failure of riveted joints; Tearing strength, shearing strength and bearing strength; Efficiency of a joint.

Books Recommended :

1. Strength of Materials by S. Ramamrutham.

2. Strength of Materials by B. C. Punmia
3. Strength of Materials by R S. Khurmi.

Subject : BTCHT 402T (BGE) **Applied Physical Chemistry II (Theory)**

Lecture : 3 Hours No. of Credits : 3
University : 80 Marks College Assessment: 20 Marks
Duration of Examination : 3 Hours

Unit I Thermodynamics I: The chemical potential, Gibb's Duhem equation, Fugacity, Activity, Determination of fugacity,Chemical equilibria only for Homogeneous system- Reaction Isotherm, Relation between Kp,Kc,Kx, The Van't Hoff equation

Unit II Thermodynamics II: The Clausius Clapeyron Equation, The Phase Rule and its derivation, its application to water system and CO_2 system, Simple Eutectic system- Lead Silver system, Nernst distribution law, its applications- Solvent extraction theory and principle

Unit III Thermodynamics of solutions I : Raoult's Law, Vapour Pressures of ideal solutions, Activity of ideal solution, chemical potential of ideal solution, Gibb- Duhem- Margules Equation, Free energy, entropy, and enthalpy of mixing

Unit IV Thermodynamics of solutions II : Vapour Pressures of real solutions, Vapour Pressure-composition and Boiling Point composition Curves of completely Miscible Binary Solutions, Distillation method of immiscible liquids : Fractional distillation and steam distillation, Colligative properties-vapour pressure lowering, Osmotic pressure, Elevation of boiling point, depression of freezing point

Unit V Electrochemistry I : Specific, Equivalent and Molecular conductance, effect of temperature on conductivity, Transport Number, their determination- Hittorf's method and Moving Boundary Method, Kohlrausch's Law, its applications, Debye Huckel Theory of strong electrolytes

Unit VI Electrochemistry II : Reversible electrodes, Reference electrodes, standard electrode potential, Thermodynamics of reversible electrodes, The Nernst Equation, Concentration cells with and without transference, liquid junction potential, Applications of Emf measurements, Hydrolysis of salts

Books Recommended:

1. Thermodynamics for Chemists : S.Glasston, D Van Nostrand Co,New York,USA
2. An Introduction to Thermodynamics : R P Rastogi and R R Mishra
3. Introduction to Electrochemistry : S.Glasston, D Van Nostrand Co,New York,USA
4. Physical Chemistry : G Barrow, Benjamin Publisher, New York,US
5. Physical Chemistry : Vemupalli, Wiley East West
6. Principles of Physical Chemistry : Puri Sharma and Pathania

Subject : BTCHT 403T (BGE) **Numerical Methods & Computer Programming (Theory)**

Lecture : 3 Hours Tutorial: 1Hour No. of Credits : 3
University : 80 Marks College Assessment: 20 Marks
Duration of Examination : 3 Hours

Unit I Introduction to programming, programming languages, algorithm, flowcharts, C Language: Features of C, data types, Identifiers, Constants, Variables, expressions, Console I/O statement, Selection statements: if-else, switch, Iteration Statements: For, while, do-while, Jump statements: return, go to, break, and continue, comments, and program using these features.

Unit II Macros, Function and Recursion, Structure and Union, Pointers, String, Basics of File handling

.**Unit III** Concept of Array, Matrix operations in C and Searching, Sorting: Linear search, Binary search, Bubble sort, Insertion sort, Selection Sort.

Unit IV Program to obtain roots of polynomial Equation: Newton-Rapson method, Regular Falsi Method, Muller method, Bisection method, false position method. Programs for interpolation and extrapolation using numerical methods.

Unit V Numerical Integral and Differential equations using: Initial value problems by Euler's method, modified Euler's, Taylor series, Runge-kutta methods, Regression analysis.

Unit VI Optimization techniques, integer programming, Simplex method, dynamic programming, programs for implementation of these method and case study.

Books Recommended:

1. Numerical methods for Scientific and Engg. Computations by M.K. Jain, Srk Iyengar, R.K. Jain, Wiley Eastern Ltd.
2. Numerical methods for Science & Engg. By Stanton R.G., PHI.
3. The C Programming Language: Dennis Ritchie & Brain Kernighan [Pearson].
4 ANSI C: By E Balagurusamy

Subject : BTCHT 404T (BGE) **Inorganic Process Technology (Theory)**

Lecture : 3 Hours No. of Credits : 3

University : 80 Marks College Assessment: 20 Marks

Duration of Examination : 3 Hours

Unit I Industrial gases**:** Manufacture of CO, CO_2, H_2, N_2 & O_2, rare gases C_2H_2, and their industrial applications

Unit II Industrial acids: Manufacture of nitric acid, sulphuric acid, Phosphoric acid and their industrial applications

Unit III Industrial Carbon & Inorganic pigments: Manufacture & applications of, Lamp black, Carbon black, Activated carbon, Graphite, Industrial diamond. Manufacture, properties & uses of white pigments- white lead, zinc oxide, titanium dioxide and Lithophone.

Unit IV Marine chemicals & Nuclear industries: Manufacture of common salt from Sea water, by-product from bitterns, Bromine. Nuclear fission reactions, Feed materials, extraction of

Uranium, uranium enrichment, nuclear reactor, reprocessing of nuclear materials, protection from radioactivity.

Unit V Chloro-Alkali & Electrolytic and Electrochemical industries**:** Manufacture of Soda ash, caustic soda &chlorine - Diaphragm cells, Mercury cathode & Mercury cells &Membrane cell. Manufacture of potassium chlorate & per- chlorate. Artificial abrasives: Calcium carbide, Silicon carbide.

Unit VI Fertilizers: Classification of fertilizers, manufacture & applications of ammonia, urea, ammonium nitrate, ammonium sulphate, Super phosphates & triple super phosphates, monoammonium and Diammonium phosphate, Potassic, compound & complex fertilizers.

Books Recommended :

1. Industrial Chemistry by B.K.Sharma, Goel Pub. House, Meerut.
2. Dryden, C. E. "Outlines of Chemical Technology" (Edited and Revised by M.Gopal Rao and Sittig .M) East West Press. Pvt. Ltd, New Delhi, 3rd Edition (1997).
3. Austin G. T,"Shreve's Chemical Process Industries", 5th ed., McGraw Hill.(1984).
4. G.N.Pandey, "Text book of Chemical Technology", Vol. I, 2nd revised edition, (1994).
5. A Text Book of Engineering Chemistry, by S.S.Dara, S.Chand & Co., New Delhi

Subject : BTCHT 405T (BCHT) **Special Technology II (Theory)**

Lecture : 3 Hours Tutorial: 1 Hour No. of Credits : 4

University : 80 Marks College Assessment: 20 Marks

Duration of Examination : 3 Hours

BTCHT 405T/1 **Food Technology II**
(Biochemistry and Nutrition)

Unit I Enzymes – Enzyme kinetics, activators and inhibitors. Techniques of immobilization of enzymes. Allosteric regulation of enzymes. Enzyme inhibitors
Cell Membrane: Structure and Transport Mechanism

Unit II Bioenergetics – Generation of high energy phosphates and their importance.

Unit III Digestion of carbohydrate based food and its metabolism.

Unit IV Metabolism of lipids and proteins. Antinutritional factors in food. Toxic compounds, alkaloids.

Unit V Nutrition – Functions of food. Energy value of food. BMR and its measurement. Energy requirement of individuals. Nutritional evaluation of proteins. Recommended dietary allowances of proteins, fats and carbohydrates.

Unit VI Vitamins – Classification, sources, functions and deficiency symptoms, assay of vitamins. Minerals – Micro & Macro Minerals. Loss of nutrients during processing, Enrichment and fortification.

Books Recommended:

1. Outlines of Biochemistry : E E Conn and P K Stumpf, Wiley Eastern Pvt. Ltd., New Delhi
2. Applied Nutrition : R Rajalakshmi, Oxford and IBH Publishing Co. New Delhi
3. Text Book of Biochemistry : A Lehninger
4. Biochemical and Physiological Aspects of Human Nutrition: Martha H Stipanuk, published by Saunders an imprint of Elsevier.

BTCHT 405T/2 Technology of Oils, Fats and Surfactants II

(Bio-Chemistry Of Oils and fats and Techniques of separation of fats and fatty acids)

Unit I Distribution of Fatty acids in oils and fats: –Theories of fatty acid distribution, Effect of fatty acid distribution on physical and chemical properties of oils and fats, Quantitative investigation of major components of glycerides.

Unit II Investigation of component fatty acids of natural and processed fats:- Lipasehydrolysis, Dilatometric measurements and their significance, Determination of color by Lavibond Tintometer, Determination of viscosity by Brookfield viscometer. Analysis of oil seeds and oil cakes

Unit III Biosynthesis of fatty acids**:-**Phospholipids and triglycerides in plants, glycol-lipids, neutral lipids, Structure of oilseed, metabolism of oils and fats in seeds, synthesis of oils in seeds, Biological utilization of fats, Essential fatty acids, Crystallization of Fats and Oils, Trans fatty acids,

Unit IV Techniques of separation of fats and fatty acids**:-**Techniques of separation of fats and fatty acids such as Low temperature crystallization, Urea adduct, Counter current distribution, salt-solvent separation etc.

Unit V Techniques of separation of fats and fatty acids**:-**Chromatographic methods of separation with specific references to Thin layer and Gas liquid chromatography, High performance liquid chromatography(HPLC),Infrared red and ultraviolet Visible spectroscopy, Nuclear magnetic resonance (NMR) analysis

Unit VI Polymorphism of fats and fatty acids**: –** Metal salts of fatty acids of alkaline earth Metals, their methods of preparation, analysis and applications, Determination of Reichert – Missel , Polenske, and Kirshner values

Books Recommended:

1. Vegetable Fats and Oils : E W Eckey
2. Rancidity of Edible fats : C H Lea
3. Fatty acids : K S Markley, Vol 3
4. Structure and Utilisation of Oilseeds: J G Vaughen
5. Gas Liquid Chromatography : S D Nagere and R S Juvet
6. This Layer Chromatography : T Bobbit
7. Industrial Chemistry of fats and waxes : T P Hilditch
8. The Lipids : H J Duel

9. Progress in the Chemistry of fats and other lipids : H T Holman, W O Lundberg
10. Lipid Chromatographic Analysis : G V Marinetti
11. Melting and Solidification of fats : A E Bailey

BTCHT 405T /3 Petroleum Refining and Petrochemical Technology II (Composition, Classification and Evaluation)

Unit I Separation of Oil and Gas, gathering, stabilization, dehydration, desalting, sortingand mixing, transportation and storage of oil and gas, metering systems, group gathering stations and tank farms.

Unit II Elementary concept of fractionation – Distillation theory (atmospheric pressure, reduced pressure, azeotropic and extractive) solvent treatment, asphaltene separation and fractionation. Absorption, chemical methods like sulphuric acid treatment, molecular complex formation, Extraction and use of data.

Unit III Composition of petroleiu, natural gas, major petroleum fractions and products (refinery gases, gasoline, naphtha, kerosene, diesel, fuel oil, lubricating oil, other oil products, waxes, asphalt, coke, acid sludge) Hydrocarbons and non hydrocarbons present (Type, name, structure, role) chemical aspects of origin of petroleum and natural gas.

Unit IV Classification and description of various crudes. General methods of classification and correlations. N-d-M ring analysis method, comparison of structural group analysis by spectroscopic and physical property methods. MW determination, correlation method for structure of solid saturated hydrocarbons.

Unit V Principles and uses of modern physico chemical analysis techniques such as UV, IR, NMR, MS, GLC etc. in petroleum and product analysis.

Unit VI Evaluation of crude and petroleum fractions and use of data with reference to physical, thermal, electrical, optical and other test properties. Significance of these tests and national and international significance.

Books recommended:

1. Modern Petroleum Technology : G D Hobson and W Pohl
2. Petroleum Refining Engineering : W L Nelson
3. Chemical Technology of Petroleum : W A Gruce and Stevens
4. The Chemistry and Technology of Petroleum : James G Speight
5. Petroleum refining, Technology and Economics : J H Gary and G E Handwork.

BTCHT 405T /4 Pulp and Paper Technology II (Pulping Process II)

Unit I Order of pulp wood operation, measurement, wood yard layout, wood preparation plant, debarking of pulp wood logs, pulp wood storage and conveying.

Unit II Preparation of pulp wood chips handling and conveying chip storage.

Unit III Manufacture of mechanical pulp, woods used, types, grades and uses, advantages and limitations.

Unit IV Equipments for ground wood pulping process, pulp mill operations, variables affecting the process, power requirements, water and pulp showers.

Unit V Semichemical pulping, NSSC process, wood preparation, digestors, fibrizing, washing, cleaning and chemical recovery and effluent disposal, properties and uses.

Unit VI Acid sulphite, semichemical pulping, bisulphate semichemical pulping, Kraft semichemical ar d cold soda semichemical processes.

Books Recommended:

1. Pulping process : Rydholm
2. Pulp and Paper Science and Technology : Vol I C E Libby
3. Pulp and Paper Chemistry and Technology : Vol I J P Casey
4. Pulp and Paper Manufacture : Vol I and III Mc Donald
5. Handbook of Pulp and Paper Technology : K W Britt, 2nd Edition

BTCHT 405T /5 **Plastics and Polymer Technology II (Polymer Materials)**

Unit I Chemical nature of Plastics and their behaviour. Elementary ideas of polymerization. Historical developments in Polymer materials, Basic raw materials for polymers, polymerization methods and applications.

Unit II Types of polymers and orientation. Relationship of structure to thermal and mechanical properties. Study of electrical, optical and chemical properties. Various engineering plastics, acrylic polymers, styrene polymers.

Unit III Additives for plastics and elementary ideas of processing and flow properties. Thermal stability, melt procdesing, thermoset technology, elastomer technology, basic raw materials, manufacture, compounding, vulcanization etc.

Unit IV Preparation, polymerization, general physical and chemical properties and application of polyethylene, PVC, Polyvinyl acetate and its derivatives. Acrylic plastics.

Unit V Plastics based on polystyrene and HIPS, ABS, TPS, Styrene Maleic anhydride, SBR and other polymers their properties and applications.

Unit VI Preparation, properties of, Phenolic, polyamides, cellulosic, MF, PF, UF, Polyurethane, Silicones and other heat resistant materials.

Books Recommended:

1. Plastic Materials : J A Brydson 6th Edition, Butterworth Heinemann Ltd., 1995
2. Vinyl and Diene Polymers : Part I and II, E C Lenord, Wiley Interscience, New York, 1970

3. Manufacture of Plastics by W M Smith, Reinhold Publishing Co., New York 1972
4. Introduction to Rubber : F R Elrich, Academic Press, 1978
5. Polymer Process : Schild Knecht, John Wiley and Sons, New York, 1979

BTCHT 405T /6 **Surface Coating Technology II**
(Chemistry of Film Forming Materials I)

Unit I Resins and resinous state, natural and synthetic resins. Classification of resins. Occurrence, composition, purification and uses. Modification of natural resins with special reference to rosin, ester gum, maleic modified. Detailed study of resins like Congo Copal Shellac, Gum and Wood Rosin, Sandarac, Damar.

Unit II Phenolic Resins, Composition, Types of Phenols used, ratio of formaldehyde, Phenolic condensates, Rosin modified Phenolics, Reactive and non Reactive type 100% phenolics. Baking phenolics, coumarone-ir dene resins. Petroleum resins, C N S L and B N S L resins and their industrial applications.

Unit III Amino resins, urea melamine formaldehyde resins. Chemistry of amino resins, conditions of reaction and products. Modification of urea formaldehyde resins. Butylated resins, general applications of urea and melamine resins in surface coatings.

Unit IV Alkyd resins, raw materials, Functionality concepts, use of polyfunctional acids and alcohols, phthalic acid resins and manufacture, types of oil modifications and properties of modified alkyd resins.

Unit V Polyster resins and styrenated resins. Unsaturated polyesters resins for surface coatings. Mechanism of curing and air inhibition.

Unit VI Polyaamide resins. Structure of polyamides, modifications necessary to make them suitable for coatings their properties and uses.

Books Recommended:

1. Organic Coating Technology: H F Payne, John Wiley & Sons, New York, 1954
2. Paint Technology Manual : Oil Colour Chemists Association, Vol 1, Vol 2 and Vol 3
3. Text Book of Polyer Science : W Billmeyer, Interscience Publishers Inc. New York, 1962
4. An Introduction to Polymer Chemistry : W R Moore, Aldine Publishing Co.

Subject : BTCHT 406P (BGE) **Numerical Methods & Computer Programming (Practical)**
Practical : 2 Hours No. of Credits : 1
University : 25 Marks College Assessment: 25 Marks
Duration of Examination : 4 Hours

LIST OF EXPERIMENTS

1. Write a simple program in C for Addition, multiplication and division of two numbers.
2. Write a program in C to find whether given year is Leap year or not.

3. Write a program in C for Fibonacci sequence using function.
4. Write a program in C for Factorial Function.
5. Program to illustrate the uses of Array.
6. Write a program in C to demonstrate the use of Selection Statement (If, Else, Switch).
7. Write a program in C to demonstrate the use of Iterative Statement (For While Do While.).
8. Write a program in C for Transpose of matrix.
9. Write a program in C for Matrix Addition and Multiplication.
10. Write a Program in C for Binary Search.
11. Write a Program in C for Linear Search.
12. Write a Program in C for Bubble Sort.
13. Write a Program in C for Insertion Sort, Selection sort.
14. Write a program in C to find a root of non-linear equation by using Newton Raphson method.
15. Write a program in C to implement Euler modified method.
16. Write a program in C to find a root of a quadratic equation using Muller method.
17. Write a program in C to implement Runga-Kutta method.
18. Write a program in C to implement Gauss-Seidal method
19. Write a program in C to find out equation dy/dx=x+y by using Euler method.
20. Write a program in C to implement Taylor's series.
21. Write a program in C to calculate coefficient of regression.
22. Write a program in C to implement Regula Falsi method.
23. Write a program in C to implement Simpson's 1/3 rd rule.
24. Write a program in C to implement Bisection Method.

Subject : BTCHT 407P (BGE) **Inorganic Process Technology (Practical)**

Practical : 3 Hours No. of Credits : 2

University : 25 Marks College Assessment: 25 Marks

Duration of Examination : 4 Hours

LIST OF EXPERIMENTS

1. To Prepare the Crystals of Chrome alum.
2. To estimate the amount of impurities in a given sample of common salt.
3. To purify the given sample of Common salt.
4. To Prepare Mohr's salt.
5. To Prepare Cuprous Chloride .
6. To estimate the % available Chlorine in a given sample of Bleaching powder.
7. To Prepare the Crystals of Sodium Thiosulphate.
8. To analyse the pigment Red Oxide.
9. To Prepare the Crystals of Ferrous Sulphate from Kipp's apparatus waste.
10. To estimate Sulphate in a given Solution by EDTA method.
11. To estimate the amount of MnO_2 and available Oxygen in the given sample of Pyrolusite.

Subject : BTCHT 408P (BGE) **Machine Drawing (Practical)**

Practical : 3 Hours No. of Credits : 3

University : 25 Marks College Assessment: 25 Marks

Duration of Examination : 6 Hours

LIST OF EXPERIMENTS

1 ISI Conventions covering the standard practice in Machine Drawing and also use of ISI specifications for limits and fits.

2 Simple exercise in converting pictorial and isometric views into other graphic projections. Sectional views and missing views preparation details and assembly drawing of simple machine parts from actual models.

3 Preparation of free hand proportionate dimensioned sketches of various machine elements such as:

Screw threads and fasteners such as nuts, bolts, studs, locking arrangements, foundation bolts, etc.

i. Rivets and riveted joints, welded joints.
ii. Keys, cotters and couplings.
iii. Cottered joint and knuckle joint
iv. Engine and machine bearing mounts
v. Bearings and bearing mountings
vi. Different types of valves.

4 Preparation of working drawings, part lists and assembly drawings of simple machine assemblies.

Subject : BTCHT 408P (BGE) **Applied Physical Chemistry II (Practical)**

Practical : 3 Hours No. of Credits : 2

University : 25 Marks College Assessment: 25 Marks

Duration of Examination : 4 Hours

LIST OF EXPERIMENTS

1. To study the $KI_3 \rightarrow KI + I_2$ equilibrium in aqueous solution.
2. To study the ternary system of Toluene-Acetic acid-water
3. To study the adsorption of acetic acid on charcoal and verify the Freundlich adsorption isotherm
4. To determine the heat of crystallization of $CuSO_4 . 5H_2O$.
5. To determine the integral and differential heats of solution of a salt.
6. To determine the thermometric titration curve in the neutralization of strong and weak acids against a strong base.
7. To find the constant of conductivity cell and hence determine the dissociation constant of a weak acid.
8. To determine the solubility of sparingly soluble salts conductometrically
9. To find the pH of buffers and the dissociation constant of an acid using Quinhydrone electrode.
10. To determine the transport number by the e.m.f. method.
11. To study the kinetics of saponification of methyl acetate by sodium hydroxide by conductometry.