# Syllabus of 2nd Year B.Tech. Chemical Engineering and Chemical Technology

**BSL- 201 MATHEMATICS –II** **Theory 4 Hour/ Week, Credits – 4**

**Unit -1 Fourier series**

Definition of Fourier series, Full Range Fourier series on $-\pi \le x \le -\pi$ and $0 \le x \le 2\pi$. Full Range Fourier series on $-l \le x \le -l$ and $0 \le x \le 2l$, Half Range Fourier series on $0 \le x \le \pi$ and $0 \le x \le l$ (10)

**Unit -2 Multiple Integrals with Applications**

Introduction to Coordinate Systems; Double Integration; Triple Integration; Applications to Volume (10)

**Unit -3 Vector Calculus**

Definition, Physical meaning of Vector Differentiation; Tangential and Normal Components of Acceleration; Vector Differential Operator Del; Gradient of Scalar Point Function; Directional Derivative and Maximum Directional Derivative; Divergence and Curl of Vector Point Function ; Irrotational and Solenoidal Vector Fields (10)

**Unit -4 Linear Differential Equations with Constant Coefficients**

Linear differential equation of order n; Solution of LDE with constant coefficients
Method of Variation of Parameters; Cauchy's Linear Equation ; Legendre's Linear Equation. (10)

**Unit -5 Laplace Transform**

Definition of Laplace Transform ; Properties of Laplace Transform, Initial and Final Value Theorem; Laplace Transform of Some Standard Functions; Problems based on Properties and Theorems of Laplace Transform; Definition and Properties of Inverse Laplace Transform ;. Inverse Transform of Some Standard Functions; Problems based on Properties of Inverse Transform, Partial Fraction Method; Convolution Theorem; Applications to the Solution of LDE. (10)

Reference Books

1. Advanced Engineering Mathematics: H.K. Das, S. Chand Publication Ltd.
2.Higher Engineering Mathematics: B.S.Grewal, Khanna Publication
3.Applied Mathematics: P.N. Wartikar and J.N. Wartikar, Pune Vidhayrthi Griha Prakashan Pune

**BSC- 202 : ORGANIC CHEMISTRY-II** **Theory 4 Hour/ Week, Credits – 4**

**UNIT 1 :**

Aromaticity and aromatic Character. Properties of aromatic compounds, Huckel's rule, Resonance, resonance energy, structure of benzene and benzenoids, non-benezenoid aromatic compounds.
Orienting influence of different substituents-charge distribution method and stability of the intermediate method. Mechanism of aromatic, electrophilic substitution reaction. Friedel-Crafts alkylation and acylation, fires rearrangement, formulation reactions- Gattermann-koch, Gattermann vilsmeier, Reimer- Tiemann reactions. **(10)**

**UNIT 2 :**

Halobenzenes : Nitration reaction, reagents and conditions used ,uses of nitrocompounds.
Aromatic amines : Introduction of-NH2 group in an aromatic ring, basicity correlations, Diazotisation of aromatic primary amines. Reactions of aryl diazonium salts-Sandmeyer, Gattermann, Azocoupling reaction, Ullmann reaction, deamination reaction, Azo dyes, benzidine rearrangement. **(10)**

**UNIT 3 :**

Blanks chlromethylation reaction, Kolbe reaction, Mannich reaction, Claisen rearrangement. Aromatic sulphonic acids: Sulphonation reaction-mechanism and reagents used, Kinetic and thermodynamic control

of a reaction, uses, SO3H group as a blocking group, as solubilising acidic group and its conversion to-OH group. **(10)**

**UNIT 4 :**

Phenols: Acidity of phenols, preparations of phenols, condensation polymerization and phenol-formaldehyde resins. Heterocyclic compounds : Nomenclature, structure, aromaticity, preparation and reaction of pyridine, pyrrole, furan and thiophene. Preparations of quinoline and isoquinoline. **(10)**

**UNIT 5 :**

Spectroscopy. Ultraviolet spectroscopy. Basic principles chromphore-auxo-chrome concept, effect of conjugation and solvent on peak position, applications. Infrared spectroscopy. Basic principles, selection rule, identification of functional groups, applications. NMR-spectroscopy: Basic principles, chemical shift, spin-spin splitting, anisotropic affects, and applications. **(10)**

REFERENCE BOOKS:


1. Organic Chemistry Vol.I&II I.L.Finar
2. Organic Chemistry Morrison and Boyd
3. Organic Chemistry S.H.Pine
4. Organic Reaction Mechanism Sing and Mukherji
5. Spectroscopy of Organic Compounds P.S.kalsi


**ORGANIC CHEMISTRY -II Practicals 3 Hour/ Week, Credits – 1.5**

1. QUALITATIVE ANALYSIS OF ORGANIC BINARY MIXTURES
   Solid-solid and solid –liquid through
   separation
   elemental analysis,
   group detection,
   physical constant (m.p./b.p.) (minimum 06mixtures)

2. ORGANIC ESTIMATIONS/DETERMINATIONS (any two)
   I) Estimation of Amide by hydrolysis
   ii)Estimation of Ester by hydrolysis
   iii) Estimation of Sugar by alkaline Cu reagent
   iv)Determination of molecular weight of a monobasic /dibasic acid by volumetric method.

**REFERENCE BOOK:**


Organic Qualitative Analysis and Separation Kulkarni and Pathak
Practical Chemistry Prof.R.B.Gujrathi, Prof.V.S.Zope
Practical Chemistry Prof.R.B.Gujrathi, Prof.A.P.Rajput


**ESC – 201 : APPLIED & STRUCTURAL MECHANICS Theory- 4 Hour/ Week, Credits – 4**

**UNIT - I**

Coplanar forces, Equivalent system, Conditions of equilibrium. Support reactions for determinate beams and trusses. Forces in members of pin joined plane trusses. Forces in cables and simple mechanisms.
Centroid and centre of gravity.
Friction : Laws of friction, Problem on block friction, wedge friction, belt friction and screw friction . (Excluding rolling pivot and journal friction). (10)

**UNIT – II**

Various types of stress and strains. Relation between elastic constants. Introduction to temperature stresses. Problems on simple and composite sections, Concept of shear stress distribution.

Concept of slope and deflection of beam. Standard cases of slope and deflection by Moment-area Method and mathematical method. Simple problems. (10)

**UNIT – III**

Shear force and Bending moment diagrams for cantilever and simply supported beams (with or without overhang). Theory of bending: Concept and problems. Thin and thick cylinders. Problems on thin cylinders and spheres. (10)

**UNIT – IV**

Torsion of a circular shaft. Transmission of Power-Close coiled Helical spring. Concept and derivation only. Simple problems.

Short and long columns and struts. Standard cases with axial load. Euler's and Rankine's formulae. (without Derivations) (10)

**UNIT – V**

**Dynamics:** Kinetics of particles and rigid bodies - Force, mass and acceleration., Kinetics of particles and rigid bodies - Work and Energy., Kinetics of particles and rigid bodies - Impulse and momentum. (10)

**REFERENCE BOOKS**


1. Applied Mechanics and Strength of Materials : I.B. Prasad.
2. A text Book of Engineering Mechanics :R. S. Khurmi.
3. Strength of Material : Ramamrutam.
4. Strength of Materials : R S Khurmi.


**APPLIED & STRUCTURAL MECHANICS Laboratory 2 Hour/week credit - 1**

Universal Force Table, roof truss apparatus, fractional plane. Reactions in beam, both simply supported and overrunning. Link polygon, B.M. apparatus. Simple machine like Screw Jack or Wheel and axle.

**HML-201 INDUSTRIAL MANAGEMENT AND ECONOMICS Theory 4 Hour/ Week, Credits – 4**

**Unit-1**

Introduction: Meaning, management and administration, Functions of Management- Planning, Organising, Scheduling, Staffing, Co-ordinating, Motivating, Leading & Controlling

Functional areas of Management- Production, Materials, Finance, Personal & Marketing management; Concept of Productivity, Wages & I salary management; Production Planning & Control, Quality control, Preventive, Maintenance. (10 Hrs)

**Unit-2**

Types of management. Different approaches to Management, evolution of Management, functional areas of management, forms of Business Organisations. Production Management: Work study, Productivity Measurement, compensation and incentives, Materials Management, Inventory analysis. Financial management: capital structure, sources of Industrial finance including institutional finance. (10 Hrs)

**Unit-3**

Marketing Management: Consumer satisfaction, management of sales and advertising, Marketing research. Personnel Management and Industrial Relations. Quality Management techniques, entrepreneurship

development. Management Information System & Information Technology in Management. Cost analysis. cost statement/sheet, cost control, cost projections (10 Hrs)

**Unit-4**

Nature & Significance of Economics, Basic problems of economics, Introduction to Macro & Micro Economics; Demand & Supply; factors of market economy; Money, Functions of Money; Banking- Types anf functions, Commercial & Central Banking, Role of RBI (10 Hrs)

**Unit-5**

Indian Economy- Liberalization, Privatization and Globalization. Mixed economy, Public Sector reforms, National income determinants, Economic Planning, Nature & Characteristic of Entrepreneurship, Small Scale Industries- The start up Process of SSI (10 Hrs)

**Recommended Books**

1. Principles & Practice of Management – by R. S. Davar
2. Industrial Organisation & Management – by Banga & Sharma
3. Managerial Economics – by D. N. Dwivedi
4. Entrepreneurship & Small Scale Business/Industries – by Vasant Desai.
5. Varma & Dewett: Economic Theory.
6. Herald Koont and Cynl O'Donnell: Management – A Systems & Contingenen Analysis.
7. Paul A Samulsen - Fundamentals of Economic.
8. A.N. Agrawal - Indian Economy.
9. Dr.S.C.Sexena - Principales and Practice of Business Administration.
10. Indian Economy – By Mishra and Puri
11. Personnel Management By P. Subbarao
12. Financial Management By Ravi M. Kishor

# Chemical Engineering (CH) Core

**CHL-201 INTRODUCTION TO CHEMICAL ENGINEERING Theory 4 Hrs/ Week Credit : 4**

**Unit I**

Definition of chemical engineering (AIChE), History of chemical engineering, Introduction: Unit operations, units and dimensions, role of chemical engineer in chemical industry, Symbol of various unit operations. (10)

**Unit II:**

Introduction: Equipments used in chemical industry, Plant utility line diagram for various chemical processes. Basic laws: Newtons law, Ideal gas law, Raults law, Boyls law, Daltons law, Henrys law, Pascals law. (10)

**Unit III**

Basics fundamentals and application of heat, mass & momentum transfer, Introduction to different modes of heat transfer (conduction, convection, radiation) and heat exchangers, Introduction to mass transfer (diffusion, absorption, adsorption, distillation, extraction, crystallization and drying), Introduction to momentum transfer: various fluids and fluid properties, fittings, valves, pumps and compressors. (10)

**Unit IV**

Safety Management: -General Principles of Management, Need for safety – Humanitarian, economics, Legal & Social considerations, Role of management in Industrial Safety. Safety Management – Principle & practices.

**Definitions: -**Incident, Accident, Injury, dangerous occurrences, Unsafe acts, Unsafe conditions / hazards. Principles of accident prevention – theories / models of accident causation.

**Safety Education & Training: -**Elements of training cycle, employees participation, safety promotions & publicity. Safety suggestion scheme, safety competitions, Safety incentives scheme. Audiovisuals methods.

**Safety Engineering:** Principles, incidental safety devices.

**Safety at work station & Plant layout:** Plant layout & work station design, Improving safety & Productivity through plant layout & work station designs. Technical & engineering control measures. Preventive maintenance in safety. Importance of standards & codes of practices for plant & equipment. (10)

**Unit V**

**Acts & Rules:**

The Factories Act 1948 & Factories rule 1963: Safety related provision. ESI & Workmen compensation Act & rules. Indian Boiler Act & Regulations, Explosive Act, Petroleum Act, Gas Cylinder Rules, SMPV Rules. Environment Protection Act – Water & Air Act, MSIHC rules.
Regulation laws for quality control & environment protection
Laws and definition of ISO 14000, ISO 18000, cGMP guidelines (10)

**Referance Books:**


1. Introduction to Chemical engg.by Bredger and branzo
2. Unit process and unit operation by Drydon
3. Industrial safety / Safety Management. K.G. Mistry
4. Safety Management, Grimaldi and Siemans.
5. IS 14489 on safety Audit.
6. Factories Act 1948.


**CHC- 202 MECHANICAL OPERATION Theory- 4 Hour/ Week, Credits – 4**

**UNIT- I**

Properties & Handling of Particulate Solids: Particle size, shape; mixed particle size & size analysis, specific surface of mixture, average particle size; properties of particulate masses; storage of solids. types of conveyers, elevators & their design. Size Reduction: Size reduction equipments for coarse, intermediate & fine size reduction; energy & power requirement; open & closed loop circuit. (10)

**UNIT - II**

Screening: Equipment, ideal screen. Screen analysis methods & std. screen series; capacity & effectiveness of screen. Mixing of Solids & Pastes: Mixers for coasive solids,
free flowing solids, paste & plastic masses, power requirement, mixing effectiveness by mixing index calculation, rate of mixing. Mixing & Agitation of Liquids: Agitation equipment & flow pattern; circulation velocities & power consumption in agitated vessel; blending & mixing. (10)

**UNIT -III**

Flow Past Immersed Bodies: Drag coefficient, Stokes law, Cozeny- Carman equation. Flow of Solids Through Fluids: Maximum settling velocity, free & hindered settling conditions. Fluidization: Minimum fluidization velocity, types of fluidization, application of fluidization in catalytic cracking, drying, etc.; fixed bed, spouted bed system. (10)

**UNIT - IV**

Classification & Sedimentation: Clarification & thickening, separation ratio; equipment for centrifugal & gravity classification; cyclone separator & design; hydrocyclones; principle of jigging, tabling, magnetic & electrostatic separation. Gravity sedimentation; laboratory batch & continuous sedimentation, centrifugal sedimentation. (10)

**UNIT -V**

Filtration: Filter aids, classification of filters, selection of filter media. Principle of batch filtration: constant pressure & constant rate filtration, factors affecting filtration. Continuous, centrifugal, vacuum, gravity filtration & related equipments. Washing of filter cake. (10)

**MECHANICAL OPERATION Laboratory 3 Hour/ Week, Credits – 1.5**

Minimum 8 Experiments based on 1. Grinding efficiency, 2. Law of crushing, 3. sieve analysis, 4. Efficiency of screening, 5. Sedimentation, 6. filtration, 7. Cyclone separators, 8. Fluidisation, 9. Mixing etc., 10. Stock law and 11. Properties of solids.

**REFERENCE BOOKS**

1. Mc Cabe W. L. & Smith J. C. " Unit Operation for Chemical Engg." 5th Edt.
2. Coulson J. M. & Rechardson J. F. " Chemical Engg.- Vol. II"
3. Badger W. L. & Banchero J. T. " Introduction to Chemical Engg."
4 Narayan & Bhatacharya " Mechanical Operation In Chemical Engg."
5 P. Chattopadhaya " Unit Operation In Chemical Engg. Vol. I "
6. G. G. Brown " Unit Operations"

## CHC - 203 MOMENTUM TRANSFER Theory- 4 Hour/ Week, Credits – 4

**UNIT I**

Fluid Properties : Definition of fluid. Viscosity concept, properties of fluid like mass, density, specific weight, specific volume, vapour pressure, compressibility, elasticity, surface tension and capillarity. Types of fluids, Compressible and incompressible, Newtonian and Non-Newtonian

Pressure measurement: Fluid Pressure at a point, Pascal's Law, Hydrostatic Equilibrium, Atmospheric, Gauge, Absolute and Vacuum Pressure. Measurement of pressure.

Hydrostatics: Total Pressure and Centre of pressure, Total pressure on a plane surface, Buoyancy, Buoyant Force, Centre of Buoyancy , Metacentre and Metacentric height, Stability of floating and submerged bodies. (10)

**UNIT II**

Kinematics of Flow**:** Velocity concept, Types of flows **(**Laminar-turbulent, steady-unsteady, two and three-dimensional flows, Uniform –Non uniform, Rotational – Irrotational Flows.) Continuity Equation. Acceleration concept.

Dynamics of Flow: Nature and mechanism of fluid flow, Euler's equation of motion Bernoulli's equation for different conditions. Applications of Bernoulli's Equations to Flow measurement (Flow meters)

Momentum changes in fluid in a bend . Notches and Weirs. (10)

**UNIT THREE**

Flow Through Pipeline System: Reynold's Experiment, Laws of Friction, Major Losses, and Friction factor chart, Effect of heat transfer on friction factor, Minor losses. Distribution of flowing fluids through branched pipes. Hydraulic Gradient Line and Total Energy Line.

Laminar Flow: steady laminar flow in circular pipes (Hagen Poiseuille equation), through annulus, parallel plates, around a sphere (Stoke's law), relations between

shear and pressure gradient, average velocity and maximum velocity, momentum correction factor.

Turbulent flow: velocity distribution in turbulent flow in pipes, hydro dynamically smooth and rough boundaries, velocity distribution equation in turbulent flow in terms of mean velocity for smooth and rough pipes, resistance to flow of fluid in smooth and rough pipes, variation of frictional factor for commercial pipes, types of problems in pipes designs. (10)

**UNIT IV**

Boundary Layer Theory: The thickness of boundary layer Boundary Layer growth along a thin flat plate (definition and formulae only). boundary layer equations laminar and turbulent boundary lever , Boundary layer in straight tubes, Boundary layer on rough surfaces, Separation of Boundary Layer, Methods of controlling the Boundary layer.

Dimensional Analysis: Dimensional Analysis, fundamental dimensions, units of various quantities used in fluid mechanics. Buckingham's Pi theorem. Dimensionless numbers, application to fluid flow problems. (10)

**UNIT V**

Pumping of fluids : Pumping equipments for liquid. The reciprocating pump, positive displacement, Rotarypumps, Centrifugal pumps, design and operating characteristics, NPSH calculations, Air lift pump.
Pumping Equipment for gases: Reciprocating piston compressors, Rotary blowers and compressor, Centrifugal blowers and compressor including turbo compressor, vacuum producing equipments.
Power required for Compression of gases: Clearance volume, multi-stage Compressor efficiency. The power requirement for pumping through pipeline for liquids and gases. (10)

**MOMENTUM TRANSFER Laboratory 3 Hour/ Week, Credits – 1.5**

1. Determination viscosity
2. Study of different types of manometers.
3. Verification of Bernoulli's Theorem
4. Venturimeter.
5. Orificemeter
6. Notch or Weirs
7. Study of flow through pipe fittings
8. Verification of Darcy's law.
9. Characteristics of Centrifugal pump.
10. Flow of gases through pipes (Study of Friction factor versus Reynolds' number)
11. Reynolds' Experiment
12. Study of different types of compressors (Minimum Eight experiments

**REFERENCE BOOKS**

1. Momentum Transfer : Vyas.
2. Momentum Transport Operations: Gupta.
3. Hydraulics and fluid mechanics : Dr. P.N. Modi & S.M.Seth
4. Unit Operation : P. Chattopadyaya
5. Fluid Mechanics: R.K. Bansal

**CHL – 204 : PROCESS CALCULATION Theory- 4 Hour/ Week, Credits – 4**

**UNIT I**

Units and dimension : Basic and derived units, dimensional analysis, dimensional and empirical equations, different ways of expressing units of quantities and physical constants.
Properties of gases, liquids and solids : Ideal and real gas laws, critical properties, properties of mixtures and solutions and equilibrium. (10)

**UNIT II**

Stoichiometry and unit operations:
Introduction to unit operation and material balance, blending ,evaporation ,crystallization, extraction and leaching, distillation, absorption & stripping, drying. (10)

**UNIT III**

Material balance involving chemical reaction

Introduction, definition of terms, material balance for chemical reactions concept of limiting & excess component . (10)

**UNIT IV**

**Humidity & energy Balance**

Humidity: terms, Humidity charts, and problems,

Energy balance: heat of reaction, combustion of formation , heat capacity & effect of pressure and temperature, heat capacity of gaseous mixture .energy balance for system. (10)

**UNIT V**

Recycle : Bypass operation & Material balance for them.

Combustion: Introduction, fuels, C.V. of fuels combustion calculation. (10)

**REFERENCE BOOKS**


1. Chemical Process Principles : O.A. Hougen, K.M. Watson, R.A. Regalz.
2. Industrial Stoichiometry : W.K. Levis, A.H. Radash, H.C. Lewis.
3. Process Calculations for Chemical Engineering : Durgaprasad Rao, D.V.S. Murthy.
4. Stoichiometry: Bhatt and Vora
5. Process Calculations : Himmablue
6. Process Calculation: S. L. Pandharipande


**CHL: 205 CHEMICAL ENGINEERING THERMODYNAMICS Theory- 4 Hour/ Week, Credits 4**

**UNIT –I**

Basic concepts of thermodynamics like temperature, energy & Zeroth law.

First Law of Thermodynamics: Thermodynamic analysis of control volume & Steady- state flow processes, concept of work & enthalpy.

Second law of Thermodynamics: Kelvin Planck & Clausius statements, Introduction & efficiency calculation to heat engine, heat pumps, Refrigeration cycle & Carnot cycle. Concept of entropy, calculation for entropy changes. Third law. [ 10 hrs ]

**UNIT – II**

Properties of Pure Substances: T-V, P-V, P-T diagram. Ideal gas law, compressibility factor, principle of corresponding state, Van der waals equation, Viral equation, Redlich Kwong equation, Redlich Kwong Soave equation of state, generalized correlations.

P-V-T relation for isothermal, isobaric, isochoric, adiabatic & polytropic processes. [ 10 hrs ]

**UNIT – III**

General Thermodynamic Property Relations: Residual properties Mathematical preliminaries on partial derivatives & associated relations, reciprocity & cyclic relations: The Maxwell relations, Gibbs & Helmotz relations, the Clapeyron equation. The general relations for du, dh, Cv, & Cp; Mayer relation.

Isothermal compressibility, volume expansivity, coefficient of linear expansion, adiabatic compressibility & adiabatic bulk modulus.The Joule Thomson coefficient. [ 10 hrs ]

**UNIT – IV**

Solution Thermodynamics& Phase Equilibria: Chemical potential, partial molar properties, Gibbs/Duhem equation, ideal gas mixtures, Kay's rule, real gas mixtures, fugacity coefficient for pure substances & for species in solution, generalized correlation for fugacity, ideal gas solution, excess properties, activity & Data reduction for VLE system (low pressure), Consistency test, models for the excess energy like Margulus equation Van Laar equation & Wilson equation, etc.

Dew point & Bubble point calculations for VLE system (low to moderate pressure), modified Roult's law. [ 10 hrs ]

**UNIT – V**

Chemical Equillibrium: Chemical equilibrium criteria, Equillibrium constant for ideal & real gas mixtures, chemical equillibria for simultaneous reactions, Effect of temperature on equilibrium constant, various factors affecting equilibrium constant. [ 10 hrs ]

References:


1. Introduction to Chemical Engg. Thermodynamics Fifth Edition by J.M.Smith
2. Fundamentals of Engg. Thermodynamics, by E.Rathakrishnan
3. Thermodynamics – An Engg. Approach, Third Edition by Yunus A. Cengel & Michale A. Boles.
4. Chemical Engg. Thermodynamics by Y.V.C.Rao.
5. Chemical Engg Thermodynamics by Daubert.


**CHC – 206 : HEAT TRANSFER** **Theory- 4 Hour/ Week, Credits – 4**

**UNIT I**

Concept of heat transfer and transport of heat,Fouriers law significance of thermal conductivity of solid liquid and gases, heat transfer trough plane &composite wall, sphere and cylinder, problem related to this cases

Differential equation of heat conduction, lagging of pipes and other equipment, optimum lagging thickens, critical radius of insulation. Heat transfer from extended surfaces (fins), fin effectiveness. (10)

**UNIT II**

Convection: Individual and overall heat transfer coefficients. natural and forced convection, laminar and turbulent flow, significance of dimensional numbers, dimensional analysis and heat transfer analogy , Flimwise and dropwise condensation, Problem based on film wise condensation and dropwise condensation (10)

**UNIT III**

Concept of condensation and boiling, their types, condensation from horizontal and inclined surface, Nussult equation.

Evaporation : Heat transfer to vaporization processes. Single and multiple effect evaporations. B.P.R. and hydrostatic head, Economy and capacity of evaporator. Problem based on single effect evaporator (10)

**UNIT IV**

Radiation : laws of radiation, radiation from solid surfaces types of surfaces. Heat exchange by radiation between two finite black surfaces, between two infinite parallel surfaces, shape factor. Laws of shape factor, Solid angle and radiation intensity, Green house effect. Electrical analogy of radiation shield. (10)

**UNIT V**

Heat Exchangers: classification overall heat transfer coefficient, fouling factor LMTD in single pass parallel, counter and cross-flow arrangements. N.T.U – effectiveness method for parallel and counter flow heat exchangers general Design aspect of heat exchangers. Problem based on LMTD AND NTU effectiveness method (10)

**REFERENCE BOOKS**


1. Engineering Heat Transfer : Gupta & Prakash
2. Problem on Heat Transfer : P. Chattopadhya
3. Heat Transfer : D. S. Pavaskar
4. A text book of Heat Transfer : Sukhatme S.P.
5. Chemical Engineering Vol. 1 and 2 : Richradson & Coulson
6. Principles of Heat and Mass Transfer : S. D. Davande

**HEAT TRANSFER** **Laboratory 3 Hour/ Week, Credits – 1.5**

1. To determine thermal conductivity of metal bar.
2. To determine thermal conductivity of an insulating material
3. To determine heat transfer coefficient by natural and forced convection.
4. To determine heat transfer coefficient in shell and tube type heat exchanger.
5. To determine heat transfer coefficient in double pipe heat exchanger.
6. To determine efficiency of pin fin.
7. To determine the critical heat flux.
8. To determine Stefan Boltzaman's constant.
9. To determine the emissivity of aluminum plate.
10. To study dropwise and filmwise condensation
11. Study of evaporators.
12. Study of different types of heat exchangers.
    (Minimum eight experiments)

**CHL – 207 CHEMICAL PROCESS TECHNOLOGY Theory- 4 Hour/ Week, Credits – 4**

**Unit – I**

Salient features of manufacture commodity chemicals , status of chemical industry in India , Current trend in chemical industry. Water for industrial use, sources of impurities , methods of softening , treatment for boiler feed water (10 hrs)

**Unit –II**

Engineering aspect of manufacture of basic inorganic chemicals such as sulphuric acid, caustic soda, soda ash, chlorine, ammonia, nitric acid and urea (10 hrs).

**Unit –III**

Introduction to petrochemicals, physical and chemical properties of petrochemicals, classification of petrochemicals, crude types and properties, concept of onshore and offshore drilling, desalting of crude and feed preparation. (10 hrs)

**Unit –IV**

Fluidized bed and catalytic cracking, thermal and hydrocracking, reforming, alkylation, isomerization, polymerization of petrochemicals, study of linear alkyl benzene, aromatic compounds, and separation techniques. (10 hrs)

**Unit –V**

Engineering aspect of the manufacture with alternative routes for basic organic chemicals such as aldehydes, ethylene, other olefins, acetylene, butadiene, phenols, amines, alcohols, carboxylic acids, esters, ketones, and ethylene oxides. Classification, sampling, analysis and selection of coal, carbonization and complete gasification of coal. (10)

**References Books**:


1. Unit Processes in Organic Synthesis: Groggins
2. Industrial Chemicals : Faith
3. Chemical Process Industries: Shrieves
4. Outlines of Chemical Tech0nology : Dryden
5. Petroleum Refining: Ram Prasad

# Food Technology (FT) Core

**FTC 201 : FOOD CHEMISTRY** **Theory 4 Hrs/week Credits- 4**

**UNIT I**

Origin of life, history of food chemistry, development of food chemistry, structure of cell. Importance of water in food, water activity, chemistry of water, structure of ice, concept of free and bound water and their implication. (10)

**UNIT II**

**Chemistry of Carbohydrates:** Nomenclature, classification, structure, chemical reactions of carbohydrates, physical and chemical properties of sugar, sensor properties of sugar, interaction with other food components, pectic substances, gums and other polysaccharides.

**Chemistry of Proteins:** Nomenclature, Classification, Structure and chemistry of amino acids, proteins, Sources and distribution of proteins, Isolation identification and purity of proteins, denaturation, physical ad chemical characteristics of proteins, Importance ad applications of proteins in food industry. (10)

**UNIT III**

**Chemistry of Lipids:** Definition, nomenclature, classification of lipids, chemistry of fatty acids and glycerides, physical and chemical characteristics and processing of fats and oils, hydrogenated fats, shortening agents, confectionery fats etc., rancidity of fats and oils, its prevention and antioxidants, fat replacer, emulsions and emulsifiers. (10)

**UNIT IV**

**Enzymes:** Introduction, Nomenclature, Classification, Specificity, Assay technique, Isolation and Purification of enzymes and their importance.

Papain, Glucose Oxidase, Phenol Oxidase, Amylase, Pectic and lypolytic enzymes.

Browning reaction in foods, Enzymatic and non-enzymatic and their control, advantages and disadvantages. (10)

**UNIT V**

**Analytical Techniques:** Physical properties of food systems, Colloidal properties, Viscosity, Sensory perception of taste, Flavor, Aroma and Texture.

Introduction, definition, functions, legislation and testing for additives, nutritional supplements. (10)

**BOOKS RECOMMENDED**


- Principles of Food Science, Vol. II by G. Borgstrom, McMillan Co. Ltd., London
- Encyclopedia of Food Science, Food Technology and Nutrition by Macrae, Robinson and Sadler
- Encyclopedia of Food Science, by G. D. Raj
- Mechanism and Theory in Food Chemistry, Wong, DWS., AVI Publishers, N. York.
- Biophysical Chemistry by Upadhyay and Nath, Himalaya Publ. Bombay.
- Essential of Food Science, Vaclavik V., Chapman and Hall, N. York


**FOOD CHEMISTRY** **Practical 3 Hrs/week Credits- 1.5**

Sampling and analysis of food constituents for carbohydrates( total carbohydrates and reducing sugars), proteins, lipids/ fats, moisture, ash, crude fiber, titrable acidity etc. Water, evaluation of quality of waters for potable purposes and for use in food industry, sanitary examination

Physical characteristics: colour, odour and taste, turbidity and

Chemical characteristics: total solids, organic matter,hardness, alkalinity, acidity, pH, nitrogen, chlorides, sulfates, free $CO_2$, oxygen absorption, heavy metals.

Analysis of Vitamins, Minerals, Coloring and Flavoring principles.
Identification and estimation of additives, toxic metals and chemicals in commercial food samples.
Technique for separation and identification and estimation of mixed food constituents, interpretation of results on the basis of legal standards.

**FTC - 202 : FOOD BIOCHEMISTRY AND NUTRITION Theory 4 Hrs/week Credits- 4**

**Unit I**
Enzymes:
Specificity of enzymes kinetics, Activation and inhibitors, Technique of immobilization of enzymes, Assay techniques, Isolation of enzymes from natural sources and their applications, Different inhibitors. (10)

**Unit II**

Microorganism Cell and Cellular Structure: Cell membrane, Structure ad transport mechanism, Bioenergetics: Generation of high energy phosphates and their importance, Photosynthesis. (10)

**Unit III**

Digestion of foods and metabolism of carbohydrates, Metabolism of lipids ad proteins, Anti-nutritional factors in food, Toxic compounds, Nucleic acid and their function. (10)

**Unit IV**

**Nutrition:** Function of food, energy value of food, BMR and its measurements, Energy requirement for individual, Nutritional evaluation of proteins, Recommended dietary allowances of proteins, fats and carbohydrates, Nutritive value of food, Balanced diet.
**Loss of Nutrients**: Loss of nutrients during processing, enrichment and fortification, formulation of diets for school going and pre school childrens (10)

**Unit V**

**Vitamins:** Classification, Sources, function and chemistry, deficiency symptoms, Assay of vitamins. Explain Vitamins A, Vitamin B, Vitamin C,. Vitamin K , Vitamin D,. Vitamin E etc.,
**Minerals**: Macro and micro minerals, Sources, function and deficiency symptoms. Explain different minerals used in food industry. (10)

**FTC 202 : Biochemistry Practical 6 Hrs/week Credits- 3**

Model experiments for selection and purification of enzymes, study of enzyme action and kinetics to illustrate substrate specificity, types of inhabitation.
Assay of vitamins in biological materials using spectrophotometric, Calorimetric, Microbiological and animal assay methods, Selected experiments involving use of paper, column and their layer chromatography, paper and gel electrophoresis etc., in biochemical analysis.
Analysis of body fluids and tissues. Determination of trace elements in living tissues.

# Oil Technology (OT) Core

**OTC-201 CHEMISTRY AND TECHNOLOGY OF OILS AND FATS Theory 4 Hrs/week Credits- 4**

**UNIT I**
General introduction to oils, fats, waxes and essential oils and their sources. Structure and composition of oils, fats, glycerides and fatty acids, their nomenclature, classification and principle sources.

Theories of glyceride structure, effect of fatty acid distribution on physical properties. Status of production of commercial oilseeds, oil bearing materials, oils and fats. Comparative statistics of Indian as well as World production, Export and Import. (10)

**UNIT II**

Non-glyceride constituents of natural oils and fats, phosphatides, sterols, hydrocarbons, constituents imparting color, odor and stability, toxic constituents etc. (10)

**UNIT III**

Physical characteristics of natural oils, fats and their fatty acids, oiliness and viscosity, density and expansibility, melting point, thermal properties, smoke, fire and flash point, stability and miscibility, refractive index and molecular refraction, adsorption spectra, electrical properties, color value.

Chemical characteristics: Acid Value, Saponification Value, Acetyl and Hydroxyl Value, Richert Missel and Polanske values and Kirschner value, Peroxide value, Diene value, Thyocyanogen value, etc. (10)

**UNIT IV**

Neutralization, hydrolysis, saponification, esterification and hydrogenation: Reactions and their industrial applications.

Reaction of fats and Fatty acids,: interesterification, acylation, formation of metallic soap, pyrolysis, halogenations, Diels-Alder reaction, miscellaneous addition reactions to double bond and chemical oxidation, etc. (10)

**UNIT V**

Autoxidaton and rancidity, Mechanism of rancidification, general characteristics of fat oxidation, antioxidants, prooxidants and synergists. Method for determination of auto oxidation, flavour reversion.

Common adulterants in vegetable oils, Methods of their detection. (10)

**OTC-201 CHEMISTRY AND TECHNOLOGY OF OILS AND FATS Practical 3 Hrs/week**
**Credits- 1.5**

a) Analysis of oilseeds and oil bearing materials for following:
   Moisture content, oil content, protein content, fiber content, ash content etc.
b) Determination of physical characteristics of oils and fats derived from oilseeds and cake:
   Refractive index, color, specific gravity, titre, melting point, gel test, cloud point,
c) Determination of chemical characteristics of oils and fats derived from oilseeds and cake: Acid value, saponification value, Iodine value, hydroxyl value, Acetyl value, peroxide value, Anisidine value, R.M., P and K value, Diene value, thicocynagen value etc.

**OTC-202 POST HARVEST TECHNOLOGY OF OIL BEARING MATERIALS**
**Theory 4 Hrs/week Credits- 4**

**UNIT I**

Plant based oil bearing materials, their production, composition, characteristics, fatty acids and glyceride composition: Coconut, Palm kernel, Cottonseed, Groundnut, Olive, Palm, Sunflower Safflower, Sesame, Corn, Mustard, Rapeseed, Linseed, Soyabean etc. (10)

**UNIT II**

Sources utilization, characteristics and composition of the following:

Rice bran, Tung, Jatropha, Castor, Neem, Mahua, Kusum, Karanja, Sal, Mangokernel, Dhupa, Kokum, Palash etc. Sources, utilization, characteristics of Milk fat and Butter. Animal fats: Lard, Tallow and Greases etc.

Fish and marine oils: Herring, Halibut, Shark, Menhaden, Whale, Sardine and Fish Liver Oils. (10)

**UNIT III**

Harvesting conditions of oilseeds and their effect on oil recovery.

Drying and storage of oilseeds and oils: various methods, conditions of drying and storage and their effect on oil yield and its characteristics. Deterioration in oilseeds, oil bearing materials and crude oil during their handling and storage. Grading and evaluation of oilseeds, oil bearing materials and crude oils.

Handling and pretreatment methods employed in the production of oils from oilseed by pressing and solvent extraction. (10)

**UNIT IV**

Solvent extraction, solvents and the criteria for their selection, Food grade Hexane.

Techniques of solvent extraction: Batch and continuous plants. Effect of operating parameters. Desolventization of meal.

Solvent losses and utilities requirements: Solvent recovery systems.

Practices of solvent extraction for the following oil bearing materials: Soyabean. Ricebran, Cottonseed, Sunflower, Mustard, Rapeseed, Expeller cakes etc. (10)

**UNIT V**

Mechanical extraction of oil from oilseeds: Batch and Continuous.

Alternative solvents for the oil extraction

Use of supercritical fluid and liquidized gases in oil extraction.

Rendering of animal fats: Different methods of rendering, production of tallow, Lard, fish oil and fish liver oil. (10)

**POST HARVEST TECHNOLOGY OF OIL BEARING MATERIALS**

**Practical 6 Hrs/week Credits- 3**

a) Processing of different oilseeds and study of oils and oilcakes derived from them: Mechanical expression, solvent extraction and other methods for recovery of oils and fats.
b) Preparation of oleo-chemicals from following oils: Castor, Neem, Mahua, Rapeseed, Soyabean, Cottonseed, Rice bran etc.
c) Analysis of industrial solvents and other materials used in oil extraction.
d) Identification tests and detection of adulterants of oils.
e) Analysis of non-glyceride constituents of oils and fats: Unsap. matter, waxes, phospholipids, hydrocarbons, sterols, metal content etc.

# Paints Technology (PT) Core

**PTC-201 - ANATOMY OF PAINTS** **Theory 4 Hrs/week Credits- 4**

**UNIT-I**

Overview and present status of Architectural, Industrial, OEM and Special Purpose Surface Coating Industry; Elaboration of terms such as Paints, Varnishes, Lacquers, Powder Coatings, Printing Inks etc., General classification of paints, Constituents of paints and their role/functions, Concept of dispersion of pigment in polymeric binder, PVC and CPVC, Salient features/ desirable requirements of sealers, primers, stoppers, fillers, undercoats, topcoats for different surfaces; Various Mechanisms of film formation/ curing. (10)

**UNIT-II**

**Polymers-** Introduction of terms such as resins, plastics, elastomers, & fibers, Chain growth and step growth polymerization; Elaboration with examples of Natural and Synthetic polymers, Thermoplastics and thermosetting, Linear, branched, and Cross-linked polymers, Homopolymer and copolymers, Commodity, Engineering and Specialty polymers, Organic and Inorganic polymers;

Molecular weight of polymers and Degree of polymerization, Concept of molecular weight distribution, Different types of average molecular weight- number average, weight average, viscosity average and z-average molecular weights and their mathematical expressions.

Melting, Softening and freezing of polymers, glass transition point, Brief Introduction to Mechanical Properties of polymers (10)

**UNIT-III**

**Pigments:** Definitions of pigment, extenders, dyes, pigment dyestuffs, toner and lakes; Classification of inorganic and organic pigments with examples, Colour and chemical constitution, chromophores, absorption and scattering of light, additive and substractive colour mixing, dimensions of colour, influence of physical structure on colour, Colour Index, Colour cards.

General properties of pigments: Crystal structure, particle size, shape and distribution, refractive index and hiding power, oil absorption, specific gravity, bulking value, reducing power, tinting strength, fastness properties such as resistance to light, heat, water, chemicals, bleeding etc. corrosion resistance, toxicity of pigments etc. (10)

**UNIT-IV Solvents:**

Theory of Solutions, Solubility parameter, Dipole Moment, Polarity, and Polarizability, Hydrogen Bond Parameters, Influence of Molecular Mass on Solubility; Solvents, Latent Solvents, and Thinners/ diluents, Dilution Ratio and Dilutability; Evaluation of water as solvent; coalescing solvents

Physical and Chemical Properties :Evaporation and Vaporization, Density and Refractive Index, Viscosity and Surface Tension, Vapor Density, Toxicology, Occupational Health Flash Point, Ignition Temperature, and Ignition Limits, Fire Hazard

Plasticizers: properties, classification, and examples (10)

**UNIT-V**

**Additives:** Constructive and corrective additive action, Wetting and Dispersing Additives, Antisettling agents, Rheology Additives, Defoamers, Antiskinning agents, Preservatives & fungicides, Light Stabilizers, Corrosion Inhibitors (10)

**References:** 1. Morgans, W.M., 'Outline of Paint Technology', 3rd Edition, CBS Publishers and Distributors, New Delhi, 1996

2. R. Lambourne (ed.), 'Paint and Surface Coatings'**,** second edition**,** Ellis Horwood, Chichester

3. F W Billmeyer, 'Textbook of Polymer Science', Wiley India Edition (2007).

4. 'Paints, Coatings and Solvents', Dieter Stoye; Werner Freitag (ed.), 2nd. Edition, Wiley-VCH. Weinheim ; (1998).

5. 'Organic coatings : science and technology'**,** Edited by Zeno W. Wicks, Jr., Frank N. Jones, S. Peter Pappas; Douglas A. Wicks,Third Edition, John Wiley & Sons, Inc., Hoboken, New Jersey. 2007.

**ANATOMY OF PAINTS Practical 3 Hrs/week Credits- 1.5**

Minimum of ten experiments with due coverage of following:

1.Determination of various physical and chemical characteristics of drying, semi-drying and non-drying oils used in surface coatings such as colour, refractive index, specific gravity, acid value, saponification value, iodine value and hydroxyl value.

2. Analysis of solvents and plasticizers such as - solvent power, distillation range, evaporation rate, flash point, refractive index, moisture content/ hygroscopicity, acidity/ alkalinity etc.

3. Determination of surface tension;Use of Ford Cup/ Gardner Tubes for estimation of viscosity; Hiding power by Chequer Board Method; Surface and Hard Dry for air drying paints; Ostwald Viscometry for polymer molecular weight determination

**PTC-202 - CHEMISTRY & TECHNOLOGY OF POLYMERS-I Theory 4 Hrs/week Credits- 4**

**UNIT-I**

Natural resins: occurrence, composition and classification. Sources, properties, modifications and uses of Shellac, Rosin, Copal , Dammer and other natural resins in surface coatings

Classification of oils as drying, semidrying, and non drying oils. Sources, fatty acid Composition, physical and chemical properties and uses of some commonly used drying, semidrying and non drying oils.

Extraction and refining of drying oils. Chemistry of thermal and oxidative Polymerization of drying oils, Yellowing of oils. Modification of oils (Dehydrated castor oil, Stand Oils, Boiled Oils and Blown Oils. Bodying rate and viscosity relationship) Type and Role of driers, manufacture of driers. (10)

**UNIT-II**.

Phenolic resins: Chemistry of novolac and resoles. Modifications of phenolic resins with other ingradients like oils, rosin and other derivatives.Plant and process for manufacture. Properties of phenolic resins and characterization.

Varnishes: oil, phenolic and spirit varnishes-constituents and properties, design of cooking vessel for manufacture of varnish; steps in varnish preparation;formulation of furniture, spar, insulating varnishes , Evaluation and characterisation.. (10)

**UNIT-III.**

Amino resins. Urea, Benzoguanamine and Melamine Formaldehyde resins. Chemistry of methyloaltion and etherification. Plant and process for manufacture, Self condensation polymerisation, Types of MF resins, MF–Polyol Reactions in Coatings, Package Stability Considerations, Properties and characterization of amino resins. (10)

**UNIT-IV**

Alkyd Resin: Selection of raw materials like oils/ fatty acids, polyols, polyacids etc. Oil length, chemical reactions involved in the Synthesis of alkyd resins, monoglyceride & fatty acid route, solvent & fusion process, Problems on Formulation Calculations of alkyd resins. Reactors and Plant for the manufacture of alkyd resins, Chemical & physical modifications of of alkyd resins, High solids and water reducible alkyds, Alkyd Emulsions (10)

**UNIT-V**

Polyester resins: polyesterification chemistry, Selection of polyols & polybasic acids and formulation, properties and applications of hydroxyl/ carboxyl terminated saturated and unsaturated polyesters, Crosslinking of polyesters, Plant and process for manufacture of polyester resins, High solids and water reducible polyesters. Applications for Polyester Resins in Surface Coatings. (10)

**REFERENCE BOOKS**

1 . Organic coatings : Science and Technology**',** Edited by Zeno W. Wicks, Jr., Frank N. Jones, S. Peter Pappas; Douglas A. Wicks,Third Edition, John Wiley & Sons, Inc., Hoboken, New Jersey. 2007.

2. Morgans, W.M., 'Outline of Paint Technology', 3rd Edition, CBS Publishers and Distributors, New Delhi, 1996

3 . " Surface Coatings" Volume 1 " Raw material and their usages" Oil and Colour Chemists' Association, TAFE Educational Books, NSW, Australia,1987.

4 . Paul Swaraj, " Surface Coatings – Science and Technology", Wiley Interscience Publishers, John Wiley and Sons, Inc.1986.

5. 'Paints, Coatings and Solvents', Dieter Stoye; Werner Freitag (ed.), 2nd. Edition, Wiley-VCH. Weinheim ; (1998).

6 . 'Resins for Surface Coatings', VOL. II 'Alkyds & Polyesters' by P. Deligny and N. Tuck, Edited by PKT Oldring, Second Edition, ,John Wiley and Sons, New York Published In Association With SITA Technology Ltd, London, UK.

**CHEMISTRY & TECHNOLOGY OF POLYMERS-I Practical 6 Hrs/week Credits- 3**

Minimum of ten experiments with due coverage of following:

1.Spot Tests for Natural resins, Acid value of Rosin, preparation of limed rosin and ester gum

2.Analysis of metal content and preparation of various driers

3.Technical Refining of Drying Oils, Preparation of modified oils used in surface coatings such as stand, boiled and double boiled oils, blown oils, D.C.O., isomerised oils, malenised oils etc.

4.Synthesis of coconut/ soya/ sunflower/ DCO alkyds (monoglyceride & fatty acid route, solvent & fusion process); determination of oil length of alkyd resins; preparation of alkyd emulsions

5. Synthesis of Novolac and Resoles; Formulation and testing of varnishes; Synthesis of Urea formaldehyde resin; etherification of amino resins

# Plastics Technology (PL) Core

**PLL 201 INTRODUCTION TO POLYMER TECHNOLOGY Theory 4 Hrs/week Credits- 4**

**UNIT I**

Classification of polymers plastics, elastomers ,resins,& fibers, Addition and Condensation polymers, Natural and Synthetic polymers, Thermoplastics and thermosetting, Linear, branched, Cross-linked polymers, Homopolymer and copolymers, Commodity, Engineering and Specialty polymers, Organic and Inorganic polymers.

**UNIT II**

Different techniques of polymerization, Distinctive features of bulk, solution, suspension and emulsion polymerization method merits, demerits and applications, Thermodynamics of polymer solutions Melting, Softening and freezing glass transition point, Phase equilibrium, crystalline, amorphous and oriented states in polymers. (10)

**UNIT III**

Structural features of polymers, the chemical nature of polymers, Relation of structure to chemical properties, polymer solubility, solubility parameter & chemical reactivity, effect of thermal, photochemical & high energy radiation on polymers, aging & weathering, diffusion & permeability, toxicity, fire & plastics (10)

**UNIT IV**

Molecular weight of polymer, Introduction to average molecular weights, Degree of polymerization, Different types of average molecular weight , Number average weight average , viscosity average & z-average molecular weights & their mathematical expressions, concept of average molecular weight & molecular weight distribution, solubility & swelling, polymer fractionation, nature of distribution curve in polymers, integral and differential distribution curve. (10)

**UNIT V**

States of aggregation in polymers, linear amorphous, crystalline polymers, relation of structure to thermal & mechanical properties, density glass transition temperature & melting temperature, stress- strain curve of polymers, tensile strength, elongation, yield strength, impact strength and melt viscosity, polymer degradation, Definition and types of degradation (10)

References

Plastic materials(6th edition) by J. A. Brydson
Polymer Science- By Gowarikar- Viswanathan- Sreedhar
Polymer Science and Technology of palstic and rubber by P. Ghosh

**PLP 202 POLYMER IDENTIFICATION AND ANALYSIS Practical 3 Hrs/week Credits- 1.5**

Identification of following polymers
Polyethylene, Polypropylene, Polystyrene, Polyamide, Polyvinyl chloride, PMMA, PE, UF, MF
Analysis of following polymers
PVA, Alkyd resin, PVAc, Epoxy resin

**PLL 203 POLYMERIZATION KINETICS Theory 4 Hrs/week Credits- 4**

**UNIT I**

**Step-Growth (Condensation) Polymerization:** Functionaltiy principle, carothers equation, Polycondensation Mechanisms**,** Polymerization Rates**,** Molecular Weight Distribution**,** Non-linear Polycondensation. (10)

**UNIT II**

**Free-Radical Chain-Growth (Addition) Polymerization:** Free-Radical Mechanisms and kinetics, Polymerization Rates, Molecular Weight Distribution, Gel Formation, living Radical Polymerization. (10)

**UNIT III**

**Ionic Addition Polymerization :** Anionic Polymerization and its kinetics, Cationic Polymerization, Heterogeneous Ziegler- Natta Polymerization, Metallocene Polymerization. (10)

**UNIT IV**

**Copolymerization :** Copolymer Composition, monomer reactivity ratio, copolymer equation and behaviour, Pseudo-Kinetic Rate Constant Method, Vinyl / Divinyl Copolymerization. (10)

**UNIT V**

**Polymer solutions:** The process of polymer dissolution, thermodynamics of polymer dissolution, the Flory-Huggins theory of polymer solutions, nature of polymer molecules in solutions, size and shape of macromolecules in solutions. (10)

Reference books


1. Principles of polymerization by George Odian Willy interscience 4th edition
2. Text book of polymer science F. W. Bilmayer Willy interscience
3. Polymer Science- By Gowarikar- Viswanathan- Sreedhar


**PLP 204 SYNTHESIS OF RESINS AND ITS CHARACTERIZATION**

**Practical 6 Hrs/week Credits- 3**

**Synthesis of following polymers (at least five)**

1. Polyvinyl acetate by bulk polymerization, 2. Polyvinyl chloride by emulsion polymerization, 3. Polystyrene by solution polymerization, 4. PMMA by Suspension polymerization, 5. Epoxy resin by condensation polymerization, 6. UF by condensation polymerization, 7. PF by condensation polymerization, 8. MF by condensation polymerization

**Characterization (at least Five)**

1. Acid value, 2.Hydroxyl value, 3. Iodine value, 5. Epoxy value and epoxy content, 6. Amine value, 7. K-value, 8. Chlorine content