# Rashtrasant Tukadoji Maharaj Nagpur University

## Faculty of Science & Technology

## Syllabus for

## Seventh Semester B.Tech. Chemical Technology

**Subject: CT-PCC-701T** (BCE) **Transport Phenomena (Theory)**

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

University : 70 Marks College Assessment : 30 Marks

Duration of Examination: 3 Hours

### Course Objectives:

- To introduce fundamentals of heat, mass and momentum transfer.
- To analyze and model a particular system for heat, mass and momentum transfer.
- To understand and apply different governing correlations/ analogies for transport of heat, mass and momentum.

### Course Outcomes:

After completion of the course, students will be able to:

**CO1:** Understand different coordinate systems & evaluate the overall heat, mass and momentum balance over a system.

**CO2:** Understand, derive and apply, the equation of continuity, equation of motion and Navier stokes of equation to evaluate the velocity profile.

**CO3:** Analyse various system & develop differential heat balance equations for temperature distribution.

**CO4:** Analyse various system & develop differential mass balance equations.

**CO5:** Analyse the analogies of heat mass and momentum transfer, concept of drag, and application of transport phenomena to biological systems.

**Unit 1:** Introduction to transport phenomena. Different coordinate systems, Basics of momentum transfer. Newtonian & Non-Newtonian fluids. Overall momentum, heat and mass balance. Substantial derivative, curvilinear coordinates.

**Unit 2:** Differential equation of continuity, Shell momentum balances for momentum flux & velocity distribution for flow of Newtonian fluids for various situations. Navier-Stokes equation and its applications.

**Unit 3:** Shell energy balances for heat flux & temperature distribution in solids by conduction with and without heat generation. Temperature distribution in laminar flow. General equation of heat transfer and its applications.

**Unit 4:** Shell mass balance for concentration distribution in solids & in laminar flow conditions, General equation for Mass transfer and its applications. Diffusion with chemical reaction. Theories of mass transfer.

**Unit 5:** Momentum, Heat and Mass transfer in boundary layers. Analogies of momentum, heat & mass transfer. Introduction to turbulent transport phenomena. Concept of Drag Introduction to transport phenomena in Bio-systems.

## Books Recommended:


1. R. B. Bird, W.E. Stewart, E.W. Lighfoot, Transport Phenomena, 2nd Edition, John Wiley, 2002
2. C. J. Geankoplis, Transport Processes and Separation Process Principles, Prentice- Hall Inc., 4th Edition 2003.
3. C. O. Bennett, J. O. Myers, Momentum, Heat and Mass Transfer, 2nd International Student Edition Mc-Graw Hill, 1983.
4. W.J. Thomson, Introduction to Transport Phenomena, Pearson Education Asia, Singapore, 2000.

**Subject: CT-PCC-702T** (BCE) **Mass Transfer II (Theory)**

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

University : 70 Marks College Assessment : 30 Marks

Duration of Examination: 3 Hours

## Course Objectives:

- To understand basic concepts of separation operations such as extraction, leaching, drying, adsorption, crystallization, humidification and membrane separation
- To understand, interpret and evaluate mass transfer coefficients in liquid-liquid extraction operations.
- To classify & analyse working principles of cooling towers, crystallizers, dryers and adsorbers.
- To design dryers, cooling towers and crystallizers.

## Course Outcomes:

.fter completion of the course, students will be able to:

**CO1**: Estimation of mass transfer coefficient and process design parameters for liquid-liquid extraction and leaching.

**CO2**: Understanding the concept of drying, humidification and estimation design parameters of dryers and cooling towers from first principle.

**CO3**: Understanding the concept of adsorption and ion exchange and estimation of design parameters of adsorbers.

**CO4**: Understanding the concept of crystallization and estimation of design parameters of crystallizers.

**CO5**: Understanding fundamentals and types of membrane separation processes and other novel separation techniques.

**Unit 1: Liquid – Liquid Extraction:** Liquid-liquid equilibria, single stage extraction, multistage crosscurrent, countercurrent and cocurrent extraction, calculations based on triangular diagrams, stage efficiency, Continuous contact extraction in packed towers, HTU and NTU concept, Equipments for extraction

**Solid – Liquid Extraction:** General principles, continuous leaching, ideal stage equilibrium, Calculation for number of stages, constant and variable underflow, stage efficiencies, right angle triangle diagram, Leaching equipments

**Unit 2: Humidification, Dehumidification, and Drying:** General principles, vapour-liquid equilibria, enthalpy of pure substances, wet bulb temperature relation, psychrometric chart, Lewis relation, methods of humidification and dehumidification, cooling towers & calculation of height of cooling tower – HTU, NTU concept. Introduction and Principles of drying, equilibrium in drying, type of moisture binding, mechanism of drying, continuous drying, time required for drying, mechanism of

moisture movement in solid, heat & mass balance in drying, drying equipments and their design principles.

**Unit 3: Adsorption and Ion Exchange:** Basic principle and equilibria in adsorption. Types of adsorption – Physical and chemical, adsorption isotherms- Langmuir and Freundlich, Single gases and vapors, Introduction to pressure Swing Adsorption (PSA), and Temperature Swing Adsorption (TSA), Equipments: Continuous Contact: steady state–moving bed Adsorbers. Ion Exchange- Principles of Ion Exchange, Techniques and applications, Equilibria and rate of ion exchange, equipments

**Unit 4: Crystallisation**: Crystallization fundamentals, solubility and saturation, Miers theory of crystallization, crystal nucleation, crystal growth, population balance and size distribution, material and energy balances, crystallization equipments, fractional crystallization, freeze crystallization, calculations of yield.

**Unit 5: Novel Techniques:** Introduction and types of membrane separation processes, Membrane separation techniques- microfiltration, ultrafiltration. Nanofiltration, reverse osmosis, dialysis, pervaporation, gas permeation membrane process, molecular sieves. Other advanced separation processes, selection of separation processes for downstream processing.

## Books Recommended:


1. J.M. Coulson, J.F. Richardson with J.R. Backhurst, J.H. Harker, Chemical Engineering Vol. I: Fluid Flow, Heat Transfer and Mass Transfer, Sixth Edition, Butterworth-Heinemann an imprint of Elsevier
2. J. M. Coulson, J.F. Richardson with J.R. Backhurst, J.H. Harker, Chemical Engineering Vol. II: Particle Technology and Separation Processes, Fifth Edition, Butterworth-Heinemann an imprint of Elsevier
3. R. E. Treybal, Mass Transfer Operations, 3rd edition, McGraw Hill, 1980.
4. C. J. Geankoplis, Transport Processes and Separation Process Principles, 4 Edition, Prentice Hall, 2003
5. W. L. McCabe, J.C. Smith, P. Harriott, Unit Operations of Chemical Engineering, Seventh Edition, McGraw Hill Publication, 2005.
6. B. K. Dutta, Principles of Mass transfer and separation processes, PHI Learning, 2007.
7. J. D. Seader, E. J. Henley, Separation Process Principles, Wiley, 1998.

**Subject: CT-CS-703T/1 (BCHT) Food Technology V: Processing of Perishable Food Commodities (Theory)**

Lecture : 3 Hours | Tutorial: 0 Hour | No. of Credits : 3

University : 70 Marks | College Assessment : 30 Marks

Duration of Examination: 3 Hours

## Course Objective:

To provide an opportunity for students to classify different processing techniques required for preservation of fruits & vegetables, fish, meat, poultry, milk and classify the different by products related to these industries.

## Course outcome (COs):

After completion of the course, students will be able to:

**CO1**: Classify climacteric and non-climacteric fruits, and identify the significance post-harvest changes in fruits and vegetables.

**CO2**: Describe and gain the knowledge of the processing techniques in fruits and vegetable processing industry and standardization of formulations of various products.

**CO3**: Differentiate various components of the meat muscle with special focus on slaughtering and post mortem changes in meat, processing techniques in meat industry, fish processing industries and describe their use.

**CO4**: Develop a general understanding on the structure, composition and nutritional values of eggs and recognize the effective preservation methods & quality aspects for egg and poultry.

**CO5**: Describe the composition of milk, thermal processing of milk and formulate different milk-based products and to prepare different traditional Indian dairy products.

**Unit 1: Post – harvest management of Fruits and Vegetables**

Physiology of Fruits & Vegetables, Quality assessment of fruits & vegetables Structure, chemistry & physiology of plant tissues. Texture of fruits & vegetables. Plant pigments. Effect of processing on colour and texture. Post-harvest changes in Climacteric and nonclimacteric fruits.CA and MA storage. Dehydration of fruits & vegetables.

**Unit 2: Process Technology of Fruits & Vegetables**

Processing & canning of fruits & vegetables and their products. Process technology of fruits & vegetable products such as purees, concentrates, jams, jellies marmalades, preserves, candied fruits, pickles, chutnies. RTS beverages, carbonated beverages. Equipment and methods of extraction, clarification and preservation for fruit juice, Tomato and Tomato base products such as puree, paste, sauce and ketchup.

**Unit 3: Process Technology of Meat and Fish Processing**

Chemistry & Physiology of Animal Muscles: Structure & chemical composition of muscle proteins, haemoglobin, myoglobin, collagen &gelatine. Post mortem changes in muscles, rigor mortis. Various cuts of meats. Texture of meat. Effect of cooking & processing on texture, palatability & tenderness of meat. Preservation & packing of meat. Processing of fish. By products in meat & fish processing industry.

**Unit 4: Process Technology of Poultry and Egg Processing**

Preservation & packing of poultry & their products, Livestock & poultry preparation, Quality control & microbiological standards of poultry products. Hygiene and sanitation in meat and poultry industry. Egg: Structure, composition and quality, Processing of eggs. By products in poultry processing industry.

**Unit 5: Process Technology of Milk & Milk Products**

Composition of milk. Processing, storage & distribution of milk. Manufacture of cream, butter, ghee, evaporated, condensed & skimmed milk, cheese, yoghurt. Whole & skimmed milk powder. Concept of prebiotics and probiotics - principle, mechanism, production and technology involved, applications - examples of bacteria used as probiotics, use of prebiotics in maintaining the useful microflora - extraction from plant sources.

## Books Recommended:


1. Preservation of fruits & vegetables by Girdharilal & Sidappa G.S., ICAR. New Delhi.
2. Fruits & vegetables juice processing technology edited by Tressler D.K. & Joslyn M.A., AVI publishing Co. Westport, Connecticut 1971.
3. The meat handbook by Levie A. AVI publishing Co. Connecticut 1970.
4. The science of meat & meat products by Price J.F. & Schweigert B.s., W.H. Freeman, San Francisco, 1970.
5. Poultry products technology by Moutney G.J., AVI publishing Co. Inc. Westport Connecticut.

**Subject: CT-CS-703T/2 (BCHT) Oil Technology V: Technology of Cosmetics and Essential Oil (Theory)**

Lecture : 3 Hours | Tutorial: 0 Hour | No. of Credits : 3

University : 70 Marks | College Assessment : 30 Marks

Duration of Examination: 3 Hours

## Course Objective:

To enable students to become professional for participation in cosmetic industries so as to adapt themselves to jobs of problem solving and Plant / Process development

## Course Outcome (COs):

After the completion of the course, students will be able to:

**CO1:** Assess the chemical composition of Cosmetic / Essential Oil products and will be capable of recommending appropriate Cosmetic / Essential Oil treatments.

**CO2:** Differentiate ingredients found in Cosmetic / Essential Oil products and identify their functions and effects.

**CO3:** Identify and apply various make-up equipment and techniques used for professional application.

**CO4:** Compare and contrast sales strategies and promotion techniques used in the Cosmetic / Essential Oil industry.

**CO5:** Identify the ecological, ethical and environmental issues of the Cosmetic / Essential Oil industry.

**Unit 1: Classification of Cosmetics and Shampoos**

Cosmetics: Definitions, Classifications and Significance, Cosmetic preparations such as Shampoos & Conditioners, hair oils & hair colorants, Hair gel & dry shampoos, hair setters, their Ingredients, types, Functions, formulation, Production techniques, evaluation and safety considerations.

**Unit 2: Face Care products**

Face creams, Cleansing and Emollient Creams and Lotions, Vanishing Creams, Moisturizing Creams, Hand Creams and Lotions, Skin Lighteners and Bleach Creams, Hormone Creams, sun care cosmetics, Foundation preparations, Rouge, etc., face powders, talcum powders, Eye makeup cosmetics, Lipsticks, makeup removal formulations.

**Unit 3: Dentifrices and Miscellaneous Cosmetics**

Toothpaste, Tooth powders, Mouthwashes, Teeth whiteners, Anti perspirants and Deodorants, depilatories, Baby Toiletries, nail lacquers and polishes, Heavy metals contents in cosmetics, Recent trends and other miscellaneous cosmetic preparations. Plant and Machinery used in cosmetic manufacture. Lay out and Hygiene aspect of cosmetic, Evaluation of cosmetic preparations.

**Unit 4: Essential oils**

Chemistry, Classification and Chemical Constituents of Essential Oils, General methods of manufacture from roots, stems, leaves, flowers and seeds. Plant and Processes involved in Production of important oils viz., rose, jasmine, khus, sandalwood, lemongrass, clove, eucalyptus oils.

**Unit 5: Properties and Composition of Essential oils**

Analysis for Physio-Chemical characteristics such as specific gravity, refractive index, optical rotation, solubility, total alcohols, aldehydes and ketones. Industrial uses of essential oils

## Books Recommended:


1. Handbook of Cosmetic Science and Technology, Barel,A.. Paye,M.,Howard I. and Maibach,H. I. Marcel Dekker, Inc.270 Madison Avenue, New York.
2. Cosmetics Formulations, Technology & Project Estimations, Institute of Natural & Modern Cosmetech,USA.
3. Cosmetic Formulation of Skin Care Products, Series EditorEricJungermann ,Jungermann Associates, Inc. New York.
4. Cosmetics-Science and Technology, Vol-2, 2nd Ed,Sagarin, E. andBalsam, M,Wiley India Pvt. Ltd,New Delhi.
5. Bailey's Industrial Oil and Fat Products, Edible Oil and Fat Products: Chemistry, Properties, and Health Effects, 6th Edition, John Wiley & Sons, USA
6. The production of essential oils, Guenther, E. Krieger Publ. Co., Malabar, FL.
7. The Chemistry of Essential Oils and Artificial Perfumes. Parry, E.J.,D. Vannostrand Co.,NY.
8. Hand Book of Oils, Fats and Derivatives with Refining and Packaging Technology, Published by Indian Institute of Consultants, Engineers India Research Institute, New Delhi
9. Essential Oils and Culinary Herbs*James E. Simon 6. Industrial Fatty Acids and their Applications," edited by E. Scott Pattison, Reinhold Publ. Corp. New York.

**Subject: CT-CS-703T/3 (BCHT) Petrochemical Technology V: Petrochemical Unit Processes (Theory)**

Lecture : 3 Hours | Tutorial: 0 Hour | No. of Credits : 3

University : 70 Marks | College Assessment : 30 Marks

Duration of Examination: 3 Hours

## Course Objective:

- To design and conduct experiments and analyze and interpret data related to petrochemical Unit processes
- To familiarize about various concepts of unit process employed in petrochemical industry and polymer complex.
- To evaluate polymer products obtained from petrochemical complex.
- To know how of various operation employed in petrochemical complex
- To understand various codes and standard applicable to process equipment

## Course Outcomes (COs):

After completion of the course, students will be able to:

**CO1:** Understand the principles of various unit processes in the petrochemical industry. Identify various routes of separations of liquid hydrocarbons.

**CO2:** Describe safety and pressure system in different petrochemical processes.

**CO3:** Analyze and evaluate physio-chemical properties of synthesis gas.

**O4:** Classify Alkylation – Oxidation – Nitration and Hydrolysis processes.

**CO5:** Gain the knowledge about the various unit operations and process practiced in petroleum chemical industry.

### UNIT 1: FEED STOCK AND SOURCE OF PETROCHEMICALS

Overview of Petrochemical Industry – The key growth area of India, Economics – Feed stock selections for Petrochemicals – Steam cracking of Gas and Naphtha to produce Olefins, Diolefins and Production of Acetylene.

### UNIT 2: SAFETY IN PROCESS DESIGN AND PRESSURE SYSTEM DESIGN

Design process, conceptual design and detail design, assessment, inherently safer design- chemical reactor, types, batch reactors, reaction hazard evaluation, assessment, reactor safety, operating conditions, unit operations and equipments, utilities. Pressure system, pressure vessel design, standards and codes- pipe

works and valves- heat exchangers- process machinery- over pressure protection, pressure relief devices and design, fire relief, vacuum and thermal relief, special situations, disposal- flare and vent systems- failures in pressure system.

**UNIT 3: SYNTHESIS GAS PRODUCTION**

Steam reforming of Natural gas – Naphtha and Heavy distillate to produce Hydrogen and Synthesis gas – Production of Methanol – Oxo process.

**UNIT 4: PRIMARY UNIT PROCESSES**

Fundamental and Technological principled involved in Alkylation – Oxidation – Nitration and Hydrolysis.

**UNIT 5: SECONDARY AND TERTIARY UNIT PROCESSES**

Fundamental and Technological principled involved in Sulphonation, Sulfation and Isomerisation.

Fundamental and Technological principles involved in Halogenation and Esterification

## Books Recommended:


1. Bhaskara Rao, B.K., "A Text on Petrochemicals", Khanna Publishers, 2000.
2. Sukumar Maiti, "Introduction to Petrochemicals", 2nd Edition, Oxford and IBH Publishers, 2002.
3. Margaret Wells, "Handbook of Petrochemicals and Processes", 2nd Edition, Ash Gate Publishing Limited, 2002.
4. Sami Matar, and Lewis F. Hatch., "Chemistry of Petrochemical Processes", 2nd Edition, Gulf Publishing Company, 2000.
5. Dryden, C.E., "Outlines of Chemical Technology", 2nd Edition, Affiliated East-West Press, 1993.

**Subject: CT-CS-703T/4(BCHT) Pulp and Paper Technology V:**

**Paper & Board Manufacture-I (Theory)**

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|---|---|---|---|---|
| Lecture | : 3 Hours | Tutorial: 0 Hour | No. of Credits | : 3 |
| University | : 70 Marks | | College Assessment | : 30 Marks |
| Duration of Examination: 3 Hours | | | | |

## Course Objective:

Students will gain an understanding of:

- Paper manufacturing using fourdrinier paper machine.
- Learning the manufacturing process of packaging boards.
- Control optimal performance of press section for dewatering paper.
- Imbibe the various factors which control the drying of paper.

## Course Outcome (COs):

After successful completion of this course, the student will be able to:

**CO1**- Analyze the process operation parameters for make quality paper using fourdrinier paper machine.

**CO2**- Relate the process operation parameters for make quality boards using cylinder mould paper machine.

**CO3**- Appraise the problems of couching paper and recommend modern press fundamentals to remove water from paper.

**CO4**- Prioritize the importance of drying in water removal and it's effect on paper properties.

**CO5**- Predict the process parameters controlling drying during paper manufacturing process.

**Unit 1: Fourdrinier paper machine and Auxiliary equipment**

Introduction to paper formation, auxiliary equipments-stock chests, pressure screen, centricleaners, deculators, approach flow systems, different types head box and role played by slices. History and development of Fourdrinier paper machine, Drainage and sheet formation on Fourdrinier, types of forming fabric, role played by breast roll, table rolls, forming boards, wire, suction boxes, dandy rolls, couch rolls, wire pit, calculation for water drainage, and production of paper machine, retention calculation of fillers, understanding the wet end chemistry of paper formation, twin wire formers types, benefits, two sidedness reduction, multiple wire former.

**Unit 2: Board Manufacture**

Cylinder mold type paper making machine, Sheet forming mechanism, different types of vats, cylinder and Fourdrinier machines comparison, combination of cylinder and Fourdrinier machines, Vat stock entry, web formation, factors affecting the quality of web, drainage through cylinder mold, machine head box, cylinder vacuum, modern web forming devices, cylinder machine products

**Unit 3:** Pick up and press section, concept of suction pick up, plain, suction and modern presses, mechanism of water removal, factors affecting water removal and moisture distribution in cross direction, paper machine felts, felt conditioning and treatment, crowning of press rolls.

**Unit 4:** Drying of paper, need, means, major characteristics, theory, mechanism of water removal, drying rate curves, effect of drying on sheet properties, critical and equilibrium moisture contents, multi-cylinder drying, Cyclic nature of paper drying, machine finish(MF) and machine glaze(MG)paper, Mechanism of heat and mass transfer, numerical problems of drying.

**Unit 5:** Yankie and MG drying, condensate removal and recycle, methods of expressing the moisture content of a wet sheet and their inter relationship, cross direction moisture control. Performance calculations, determination of centre line temperature distribution, air drying, radiant drying, psychrometry, heat requirements, ventilation in paper machine, cost economics in drying.

## Books Recommended:


1) Papermaking Science and Technology, Vol- 8, Papermaking Part 1 -Stock Preparation and Wet End, Joint Textbook Committee of TAPPI and Finnish Paper Association, TAPPI PRESS, 2002.
2) Papermaking Science and Technology, Vol- 9, Paper Making Part 2 -Drying, Joint Textbook Committee of TAPPI and Finnish Paper Association, TAPPI PRESS, 2002.
3) Pulp and Paper Manufacture,Volume – 7 Paper Machine Operation, M. J. Kocurek (Ed), TAPPI Press, 1992.
4) The Handbook of Pulp and Paper Technology ( Fourth edition) By Gary Smook, TAPPI PRESS, 2016.

**Subject: CT-CS-703T/5 (BCHT) Plastics and Polymer Technology V: Polymer Blends and Composites (Theory)**

Lecture : 3 Hours | Tutorial: 0 Hour | No. of Credits : 3

University : 70 Marks | College Assessment : 30 Marks

Duration of Examination: 3 Hours

## Course Objectives:

- To describe purpose and different methods of blending.
- To explain manufacturing, trouble shooting and uses of composites.
- To understand role of constituents of composites.

## Course Outcomes (COs):

After completion of the course, students will be able to:

**CO1:** Modify polymer by suitable blending technique.

**CO2:** Select and use available commercial blend for desired application.

**CO3:** Select suitable resin, reinforcement and additive for a composite.

**CO4:** Apply suitable processing technique for composite product manufacture.

**CO5:** Identify components of nanocomposite essential for desired improvement in performance.

**Unit 1: Fundamentals of Blend**

Polymer blends terminology, classification of polymer blends, significances of blends over conventional polymers, thermodynamics of polymer blends (Flory-Huggins Equation), steps involved in designing of a blend, compatibilizer, methods of compatibilization. Methods of Blending- melt, solution and latex blending. Morphology and Rheology of blends, Interactions, Phase structure development in polymer blends UCST and LCST.

**Unit 2: Commercial Polymer Blends**

Commercial polymer blends and their applications such as Polyolefin blends, Styrenic blends, Vinyl resin blends, Acrylic blends, Elastomeric blends, Polyamide blends, Polycarbonate blends, Polyoxymethylene blends, Polyphenylene ether (PPE) blends, Thermoplastic polyester blends, Specialty polymer blends. Interpenetrating polymer network (IPN), its types, methods of preparation and applications.

**Unit 3: Types of Composites, Matrix and Reinforcement**

Definition of Composites, its main elements, their role, Classification of composite. Advantages of composites.

Matrix: Grades, properties and applications of unsaturated polyester, Epoxy, Vinyl esters, Phenolics. Properties and applications of Polyimides, PC, PP, Polyamides. Prepregs and Moulding compounds SMC, BMC.

Reinforcement: Preparation, properties, applications of Glass (types and forms), Carbon, Graphite, Aramid, Boron fibres, Natural Fibres. Hybrid and Sandwich Composite, Effect of loading and orientation on strength of composites

Additives: Curing agents, accelerators, inhibitors, filler, thixotropic agent, flame retardant, pigment, coupling agent, internal lubricant, mould release agent.

**Unit 4: Processing of Composites**

Moulds for composites, Hand Lay Up, Spray Up, Vacuum Bag Moulding, Pressure Bag Moulding, Autoclave Moulding, Resin Transfer Moulding, Cold Press Moulding, Hot Press Moulding, Transfer Moulding, Injection Moulding, Filament winding, Centrifugal Moulding, Pultrusion, Continuous Sheet Manufacturing. Common faults observed in Composites and their remedies. Applications of Composites in Sports, Construction, Automobile, Aerospace, Electrical & Electronics and Marine.

**Unit 5: Polymer Nanocomposites**

Definitions, classification of nanofillers, layered nanoparticles, (Clay), fibrillar nanoparticles (carbon nanotubes (CNTs) etc.) and other nanoparticles, polymer clay nano-composites (PCNC), preparation steps - intercalation, exfoliation, Methodologies of preparation- solution, in situ polymerization, melt mixing technique, comparison of PNC with normal composites based on composition, mechanical, rheological, gas barrier, thermal, flame retardancy, optical properties. Applications of polymer nanoncomposites.

## Recommended Books:


Polymer Blends and Alloy by Hope, Chapman & Hall.

2. Polymer Blends Handbook by Utracki, Kluwer. KLUWER ACADEMIC PUBLISHERS.
3. Commercial Polymer Blends by U L Utracki. SPRINGER-SCIENCE+BUSINESS MEDIA,
4. Handbook of Reinforced Plastics by John Murphy, Elsevier.
5. Fundamentals of Polymer Composites by Brent Strong, SPE.
6. Handbook of Polymer Composites by Peters, Chapman & Hall.
7. Rheometry by K. Walters, Chapman and Hall.
8. Rheology of Polymers by G. V. Vinogradov, A. Ya. Malkin, Mir Publications.
9. FRP Technology by R. G. Weatherhead, Applied Science Publishers Ltd.

**Subject: CT-CS-703T/6 (BCHT) Surface Coating Technology V: Paint Constituents, Formulations and Evaluation of Coatings (Theory)**

Lecture : 3 Hours | Tutorial: 0 Hour | No. of Credits : 3

University : 70 Marks | College Assessment : 30 Marks

Duration of Examination: 3 Hours

## Course Objectives:

To enable students to select constituents of paint, formulate the same and evaluate coatings from the perspective of industry requirement.

## Course Outcomes (COs):

After completion of the course, students will be able to:

**CO1:** Understand the role of plasticizers and solvents in surface coatings formulations.

**CO2:** Understand the requirement and use of various additives in the coating/paint.

**CO3:** Understand the principles underlaying in the formulations of surface coatings.

**CO4:** Use the steps and equipment involved in the manufacture of paint and related products.

**CO5:** Test the paints/coatings by various methods as per standards.

**Unit 1: Solvents**: Classification of solvents, solvent characteristics, role of solvent in coatings, true and latent solvents, types of volatile solvents and their use in surface coatings, effect of volatile solvent on film properties, Toxicity of solvents. Plasticizers, general uses, requirement of plasticizers and desirable characteristics, Types of plasticizers and their evaluation

**Unit 2: Additives**: Definition, Classification according to functions, In-organic, Organic and PUR Thickeners, Surface-Active Agents, Surface modifiers, Flow-Levelling and Coalescing Agents, Catalytically Active Additives, Additives for Special Functions: Anti-Skinning Agents. Light Stabilizers, Corrosion Inhibitors, Biocides, Flame Retardants, Photo-initiators as Additives in UV-Curable Lacquers.

**Unit 3: Principles of Formulations**: Four steps formulation, production, application, drying and aging. Formula calculations concept, pigment volume concentration (PVC), and Critical Pigment Volume Concentration (CPVC). Rheology of Coatings, Newtonian and Non-Newtonian flow, Thixotropy, Chemicals for inducing thixotropy in paints.

**Unit 4: Paint Manufacture**: Steps in manufacture, mixing, grinding, letting down, tinting, straining, filling. Types of machinery required for various steps and their working, construction, designing and function of various parts. Details of machinery for Mixing, edge runners, roll mills (single, twin, three and four roll mills), Ball and pebble mills, sand grinders, attritors, kady mill, high speed impellers, Filling and labeling machines.

**Unit 5: Evaluation of Film-former and Coatings**: Percentage solids, viscosity, colour, acid number and bulk density. film thickness, Performance tests for resins, varnishes and coatings namely drying, skinning, gas-proofing, hardness, flexibility, cold check, impact resistance, abrasion resistance, adhesion, exterior durability, water resistance, permeability to water, soap and alkali solutions, alcohol and chemical resistance, electrical resistance. Weatherometer tests, Outdoor exposure tests, BIS/ISO/ASTM Methods in coatings.

## Books Recommended:


1. Organic Coating Technology, Payne, H.F., Volume one, John Wiley & Sons, New York, 1954.
2. Organic Coating Technology, Payne, H.F., Volume" Volume Two, John Wiley & Sons, NY.
3. Protective and Decorative Coatings, Volume Two, Matellio, J.J.,, John Wiley & Sons.
4. Protective and Decorative Coatings" Volume Three, Matellio, J.J., John Wiley & Sons.
5. Paint Technology Manual, Vol 1, Oil, Colour Chemists Association.
6. Paint Technology Manual, Vol 2, Oil, Colour Chemists; Association.
7. Paint Technology Manual,Vol 3, Oil, Colour Chemists; Association.
8. Paint Technology Manual, Vol 4, Oil, Colour Chemists; Association.
9. Surface Coatings-Vol 1-Raw materials and their usage", OCCA, Australia
10. Treatise on Coatings Vol 4 – Formulations, Long J. S. and Myers R. R., Marcle & Dekker, N. Y.
11. Paints, Coatings and Solvents, W. Freitag, and D. Stoye 2nd Ed, WILEY-VCH Verlag GmbH Testing of Paints, Shrikant Patil, Colour Publications
12. Organic Coatings Science and Technology Zeno W. Wicks, Jr. Frank N. Jones, S. Peter Pappas, Douglas A. Third Edition John Wiley & Sons, Inc., Hoboken, New Jersey, 2006
13. Paint and Surface Coatings: Theory and Practice, R Lambourne, T A Strivens, Woodhead Publishing Ltd.UK.
14. Additives for Coatings Edited by Johan Bieleman, WILEY-VCH Verlag GmbH.
15. Additives in Water-borne Coating, Gerry Davison and Bruce Lane, The Royal Society of Chemistry, UK.

**Subject: CT-CS-704T/1 (BCHT) Food Technology VI: Food Fermentation & Packaging Technology (Theory)**

Lecture : 3 Hours | Tutorial: 0 Hour | No. of Credits : 3

University : 70 Marks | College Assessment : 30 Marks

Duration of Examination: 3 Hours

## Course Objective:

To provide an opportunity for students to know about the beneficial organisms and the use of beneficial organisms in food industry using various types of fermenters.

## Course Outcomes (COs):

After the completion of course, students will be able to:

**CO1**: Use the idea of fermentation and understanding basic types of fermentation.

**CO2**: Know about production method of organic acids, alcoholic beverages and glycerol

**CO3**: Understand microbiology in production of biological biomass and their importance in food industry.

**CO4**: Apply fermentation method to produce different metabolites and medicines

**CO5**: Describe and gain the knowledge of the processing techniques in fermented food products, processing of traditional fermented products and packaging.

**Unit 1: Fermentation Process Strategies**

Biotechnology in Food Preservation and Processing, Types of Fermentation – submerged, solid and surface type. Bioreactor configuration: Fermenters – Types, functions, design and control, Submerged fermenters and their types, Solid state fermenters and their types. Upstream and Downstream processing.

**Unit 2: Production of Organic Chemicals & Biomass**

Production of industrial alcohol, acetic acid, citric acid, vinegar and Acetone Butanol by fermentation. Production of bakers yeast, starter cultures, algae, mushrooms & single cell proteins from different substrates. Algae as source of omega - 3 fatty acids, antioxidants and minerals - extraction and enrichment.

**Unit 3: Production of Secondary Metabolites**

Production of antibiotics and bacteriocins, Industrial enzymes, polysaccharides, flavors & fragrances and Vitamin B – 12. Algae as source of omega - 3 fatty acids, antioxidants and minerals - extraction and enrichment. Types of nutraceutical compounds – Phytochemicals, phytosterols and other bioactive compounds, peptides and proteins, carbohydrates (dietary fibers, oligosaccharides and resistant starch), vitamins and minerals; Such as Polyphenols: Flavonoids, catechins, isoflavones, tannins, Protease and their sources and role in promoting human health.

**Unit 4: Fermented Foods**

Process technology of alcoholic beverages: Types of alcoholic beverages. Raw material, fermentation & processing of alcoholic beverages. Modern brewing technology. Oriental fermented foods: Soya sauce, Tofu, Tempeh, Idli, dosa, etc. Functional fruits and vegetables, herbs and spices, beverages (tea, wine etc), Future prospects of functional foods and nutraceuticals and their potential for use in improving health. Development in processing of functional foods. Formulation and fabrication of functional foods.

**Unit 5: Food Packaging Technology**

Definition, importance and scope of packaging of foods, Important functions of package, packaging materials, types, properties, advantages & disadvantages of packaging materials, packaging materials: Metal, Glass, Paper, Laminates, Plastics. Testing Procedures for Packaging Materials- thickness, tensile strength, puncture resistance, bursting strength, seal strength, water vapor permeability, CO2 permeability, oxygen permeability, grease resistance, Testing Procedures for Packaged Foods - Compatibility and shelf life studies, evaluation of transport worthiness of filled packages.

## Books recommended:


1. Industrial Fermentation Vol 1&2 by Underkoffler L.A., Chemical publishing Co. Inc. 212, Fifth Avenue, New york, 1954.
2. Microbial Technology vol 1 & 2 by Peppler.
3. Biotechnology: Food Fermentations Ed. VK Joshi, Ashok Pandey Educational Publishers and Distributor, New Delhi 1999
4. Fundamentals of Food Packaging By Payne FA
5. Food Packaging by Stanley S
6. Industrial Microbiolgy by Casida L.E., John Wiley & Sons Inc New York, 1964.
7. Industrial Microbiology by Presscot & Dunn, McGraw Hill Book Co. Inc. New York, 1940.
8. Biotechnology B. D. Singh Kalyani Publishers, Ludhiana,1999

**Subject: CT-CS-704T/2 (BCHT) Oil Technology VI: Technology of Paints, Resins & Inks (Theory)**

Lecture : 3 Hours | Tutorial: 0 Hour | No. of Credits : 3

University : 70 Marks | College Assessment : 30 Marks

Duration of Examination: 3 Hours

## Course Objective:

- To understand nature, characteristics and classification of paints and coatings.
- To recognise the corrective use of additives in paints & coatings.
- To Assess and develop the use of modified oils in paints.
- To acquaint students with the principles of printing inks, nature and various formulations.

## Course Outcomes (COs):

After the completion of course, students will be able to:

**CO1**: Understand nature, characteristics and classification of paints and coatings.

**CO2**: Recognise the corrective use of additives in paints & coatings.

**CO3**: Assess and develop the use of modified oils in paints

**CO4**: Explain the principles of printing inks, nature and various formulations

**CO5**: Classify and evaluate various types of paints.

**Unit 1: Paint**

Definition, ingredients, Formulation, manufacture, machinery Principles of paint formulations and testing, varnishes and lacquers, primers, undercoats and finish coats Manufacture, classification and types of powder coating Sketches of the machinery used Manufacture of different types of wall finishes.

**Unit 2: Technology of Pigments and Extenders**

Definition, classification, Sources, properties, manufacture, testing and evaluation of pigments, preparation and uses of important pigments such as White and red pigments, Metallic pigments, Natural organic pigments, comparison of organic pigments, Extenders: - Sources, manufacture, properties and uses, recent developments.

**Unit 3: Convertible and Non-convertible coatings and Technology of Drying oils**

Chemistry, Thermal and chemical modification methods; Properties and uses, drying, semi drying oils, yellowing of oils: modified oils like heat treated oils, Melanised oils, Co-polymerized oils, dehydration, isomerised oils, segregated, reconstituted oils. Natural Resins Classification, composition, Rosin and shellac, properties, Processing and application in surface coatings Oleoresins, Recovery of resin and turpentine,

**Unit 4: Convertible and Non-convertible coatings**

Synthetic Resins -Chemistry and manufacture of Alkyd resins, raw materials, chemistry, formulation and its application. amino resins, urea formaldehyde, epoxy resins, various epoxy modified resin and their application, water soluble epoxies, polyamide resin, amino resins, chlorinated rubber, vinyl resins with special reference to acrylics. Polyurethanes, classification, properties and application

**Unit 5: Solvents and General Paint Properties**

Hazards and precautions Diluents, thinners, lacquers-Types, general properties, classification, evaluation of solvents, solubility parameters. Safety measures for coatings, ISI methods of testing of paints, specialty paints, paint film defects, recent developments. Industrial Formulation and Applications of paints

## Books Recommended:


1. Protective and Decorative Coatings, Paint, Varnishes, Lacquers, and Inks, Mattiello, J. J., John Wiley and Sons, New York.
2. Organic Coating Technology Vol, 1 & 11 by, Payne, H.Y.
3. Paint Technology Manuals., Oil and colour chemists Association, Vol-I – Vol. VIII, Chapman and Hall , London
4. Pigment Hand book Vol. 1 – Vol. VIII,. Patton, T. C., Wiley-Inter science Publications, New York.
5. The Testing of Paints, Vol – V, Paint Technology Manual,. Dunkley F.G. and Collier, C.W., Chapman and Hall. London
6. Paint film defects and their remedies, Manfred, H., Chapman and Hall Ltd. London.
7. Introduction to paint chemistry – Principles of paint technology, Turner G.P.A.,, Chapman and Hall , London
8. Outline of paint technology, Morgan's, W.M. Edward Arnold Publishers, ,London
9. OCCA Surface Coating Technology Vol, 1 & 11
10. Printing inks: their chemistry and technology - Ellis, C., New York

**Subject: CT-CS-704T/3** (BCHT) **Petrochemical Technology VI: Petroleum Refinery Distillation (Theory)**

Lecture : 3 Hours | Tutorial: 0 Hour | No. of Credits : 3

University : 70 Marks | College Assessment : 30 Marks

Duration of Examination: 3 Hours

## Course Objective:

- To get acquainted with process design of petroleum distillation columns involving multicomponent and complex mixtures.
- To learn methodologies practiced in rating and designing heat transfer equipment used in refining and process industry.

Students learn process design aspects related to distillation column, Fired Heaters, pumps and compressors.

## Course Outcomes (COs):

After completion of the course, students will be able to:

**CO1:** Understand the basic design concepts required for designing multicomponent petroleum distillation column.

**CO2:** Describe petroleum refinery distillation techniques viz. TBP, EFV, ASTM and apply knowledge of TBP distillation to set the operating conditions of Petroleum Refinery

**CO3:** Apply knowledge to the design-based research project based on software (ex. Hysys, Aspen) to provide design calculations for ADU/VDU columns

**CO4:** Design of Fired heaters used for crude oil heating in Petroleum Refinery and understand the codes and standard for Pipe still heaters used in crude oil heating.

**CO5:** Describe different pumps and compressors power rating calculations based on process duty.

**UNIT 1: MULTICOMPONENT DISTILLATION**

Dew point and bubble point for multi component mixtures. Design of multi component distillation column, Number of variables, Selection of key components, Selection of column pressure, Feed condition, Plate-to-plate calculations, Empirical short cut methods, Introduction to rigorous solution procedures.

**UNIT 2: PETROLEUM REFINERY DISTILLATION**

TBP, EFV, ASTM distillation curves and their relevance, Material balance and flash zone calculations for petroleum refinery distillation columns, Pump around and pump back calculations, Overall energy requirements, Estimation of number of equilibrium stages, Design using Packie charts and Watkins method, Introduction to rigorous solution procedure based on pseudo components.

**UNIT 3: COLUMN DESIGN**

Process design of distillation towers. Flooding charts. Trays and packings. Vacuum devices. Pressure drops. Height, diameter, supports. Piping requirements. Aspects of mechanical design. A typical P&ID for a distillation column.

**UNIT 4: FIRED HEATERS**

Heat load calculations for furnace heaters used in crude refining, Basic constructional features, Different furnace types, Review of factors to be considered in the design of fired heaters, Introduction to manual calculations methods.

**UNIT 5: PUMPS AND COMPRESSORS**

Types of pumps and compressors. Selection criteria. Power rating calculations based on process duty. Use of operating curves of centrifugal pump. NPSHR and NPSHA. Pump Cavitation. Surge problem in compressors.

## Books Recommended:


1. Van Winkle M., "Distillation", McGraw Hill, 1967.
2. Watkins, "Petroleum Refinery Distillation", McGraw Hill, 1993
3. Sinnott R. K., "Coulson and Richardson's Chemical engineering", Vol. 6, Third Edition, Butter Worth-Heinemann, 1999.
4. Kern D. Q., "Process Heat Transfer", McGraw Hill, 1965.
5. Cao Eduardo, "Heat Transfer in Process Engineering", McGraw Hill,2010

## Subject: CT-CS-704T/4 (BCHT) Pulp and Paper Technology VI:

## Paper & Board manufacture-II (Theory)

| | | | | | |
|---|---|---|---|---|---|
| Lecture | : 3 Hours | Tutorial: 0 Hour | | No. of Credits | : 3 |
| University | : 70 Marks | | | College Assessment | : 30 Marks |
| Duration of Examination: 3 Hours | | | | | |

### Course Objectives:

Students will gain an understanding of:

- Monitor the factors controlling conversion of paper reels usuable by customers.
- The application and objectives of surface treatment and sizing material in the manufacture of paper.
- The mechanism and development process of various specialty papers.
- Analysis and testing of various properties of pulp and paper in paper industries.
- To control various operating parameters using instrumentation and process control.

### Course Outcomes (COs):

After successful completion of this course, the student will be able to:

**CO1-** Apply different mechanical operations during finishing of paper to make it suitable for customers.

**CO2-** Relate the role played by surface treatment of paper and the benefits obtained due to the process.

**CO3-** Appraise the role played by quality control process in analyzing and testing of paper and paper boards.

**CO4-** Discover the factors controlling instrumentation in maintaining quality of paper and paper boards.

**CO5-** Demonstrate the process parameters of manufacturing different grades of speciality papers and boards for various end use.

**Unit 1: Finishing of Paper**

Winding of paper on winders, different types of winders, pope reel, theory of calendaring, factors controlling calendaring, effects of calendaring on paper properties, mechanism of super calendaring, calendar/supercalendar roll fabrication, gloss development in paper, rewinder operation, sheet cutter operation, simplex and duplex sheet cutter, corrugation unit, manufacture of corrugation boards, embossing of paper, understanding grain of paper, various steps of paper finishing, packaging and dispatch.

**Unit 2: Surface treatment of paper**

Objective, equipment for surface sizing, effect of surface sizing on paper, factors controlling surface sizing, use of starch, glue, poly vinyl alcohol, carboxy methyl cellulose and specialty surface sizing chemicals.

Coating of paper, benefits of paper coating, coating colour preparation, different types of coating equipment, coating of boards, calculation of coat weight and coater production.

**Unit 3: Analysis and testing of pulp and Paper**

Various analysis and testing of fibrous raw material, pulp, paper and boards, need for testing, scientific methods of taking sampling,standard test methods, equipments used for testing, testing equipment calibration and reproducibility, analysis of converted products.

**Unit 4: Instrumentation in Mill**

Process control and instrumentation in mills, maintenance, instruments specifications, on line measurement and control of parameters computer applications in pulp and paper industries, Flow measurement in paper industry, Analytical measurements in paper industry – conductivity measurement, Hydrogen-ion concentration (pH) measurement, Ion selective measurement –theory, Oxidation -Reduction potential-theory, consistency measurements- theory, continuous consistency measurement devices.

**Unit 5: Speciality papers**

Manufacturing and properties of Tissue paper, Electrical Insulating Paper, air laid paper, absorbant, lamination paper, décor paper, overlay, preimpregnated foils, laminates, filter paper, special strong paper: abrasive base, sand paper, release paper, Building Paper, Cigarette Paper. Manufacture of Hard board, Insulation board and particle board.

## Books recommended:


1) Starch and Starch Products in Surface Sizing and Paper Coating, by Hans W. Maurer, Detlev Glittenberg, TAPPI Press, 2007.
2) Papermaking Science and Technology, Vol- 18, Paper and Board Grades, Joint Textbook Committee of TAPPI and Finnish Paper Association, TAPPI PRESS, 2002.
3) Papermaking Science and Technology, Vol- 10, Papermaking Part 3 -Finishing, Joint Textbook Committee of TAPPI and Finnish Paper Association, TAPPI PRESS, 2002.
4) Winders: The Complete Guide for Paper Mills and Converters, by Jan Gronewold, TAPPI Press, 1998.
5) Papermaking Science and Technology, Vol- 11, Pigment Coating and Surface Sizing of Paper, Joint Textbook Committee of TAPPI and Finnish Paper Association, TAPPI PRESS, 2002.
6) Papermaking Science and Technology, Vol- 17, Pulp and Paper Testing, Joint Textbook Committee of TAPPI and Finnish Paper Association, TAPPI PRESS, 2002.

**Subject: CT-CS-704T/5** (BCHT) **Plastics and Polymer Technology VI: Plastics Packaging and Waste Management (Theory)**

Lecture : 3 Hours | Tutorial: 0 Hour | No. of Credits : 3

University : 70 Marks | College Assessment : 30 Marks

Duration of Examination: 3 Hours

## Course Objectives:

- To understand the need and types of plastics packaging.
- To understand importance of plastics materials and methods for packaging.
- To help tackle plastics waste in ecofriendly manner.

## Course Outcomes (COs):

After completion of the course, students will be able to:

**CO1:** Select appropriate material and test for packaging.

**CO2:** Manufacture package with suitable technique.

**CO3:** Convert semi-finished material into final package by suitable conversion process.

**CO4:** Manage plastics waste generating during processing.

**CO5:** Manufacture and evaluate biopolymer/biodegradable polymer.

**Unit 1: Packaging Materials and Testing**

Advantages of plastics packaging, special requirements of food and medical packaging, Function of packaging. Introduction to packaging plastics- PE, PP, PS, PVC, PET, PVAl, PVDC, EVA, EVOH, PA, PC, Fluoropolymers. Selection criteria for packaging materials. Packaging legislations.

Tests-Compatibility, Product loss, stress crack resistance, migration test, stack load test, drop test and vibration test. Packaging hazards and their controls. Foams- PS (expanded and extruded), PU, Polyolefins.

**Unit 2: Flexible and Rigid Packaging**

Flexible Packaging: Extrusion, cast film and blown film, multilayer film, Extrusion and adhesive lamination, Extrusion coating. Advantages of flexible packaging, flexible packaging products and specialized packaging for food products (Aseptic and vacuum/modified atmosphere packaging).

Rigid Packaging: Blow moulding-Extrusion and injection blow moulding. Thermoforming, drape forming, pressure forming, vacuum forming, plug assist forming, bubble forming, vacuum snap-back forming, matched mould forming, scrap less, dual sheet, melt-to-mould thermoforming, twin sheet thermoforming, skin packaging, blister packaging and thermoform-fill-seal system.

**Unit 3: Conversion Processes**

Skin, Shrink and Blister packaging, Stretch Wrapping, Pouching, Bag making. Sealing methods-Bar, Band, Impulse, Wire, Ultrasonic, Friction, Gas, Contact, Hot melt, Dielectric, Induction and solvent sealing. Decoration processes-Hot stamping, Screen printing, Pad printing, Flexographic printing, Rotogravure printing, in-mould decoration, Labelling, Vacuum metallization. Form-Fill-Seal-vertical and horizontal

**Unit 4: Plastics Waste Management**

Sorting and segregation of waste, Plastics identification, Plastics waste: Composition, quantities and disposal, R's of plastics waste management, Need for recycling, alternative types of recycle methods, recycling of plastics from urban waste, Waste management of plastics packaging.

**Unit 5: Biopolymers**

Introduction, classification, applications, advantages and disadvantages, Biopolymers vs polymers, Biopolymers vs Biodegradable polymers, introduction of different types of biopolymers like polypeptides, nucleic acid, sugar based, poly lactic acid, PHBV, biodegradation and its classification, degradation - Intracellular biodegradation, extra cellular biodegradation, thermal degradation, hydrolytic degradation, environmental degradation, criteria used in the evaluation of biodegradable polymers.

## Books Recommended:


1. Plastics in Packaging by Athalye, McGraw Hill.
2. Packaging Technology by Athalye, Multitech.
3. Food Packaging Science and Technology by Lee, CRC Press.
4. Plastics in Food Technology by Brown, Marcel Dekker.
5. Recycling of Plastics by Adobe & Chandra, NIIR
6. Emerging Technology in Plastics Recycling by Andrews, Multitech.
7. Production of Biodegradable Plastics and Bioplastics Technology by Panda, EIRI.
8. Plastics Waste Management and Environment by Malhotra.

**Subject: CT-CS-704T/6** (BCHT) **Surface Coating Technology VI: Technology of Industrial Paints and Application Techniques (Theory)**

Lecture : 3 Hours | Tutorial: 0 Hour | No. of Credits : 3

University : 70 Marks | College Assessment : 30 Marks

Duration of Examination: 3 Hours

## Course Objectives:

1. Formulate and apply Architectural finishes on different substrates/surfaces.
2. Formulate and apply Industrial finishes on different substrates/surfaces.
3. Understand the powder coatings and its application techniques
4. Understand marine paints, its formulation, and applications.
5. Understand substrate preparation and application methods/techniques in coatings.

## Course Outcomes (COs):

After the completion of course, students will be able to:

**CO1** Understand, formulate and applications Architectural finishes.

**CO2** Understand, formulate and applications Industrial finishes

**CO3** Understand, Compare, Formulate and applications powder coatings

**CO4** Understand Marine paints and its formulation, methods of manufacture and application of marine coatings

**CO5** Understand pretreatment techniques of substrate and application techniques of coatings.

### Unit 1:Architectural Finishes

Formulation and methods for manufacture of paints for exterior and interior house design, paints for wood interior and exterior, formulation for plaster and wallboard coatings, exterior emulsion paints for masonry, interior and exterior enamels.

### Unit 2:Industrial Finishes

Formulation and methods of manufacture for clear finishes for wood, furniture, metal goods, overprint finishes, automotive finishes, Lacquers for wood, metal and decorative finishes.

**Unit 3: Powder Coatings**

History of powder coatings, Comparison of powder coatings with solvent based coatings. Thermoplastic and thermosetting binders for powder coatings, Properties and use of thermoplastic and thermosetting powder coatings,. Manufacture of Powder Coatings: Dry-blend and melt-mix method, Application of powder coatings: Fluidized bed, Electro-static fluidized bed and Electrostatic spray techniques.

**Unit 4: Marine Paints**

Introduction to marine coatings, Coatings for ship, on and off-shore structures, Blast primers, formulation of blast-primers, Fouling, causes of fouling, anti-fouling paints, soluble and insoluble matrix for anti-fouling coatings, Toxins in anti-fouling coatings.

**Unit 5: Pretreatment of Surfaces and Application Techniques**

urface preparation for coating, solvent wipe-off, vapour degreasing, alkali cleaning, chemical cleaning, burn off and flame cleaning, mechanical cleaning with hand and power tools, sand blasting, phosphate treatment, treatments for aluminum and magnesium, conversion coatings. Application Techniques: Brush and roller coating, spray painting (ordinary, Electrostatic, power, airless, two components, hot spray), dipping, flow coating, fluidized bed coating, pressure curtain coating, knife and roller coating, tumbling barrel.

## Books Recommended:


1. Payne, H.F., "Organic Coating Technology" Volume one, John Wiley & Sons, New York, 1954.
2. Payne, H.F., "Organic Coating Technology" Volume Two, John Wiley & Sons, New York, 1954.
3. Protective and Decorative Coatings, Volume Two, Matellio, J.J.,, John Wiley & Sons.
4. Protective and Decorative Coatings" Volume Three, Matellio, J.J., John Wiley & Sons.
5. Paint Technology Manual, Vol 1, Oil, Colour Chemists Association.
6. Paint Technology Manual, Vol 2, Oil, Colour Chemists; Association.
7. Paint Technology Manual,Vol 3, Oil, Colour Chemists; Association.
8. Paint Technology Manual, Vol 4, Oil, Colour Chemists; Association.
9. Paints, Coatings and Solvents, W. Freitag, and D. Stoye (Eds.) Second Edition, WILEY-VCH Verlag GmbH & Co.
10. Coating Methods, Powder Technology, Encyclopedia of Polymer Science and Technology. Volume 5, John Wiley & Sons, Inc.
11. Organic Coatings Science and Technology Zeno W. Wicks, Jr. Frank N. Jones, S. Peter Pappas, Douglas A.,John Wiley & Sons, Inc.

12. Paint and Surface Coatings: Theory and Practice, R Lambourne, T A Strivens, Woodhead Publishing Ltd.UK.
13. Antifouling Paint Biocides Volume Editor: Ioannis K. Konstantinou, Springer
14. Outlines of Paint Technology, W. M. Morgan, CBS Publishers and Distributors Pvt. Ltd.
15. Basics of Paint Technology, Part 1 & 2, V. C. Malshe & Meenal Sikchi.

**Subject: CT-OEL-705T** (BCE)

**Open Elective- II: Nanoscience and Nanotechnology (Theory)**

| | | | |
|---|---|---|---|
| Lecture | : 3 Hours | No. of Credits | : 3 |
| University | : 70 Marks | College Assessment | : 30 Marks |

Duration of Examination: 3 Hours

## Course Objectives:

- To explore the basic concept of nanoscience and nanotechnology and its scope.
- To study various synthesis methods, analysis tools for nanomaterial's preparation and characterization.
- To understand the fundamental properties and emerging applications for nanomaterials

## Course Outcomes:

After completion of the course, students will be able to:

**CO1**: Understand the concept of nano scale and nanotechnology, and classify various types of nanomaterial.

**CO2**: Learn the fundamentals and procedure of synthesis of nanomaterial and its method of synthesis according to application.

**CO3**: Identify the suitable type of characterization technique for Nano material.

**CO4**: Understand the synthesis and role carbon nanomaterials in various applications.

**CO5**: To identify the application of nanotechnology in chemical Engineering and evaluate the impact of nanotechnology on Environment and its safety aspects.

**Unit 1: Introduction:** Nano Scale, history and Scope of Nano Technology., Nanomaterials, Morphology. Enhanced properties at nano scale. Comparison with bulk materials. Applications of nanomaterials

**Unit 2: Fabrication of Nanomaterials:** Top-Down Approach: Grinding, Planetary milling and Comparison of particles, Bottom-Up Approach: Wet Chemical Synthesis Methods, Micro emulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods: Chemical Vapour Depositions. **Kinetics at Nanoscale:** Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface Charges, Zeta Potential and pH

**Unit 3: Introduction to Instrumentation and characterization:** Instrumentation Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential, SEM, TEM, AFM, STM, DLS, Spectroscopy. etc.

**Unit 4: Carbon Nanomaterials:** Synthesis of carbon buckyballs, List of stable carbon allotropes extended fullerenes, metallofullerenes solid C60, bucky onions nanotubes, nanocones Difference between Chemical Engineering processes and nanosynthesis processes.

**Unit 5: Unit Applications, Safety and Environment:** Waste water treatment, nanobiotechnology: drug delivery, nanoclay, nanocomposites, Surface coatings. self-cleaning materials, hydrophobic nanoparticles. Societal, health and environmental impacts. Commercial processes for nanotechnology and chemical engineering applications: nanohydrogel, photocatalytic reactors, nanoclay synthesis, polymer nanocomposite, introduction to industries which produces commercial nanomaterials.

## Books Recommended:


1. Sulabha K. Kulkarni, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007.
2. Gabor L. Hornyak., H.F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2008.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4. K. K. Chattopadhyay, A.N. Banerjee, Introduction to Nanoscience and Nanotechnology, PHI Learning Private Limited.
5. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
6. Poole C., and Owens F., Introduction to Nanotechnology, John Wiley, New Jersey, 2003.
7. Singh Nalwa, 10 Volume Enclypedia of Nanoscience and NanoTechnology, 2004.
8. Catherine Brechignac, Philippe Houdy, Marcel Lahmani (Editors) Nanomaterials and Nanochemistry, Springer-Verlag Berlin Heidelberg, 2007.

**Subject: CT-OEL-705T** (BCE)

## Open Elective- II: Optimization of Chemical Processes (Theory)

| | | | |
|---|---|---|---|
| Lecture | : 3 Hours | No. of Credits | : 3 |
| University | : 70 Marks | College Assessment | : 30 Marks |

Duration of Examination: 3 Hours

## Course Objectives:

- Provide an overview of state-of-the-art optimization algorithms
- Impart the theoretical knowledge of chemical engineering principles that underpin optimization techniques.
- Enhance the modelling skills to describe and formulate optimization problems and their use for solving several types of practically relevant optimization problems in Chemical engineering

## Course Outcomes:

After completion of the course, students will be able to:

**CO1:** Understand the importance & relevance of optimization in chemical processes.

**CO2:** Formulate objective function for a given problem

**CO3:** Understand unconstrained single variable optimization and apply numerical methods for optimizing a function.

**CO4:** Understand multivariable optimization and linear programming techniques

**CO5:** Understand nonlinear programming techniques and use dynamic programming for optimization

**Unit 1:** **The Nature and Organization of Optimization Problems**: Scope and Hierarchy of Optimization, Examples of applications of Optimization, The Essential Features of Optimization Problems, General Procedure for Solving Optimization Problems, Obstacles to Optimization, Introduction to single and multi-objective optimization.

**Unit 2:** **Basic Concepts of Optimization**: Continuity of Functions, Unimodal vs. multimodal functions, convex and concave functions, convex region, Necessary and Sufficient Conditions for an Extremum of an Unconstrained Function, Interpretation of the Objective Function in terms of its Quadratic Approximation.

**Unit 3:** **Optimization of Unconstrained Functions**: One Dimensional search Numerical Methods for Optimizing a Function of One Variable, Scanning and Bracketing Procedures, Newton and Quasi-Newton Methods of Uni-dimensional Search, Polynomial approximation methods, How One-Dimensional Search is applied in a Multidimensional Problem, Evaluation of Uni-dimensional Search Methods.

**Unit 4:** **Multivariable Optimization**: Direct methods, Indirect methods – first order, Indirect methods – second order. **Linear Programming and Applications**: Basic concepts in linear programming, Degenerate LP's – Graphical Solution, Natural occurrence of Linear constraints, The Simplex methods of solving linear programming problems, standard LP form, Obtaining a first feasible solution, Sensitivity analysis, Duality in linear programming

**Unit 5:** Nonlinear programming with constraints The Lagrange multiplier method, Necessary and sufficient conditions for a local minimum, introduction to quadratic programming. **Optimization of Stage and Discrete Processes**: Dynamic programming, Introduction to integer and mixed integer programming. Applications to different processes.

## Books Recommended:


1. Edger T.F., Himmelblau D.M., Lasdon L.S., Optimization of Chemical Processes, 2nd ed., McGraw-Hill, USA, 2015.
2. Hillier F.S., Lieberman G. J., Introduction to Operations Research, 7th ed., McGraw-Hill, USA, 2001.
3. Rao S.S., Engineering Optimization: Theory and Practice, 4th ed., John Wiley & Sons Ltd., USA, 2009.

**Subject: CT-OEL-705T** (BCE)

## Open Elective- II: Biochemical Engineering (Theory)

Lecture : 3 Hours
University : 70 Marks
Duration of Examination: 3 Hours
No. of Credits : 3
College Assessment : 30 Marks

### Course Objectives:

- To impart the basic knowledge and overview of biotechnology covering the principles of cell and kinetics
- To develop general understanding on major metabolic pathways
- To evaluate different fermentation processes and to identify the bioreactor components and their application in design

To recognize the role of biochemical engineering in pollution management.

### Course Outcomes:

After completion of the course, students will be able to:

**CO1:** Understand the importance & relevance of bioprocessing.

**CO2:** Recognize the function of enzyme and develop the understanding about enzyme kinetics.

**CO3:** Develop general understanding on major metabolic pathways

**CO4:** Design bioreactor and analyze the performance of the bioreactor

**CO5:** Design and develop the wastewater treatment unit using principles of biochemical engineering

**Unit 1: Introduction to bioprocessing fundamentals:** Overview of microbiology, importance of microbiology, introduction to biochemistry, Classification and nomenclature of enzymes, industrial applications of enzymes, aerobic and anaerobic fermentation processes, solid state fermentation and submerged fermentation, Cell cultivation

**Unit 2: Enzyme Kinetics:** Models for simple and complex enzyme kinetics, modelling of effect of pH and temperature, models for insoluble substrate, models for immobilized enzyme systems, diffusional limitations, electrostatic and steric effects.

**Unit 3: Major metabolic pathways:** Introduction, Bioenergetics, Glucose metabolism, metabolism of nitrogenous compounds, respiration, metabolism of hydrocarbons, anaerobic metabolism, autotrophic metabolism.

**Unit 4: Cell Kinetics and Bioreactor design:** Growth Cycle for batch cultivation, Various types of Fermenters for cell growth, Sterilization techniques, Modifications of batch and continuous reactors, chemostat with recycle, multistage chemostat, fed-batch operation, perfusion system, active and passive immobilization of cells, diffusional limitations in the immobilized cell system,

Agitation and aeration, cultivation and media optimization, product recovery by various unit operations, Scaleup and difficulties.

**Unit 5: Biological waste water treatment:** Mixed Culture Introduction, Microbial participation in natural cycle of matter, activated sludge process, design and modeling of activated sludge process, nitrification, anaerobic digestion, mathematical modeling of anaerobic digester, anaerobic denitrification, phosphate removal.

## Books Recommended:


1. D.G. Rao, Introduction to Biochemical Engineering, Tata McGraw Hill Education, 2010.
2. M. L Shuler, F. Kargi, Bioprocess Engineering – Basic Concepts, 2nd Edition, Prentice Hall Publication, 2003.
3. J.E. Bailey, D.E. Ollis, Biochemical Engineering Fundamentals, 2nd Edition, McGrawHill, Inc., 1986.
4. A. Whitekar, P. F. Stanbury, S. J. Hall, Principles of Fermentation Technology, 2nd Edition, Butterworth-Heinemann, 1999.
5. S. Aiba, A. E. Humphrey and N. F. Millis, Biochemical Engineering, 2nd Edition, Academic Press, New York, 1973.
6. B. Atkinson, Biochemical reactors, Pion Limited, London, 1974.

**Subject: CT-CS-706P/1** (BCHT) **Food Technology Lab III: Food Processing (Practical)**

| | | | |
|---|---|---|---|
| Practical : 6 Hours | Tutorial: 0 Hour | No. of Credits | : 3 |
| University : 25 Marks | | College Assessment | : 25 Marks |
| Duration of Examination: 6 Hours | | | |

## Course Objectives:

To assist the students, use laboratory techniques common to basic Food Processing and to provide an opportunity to the students to evaluate the effective test methods used in sensory evaluation and analyse the resulting information.

## Course Outcomes (COs):

After the completion of the course, the students will be able to:

**CO1**: Use laboratory techniques common to basic Food Processing.

**CO2**: Apply the principles that make a food product safe for consumption.

**CO3**: Develop skills to monitor various food processing operations in food industries.

**CO4**: Evaluate the effective test methods used in sensory evaluation and analyze the resulting information.

## Experimentation:

1. Preparation of fruit juices, concentrates, squashes
2. Preparation of fruit jam/mixed fruit jam/marmalade, jellies,
3. Preparation of Tomato puree/ ketchups/sauce
4. Preparation of fermented cereal/vegetable (Sauerkraut) food products
5. Preparation of Cake
6. Preparation of Cookies
7. Preparation of Bread
8. Preparation of confectionary products like soft & hard boiled candies,
9. Preparation of fruit candies,
10. Preparation of groundnut, Dry fruits and Sesame chikki etc.
11. Preparation of dairy products like ice cream, paneer etc.

## Books Recommended:

1. Practical baking by Sultan W.J., AVI publishing Co. Inc. 1969.
2. Manufacture of confectionary by an industrialist, industry publishers Ltd., 22. R.G. Kar Road, Shyam Bazaar, Calcutta.
3. Preservation of fruits & vegetables by Girdharilal & Sidappa, ICAR, New Delhi, 1967

**Subject: CT-CS-706P/2** (BCHT) **Oil Technology Lab III: Processing & Analysis of Cosmetics, Paints & Oleo Chemicals (Practical)**

Practical : 6 Hours | Tutorial: 0 Hour | No. of Credits : 3

University : 25 Marks | College Assessment : 25 Marks

Duration of Examination: 6 Hours

## Course Objectives:

To enable students to develop the practical proficiency in cosmetic preparations

## Course Outcomes (COs):

After the completion of the course, the students will be able to:

**CO1**: Understand the techniques to be used for processing and analysis of cosmetics and paint formulations.

**CO2**: Acknowledge about interaction of additives and basic components on paint formulations.

**CO3**: Understand the principle involved in chemical and bio-chemical processing of oil allied products by performing reactions.

**CO4**: Develop the practical proficiency in cosmetic preparations.

## Experimentations:

1. To prepare shaving soaps.
2. To prepare shampoos
3. To prepare cleansing creams and lotions
4. Analysis of cosmetic products
5. To prepare the red oxide metal primer and evaluation of its properties
6. To prepare synthetic enamel and evaluation of its properties
7. Analysis of paints
8. Inter-esterification & Trans-esterification of oils by chemical and bio-chemical process and its analysis
9. Preparation of Melanised oil and its analysis
10. Analysis of Mono and Di – Glycerides in oil and fats.
11. Preparation of Alkyd Resin
12. Recovery of glycerine & its application
13. Isolation and detection of Protein Content from deoiled cake.

**Subject: CT-CS-706P/3 (BCHT) Petrochemical Technology Lab III: Petrochemical Processin**

**(Practical)**

| | | | |
|---|---|---|---|
| Practical : 6 Hours | Tutorial: 0 Hour | No. of Credits | : 3 |
| University : 25 Marks | | College Assessment | : 25 Marks |
| Duration of Examination: 6 Hours | | | |

## Course Objectives:

- To introduce various unit operations & unit processes used in the petroleum refining.
- To familiarize the students about various types of reactors used in process industries.

## Course Outcomes (COs):

After completion of the course, students will be able to:

**CO1:** Understand true boiling point distillation, its application & sketch mid percent curves and yield percent curves.

**CO2:** Gain the knowledge about mechanism of mass transfer & familiarize with various mass transfer equipments.

**CO3:** Understand thermal cracking reactions & evaluate the products.

**CO4:** Understand & evaluate kinetic parameters for various reactions.

## Experimentation (Minimum of 8 experiments to be conducted):

1. To study TBP distillation of a petroleum fraction
    - 1.1 Verification of ASTM and TBP correlations
    - 1.2 Distillate blending of TBP fractions
    - 1.3 Residue blending of TBP fractions
    - 1.4 Construction of Mid-Percent curves
    - 1.5 Construction of Yield curves
2. To Study thermal cracking of a petroleum fraction in a tubular flow reactor.
    - 2.1 Feed characterization.
    - 2.2 Determination of temperature profile of tubular flow reactor.
    - 2.3 Product characterization.
3. To study Liquid-liquid extraction
    - 3.1 Extraction of acid from kerosene fraction in Bubble column.
    - 3.2 Extraction of acid from kerosene fraction in Packed column.
    - 3.3 Extraction of acid from kerosene fraction in Mixer settler.
4. Study of adsorption isotherms for solid-liquid system

4.1 Adsorption of toluene from toluene-heptane system using silica gel as an adsorbent.

4.2 Adsorption of acetic acid from acetic acid-water system using granular activated carbon as an adsorbent.

5. Study of trans-esterification reaction and product analysis.

6. To study residence time distribution

6.1 In continuous flow stirred tank reactor

6.2 In plug flow reactor

7. Study of saponification reaction

7.1 In a batch reactor

7.2 In continuous stirred tank reactor

7.3 In plug flow reactor

8. To study the acid refining of lubricating oil stock using concentrated sulphuric acid at fixed set of parameters & observe the improvement.

9. To study coking reaction for the comparison of yield of coke & other products.

10. Flue gas analysis by Orsat's apparatus

11. Sulphonation of Alkyl Benzene to get acid slurry and neautralisation of acid slurry to get detergent type mixture.

12. To study Chlorination reaction:

12.1 Chlorination of benzene by photochemical reaction to observe yield versus time for definite intensity of UV light.

12.2 Liquid phase chlorination of petroleum oil to analyze chlorine content with the extent of reaction.

13. Qualitative & quantitative analysis of petroleum samples using HPLC, Gas chromatography.

**Subject: CT-CS-706P/4** (BCHT) **Pulp and Paper Technology III Lab: Paper Analysis (Practical)**

| | | | | | |
|---|---|---|---|---|---|
| Practical | : 6 Hours | Tutorial: 0 Hour | No. of Credits | : 3 |
| University | : 25 Marks | | College Assessment | : 25 Marks |

Duration of Examination: 6 Hours

## Course Objectives:

Students will gain an understanding of:

- Procedure to measure the physical properties of pulp and paper
- Analysis of various chemical composition present in pulp
- Identify the best suitable procedure for analysis of alkalinity or acidity of paper

## Course Outcomes (COs):

After successful completion of this course, the student will be able to:

**CO 1**: Analyze the chemical content of paper.

**CO2**: Test and calculate the physical properties of paper.

**CO3**: Evaluate the physical and chemical properties of handmade paper.

**CO4**: Summarize the optimal process condition in pulp and paper for manufacture of various paper grade.

## Experimentation:

1. Determination of moisture content of paper
2. Determination ash content of paper
3. Determination of 1%, 10%, and 18% NaOH solution solubility of a sample of pulp and paper
4. Determination of Permanganate number of a sample of pulp and paper
5. Determination of Kappa number of a sample of pulp and paper
6. Determination of Copper number of a sample of pulp and paper
7. Determination of rosin size in a sample of paper.
8. Determination of hot water extractable alkalinity or acidity of paper.
9. Determination of air permeability of paper.
10. Determination of smoothness of paper.
11. Determination of folding endurance of paper.
12. Determination of oil absorbancy of paper.
13. Determination of water absorbancy of paper.
14. To execute hand sheet paper making and analysis of the paper formed.
15. Determination of bursting strength and stiffness of paper.

**Subject: CT-CS-706P/5** (BCHT) **Plastics and Polymer Technology Lab III: Polymer Testing (Practical)**

| | | | | | |
|---|---|---|---|---|---|
| Practical | : 6 Hours | Tutorial: 0 Hour | | No. of Credits | : 3 |
| University | : 25 Marks | | | College Assessment | : 25 Marks |

Duration of Examination: 6 Hours

## Course Objectives:

- To understand the working of polymer testing machines.
- To set parameters on control panel of machines.
- To operate the testing instrument with safety precautions.

## Course Outcomes (COs):

After completion of the course, students will be able to:

**CO1:**Prepare specimen according to standard.

**CO2:** Arrange requirements for testing specimen.

**CO3:** Choose and set the testing parameters.

**CO4:** Conduct test with safety precaution and interpret the result.

**Experimentation: (Any Twelve)**

1. Determination of specific gravity of plastics.
2. Determination of moisture content of polymer.
3. Determination of viscosity of polymer by Brookfield viscometer.
4. Determination of tensile strength, % elongation and modulus of plastics.
5. Determination of Charpy/Izod impact strength of plastics.
6. Determination of toughness of plastic film by dart impact tester.
7. Determination of hardness of polymer.
8. Determination of HDT/VSP of plastics.
9. Determination of melt flow index (MFI) of polymer.
10. Determination of static coefficient of friction of plastic film.
11. Determination of breakdown voltage of polymer.
12. Determination of stain resistance of polymer.
13. Determination of environmental stress cracking resistance (ESCR) of plastics.
14. Determination of flammability of polymer.
15. Perform adhesive testing- peel, shear, tension test.

**Subject: CT-CS-706P/6 (BCHT) Surface Coating Technology Lab III: Formulation and Evaluation of Coatings (Practical)**

| | | | |
|---|---|---|---|
| Practical : 6 Hours | Tutorial: 0 Hour | No. of Credits | : 3 |
| University : 25 Marks | | College Assessment | : 25 Marks |
| Duration of Examination: 6 Hours | | | |

## Course Objectives:

- To familiarize students with formulation and evaluation various paints and coatings.

## Course Outcomes (COs):

After completion of the course, students will be able to:

**CO1:** Select components of paints and coatings according to it's type.

**CO2:** Formulate the various paints and coatings for desired applications.

**CO3:** Evaluate paints and coatings for expected performance.

**CO4:** Modify paints and coatings for improvement in performance.

## Experimentation:

1. Formulation and Evaluation of Red oxide.
2. Formulation and Evaluation of Red oxide -Zinc Chrome Primers.
3. Formulation and Evaluation of Universal Zinc Chrome Primers.
4. Formulation and Evaluation of Synthetic Enamels.
6. Formulation and Evaluation of Interior and Exterior Emulsion Paints.
7. Formulation and Evaluation of Varnish.
8. Formulation and Evaluation of Aluminum paint.
9. Formulation and Evaluation of Etch primer.
10. Formulation and Evaluation of General-purpose Air-drying paint.
11. Formulation and Evaluation of Zinc silicate primer.
12. Formulation and Evaluation of Powder Coatings.
13. Formulation and Evaluation of Stoving Finish.
14. Formulation and Evaluation of Automotive Finish.
15. Formulation and Evaluation of Marine Coating.
16. Formulation and Evaluation of Epoxy two-pack coatings.
17. Formulation and Evaluation of PU coatings.
18. Formulation and Evaluation of Coal Tar -Epoxy Two pack coating.

19. Formulation and Evaluation of Bituminous paint.
20. Formulation and Evaluation of Cement Paint.
21. Formulation and Evaluation of Putty for Wood, Metal and Cement.

| **Subject: CT-PCC-707P** (BCE) | **Mass Transfer Lab (Practical)** |
|---|---|
| Practical : 3 Hours | No. of Credits : 1.5 |
| University : 25 Marks | College Assessment : 25 Marks |
| Duration of Examination: 6 Hours | |

## Course Objectives:

- To perform experiments related to estimation of diffusion coefficient and mass transfer coefficient for vapor-liquid, liquid-liquid and solid-liquid systems.
- To perform experiments related to evaporation from free surface, batch & forced draft drying, crystallization and adsorption.
- To introduce different experiments based on types of distillation, absorbers, extractors and membrane-based method of separation
- To relate theoretical knowledge with laboratory-based experiments for the analysis of input and output conditions.

## Course Outcomes:

After completion of the course, students will be able to:

**CO1**: Understand diffusion mechanism and estimation of mass transfer coefficient for vapor-liquid, liquid-liquid and solid-liquid systems

**CO2:** Understand and analyse equilibria in distillation, absorption, extraction and membrane-based processes

**CO3:** Study of evaporation from free surface, batch & forced draft drying, crystallization and adsorption for estimation of various process parameters

**CO2:** Apply various approaches and to estimate the desired degree of separation using distillation, absorption, extraction etc. and Apply separation principles in estimation of design parameters of contacting equipment for distillation, absorption, extraction.

**LIST OF EXPERIMENTS:**

Required to perform minimum 10 practicals from the list given below:

1. Winkelmann's method – To find the diffusion Coefficient of vapour in still air
2. Liquid Diffusion – To find the Diffusion Coefficient for a liquid –liquid system
3. To calculate rate of Drying.
4. Studies of crystallization phenomena in Batch Crystallization
5. To evaluate the performance of Cooling Tower.
6. To find the mass transfer coefficient in a wetted wall Column
7. Determination of solid-liquid mass transfer coefficient.

8. Evaporation from free surface.
9. Determination of HTU in packed bed.
10. Study of Ion exchange process.
11. Removal of impurities by use of adsorption techniques.
12. To verify Rayleigh's Equation for Simple Distillation
13. To construct the boiling point diagram for binary – miscible system
14. Distillation using Sieve Plate, Bubble Cap Column
15. To determine the thermal and vaporization efficiencies in Steam Distillation
16. Single/multiple stage extraction studies
17. To prepare the ternary phase diagram.
18. Soxhlet Extraction
19. Absorption studies in packed column
20. Absorption studies in bubble column
21. Batch/ Continuous Leaching
22. Membrane separation

**Books Recommended:**


1. J. M. Coulson, J. F. Richardson with J. R. Backhurst, J.H. Harker, Chemical Engineering Vol. I: Fluid Flow, Heat Transfer and Mass Transfer, Sixth Edition, Butterworth-Heinemann an imprint of Elsevier
2. J. M. Coulson, J. F. Richardson with J. R. Backhurst, J. H. Harker, Chemical Engineering Vol. II: Particle Technology and Separation Processes, Fifth Edition, Butterworth-Heinemann an imprint of Elsevier
3. R. E. Treybal, Mass Transfer Operations, 3rd edition, McGraw Hill, 1980.
4. C. J. Geankoplis, Transport Processes and Separation Process Principles, 4 Edition, Prentice Hall, 2003
5. S. L. Pandharipande, Principles of Distillation, Dennet and Co.
6. W. L. McCabe, J. C. Smith, P. Harriott, Unit Operations of Chemical Engineering, Seventh Edition, McGraw Hill Publication, 2005.
7. B. K. Dutta, Principles of Mass transfer and separation processes, PHI Learning, 2007.
8. J. D. Seader, E. J. Henley, Separation Process Principles, Wiley, 1998.

**Subject: CT-CS-708P** (BCHT)

**Seminar and Summer Internship Evaluation**

| | | | |
|---|---|---|---|
| Practical | : 3 Hours | No. of Credits | : 1.5 |
| University | : 00 Marks | College Assessment | : 50 Marks |

Duration of Examination: 6 Hours

## Course Objectives:

- To develop self-learning habit for understanding recent developments in the field of engineering.
- To develop report writing and presentation skills.

## Course Outcomes:

After completion of the course, students will be able to:

**CO1:** Carry out literature survey on a topic of latest development / innovation in chemical engineering and technology.

**CO2:** Analyze topics related to chemical technology for environment and sustainability issues.

**CO3:** Apply ethical principles and social responsibility in execution of individual/team work.

**CO4:** Prepare a formatted report on selected topic after study / experimentation and present a work on selected topic using modern presentation software.

The seminar work shall consist of preferably study of certain phenomenon, system, equipment, process design in depth, review of certain research work, compilation and analysis of certain engineering/ management activity including costing, safety, administration, market study, field study, etc. or on any relevant topic which may have importance in chemical engineering and technology.

Students are expected to work individually on the seminar and the report shall be a bound journal written in :chnical format with illustrations by graphs, charts, tables, photographs etc. about the specific work undertaken by the student. The number of copies of the report shall be such that the guide, departmental library and the concerned student shall have one copy each. Students will also be required to make an oral presentation for review using modern presentation software in presence of faculty and students of Programme.

Further, each student needs to submit a written report (3 copies) based on the work carried out during the Summer Internship (3-4 weeks) undergone at the end of 6$^{th}$ semester in the given format. The report and certificate shall be countersigned by the Supervisor from Industry / Institute as the case may be. Performance of the student will be assessed based on the written report and a presentation to a departmental committee of faculty member. Students will be evaluated and marks will be awarded based on the written report and a presentation; evaluated by a committee of faculty members.