Rashtrasant Tukadoji Maharaj Nagpur University

Faculty of Science & Technology

Structure & Syllabus

5th and 6th Semester B. Tech

(Chemical Technology)

SCHEME OF EXAMINATION

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR

FIFTH SEMESTER B. TECH (CHEMICAL TECHNOLOGY)

Sr. No.	Code Theory (T) Practical (P)	Subject	Board	Work Load Hrs				Credit				Marks				Total Marks	Min. % of Marks Required for Passing
												Theory		Practical			
				L	P	T	Total	L	P	T	Total	College Assessment	University	College Assessment	University		
1	CT-PCC-501T	Heat Transfer	BCE	3	0	1	4	3	0	0	3	30	70	-	-	100	45%
2	CT-PCC-502T	Chemical Reaction Engineering I	BCE	3	0	1	4	3	0	0	3	30	70	-	-	100	45%
3	CT-PCC-503T	Mass Transfer I	BCE	3	0	0	3	3	0	0	3	30	70	-	-	100	45%
4	CT-CS-504T	*Special Technology II	BCHT	3	0	0	3	3	0	0	3	30	70	-	-	100	45%
5	CT-OEL-505T	Open Elective I	BCE	3	0	0	3	3	0	0	3	30	70	-	-	100	45%
6	CT-HSMC-HS-506T	HASS III Industrial Economics & Project Management	BCE	2	0	0	2	2	0	0	2	15	35	-	-	50	45%
7	CT-PCC-507P	Chemical Reaction Engineering I Lab	BCE	0	3	0	3	0	1.5	0	1.5	-	-	25	25	50	50%
8	CT-CS-508P	*Special Technology I Lab	BCHT	0	3	0	3	0	1.5	0	1.5	-	-	25	25	50	50%
9	CT-PCC-509P	Heat Transfer Lab	BCE	0	3	0	3	0	1.5	0	1.5	-	-	25	25	50	50%
10	MC	Constitution of India/ Essence of Indian Traditional Knowledge		2	0	0	2	0	0	0	0	-	-	-	-	-	Audit Course
		Total		**19**	**9**	**2**	30	17	4.5	0	21.5	165	385	75	75	700	-

Elective	Subject Name		
	BOARD		
	BCE		
Open Elective I	Environmental Pollution and Control	Renewable Energy	Energy Conservation and Recycling

*****Food Technology, *Oil Technology, *Petrochemical Technology, *Pulp and Paper Technology,
*Plastic and Polymer Technology, *Surface Coating Technology

SCHEME OF EXAMINATION

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR

SIXTH SEMESTER B. TECH (CHEMICAL TECHNOLOGY)

Sr. No.	Code Theory (T) Practical (P)	Subject	Board	Work Load Hrs				Credit				Marks				Total Marks	Min. % of Marks Required for Passing
												Theory		Practical			
				L	P	T	Total	L	P	T	Total	College Assessment	University	College Assessment	University		
1	CT-PCC-601T	Chemical Reaction Engineering II	BCE	3	0	1	4	3	0	0	3	30	70	-	-	100	45%
2	CT-PCC-602T	Process Equipment Design	BCE	3	0	1	4	3	0	0	3	30	70	-	-	100	45%
3	CT-PCC-603T	Process Dynamics & Control	BCE	3	0	1	4	3	0	0	3	30	70	-	-	100	45%
4	CT-CS-604T	*Special Technology III	BCHT	3	0	0	3	3	0	0	3	30	70	-	-	100	45%
5	CT-CS-605T	*Special Technology IV	BCHT	3	0	0	3	3	0	0	3	30	70	-	-	100	45%
6	CT-HSMC-HS -606T	HASS IV Industrial organization & Entrepreneurship Development	BCE	2	0	0	2	2	0	0	2	15	35	-	-	50	45%
7	CT-PCC-607P	Chemical Reaction Engineering II Lab	BCE	0	3	0	3	0	1.5	0	1.5	-	-	25	25	50	50%
8	CT-PCC-608P	Process Equipment Design & Drawing Lab	BCE	0	3	0	3	0	1.5	0	1.5	-	-	25	25	50	50%
9	CT-PCC-609P	Process Dynamics & Control Lab	BCE	0	3	0	3	0	1.5	0	1.5	-	-	25	25	50	50%
10	CT-CS-610P	*Special Technology II Lab	BCHT	0	3	0	3	0	1.5	0	1.5	-	-	25	25	50	50%
11	CT-CS-611P	Summer Internship (3-4 weeks) (to be evaluated in seventh semester)	BCHT	0	0	0	0	0	0	0	0	-	-	-	-	-	-
		Total		**17**	**12**	**3**	**32**	**17**	**6**	**0**	**23**	165	385	150	100	800	-

*Food Technology, *Oil Technology, *Petrochemical Technology, *Pulp and Paper Technology,
*Plastic and Polymer Technology, *Surface Coating Technology

Rashtrasant Tukadoji Maharaj Nagpur University

Faculty of Science & Technology

Syllabus for

Fifth Semester B. Tech Chemical Technology

Subject: CE-PCC-501T (BCE) **Heat Transfer (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 understand basic concepts and laws of heat transfer.
- To Formulate heat balance equations for heating, boiling & related operations.
- To Evaluate the coefficients for heat transfer operations based on concepts of resistances.
- To classify, analyse and design of double pipe heat exchanger, shell & tube heat exchanger and evaporators.

Course Outcomes:

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

CO1: Understand the basic laws governing modes of heat transfer & estimation of heat rate, load, transfer area & temperature distribution for various geometries of objects for steady & unsteady state heat transfer.

CO2: Understand heating, cooling operations & phenomena of natural & forced convection and evaluation of heat transfer coefficient.

CO3: Understand boiling & condensation operations and evaluation of heat transfer coefficient.

CO4: Estimation of design parameters of double pipe and shell & tube heat exchanger from first principle as per requirements of the situation/problem

CO5: Understand radiative heat transfer. Analysing given situation/problem for the estimation of heat transfer coefficient for different types of heat transfer equipment such as packed bed, fluidized bed.

Unit 1: Concept of Heat Transfer, Unsteady State Heat Transfer, Fins & Insulation: Introduction & mechanism of heat transfer. Development and use of general differential equation for heat transfer rate & temperature distribution for steady state heat conduction for various shapes & geometries of solids with various boundary conditions, with & without heat generation. Use

of lumped capacitance, Heisler charts and error function methods for unsteady state heat transfer. Classification of fins. Fin efficiency and overall effectiveness. Classification and selection of various types of thermal insulations. The concept of critical and economical thickness of insulation and its evaluation for cylindrical and spherical heat transfer equipment.

Unit 2: Natural & Forced Convection: Heat Transfer without Phase Change: Introduction to natural and forced convection in laminar and turbulent flow over flat plate, over cylinder & sphere and through closed channels. Concept and use of thermal & hydrodynamic boundary layer and its significance. Prediction of heat transfer coefficient using theoretical, empirical and analogies concepts.

Unit 3: Condensation & Boiling: Convection Heat Transfer with Phase Change: Mechanism of condensation: Nusselt's approach and its extension. Heat transfer in saturated pool & forced convection boiling of liquids. Study of Boiling curve: Its significance and relevance in constant wall temperature & constant heat flux boiling with specific reference to critical (Maximum) heat flux and minimum heat flux (Ladenfrost point).

Unit 4: Heat Exchangers & Evaporators: Concept of fouling resistance & overall heat transfer coefficient in heat exchangers. Classification of heat exchangers. Design and rating of double pipe, shell and tube heat exchangers by LMTD and ε-NTU methods. Compact heat exchangers: Plate heat exchangers, helical coil heat exchangers, spiral heat exchangers, regenerators. Classification of evaporators. Steam economy and capacity of multiple effect evaporators. Design considerations of evaporators.

Unit 5: Radiation & Special Cases of Heat Transfer: Radiation fundamentals, properties of materials and heat exchange. Use of solar energy & thermic fluids. Heat transfer in furnaces, agitated vessels, fluidized beds, packed beds, jacketed vessels, immersed helical and spiral coil equipment.

Books Recommended:

1. B. K. Dutta, Heat transfer Principles and Applications, PHI Private Limited, 2001.
2. S. D. Dawande, Principles of Heat Transfer and Mass Transfer, Denett & Co, 2009.
3. R. K. Rajput, Heat and Mass Transfer, S. Chand & Company Ltd., 2007.
4. C. J. Geankoplis, Transport Processes and Separation Process Principles, 4 Edition, Prentice Hall, 2003
5. 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
6. D. S. Kumar, Basics of Heat & Mass Transfer, Eight Edition, S.K. Kataria & Sons, 2010.

Subject: CT-PCC-502T (BCE) Chemical Reaction Engineering I (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:

- Basic Concepts of Kinetics and Rate Laws
- Design and Rating of Ideal Reactors including heat effects
- Interpretation of Rate data
- Design and Rating of Reactors involving multiple reactions including heat effects
- Analysis of Non-ideal flow Behavior in Reactors

Course Outcomes:

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

CO1: Determine the rate laws for reactions using concentration time data obtained from batch reactor

CO2: Determine volume of ideal reactors (batch, mixed flow and plug flow) for given conversion using model equations

CO3: Suggest the best arrangement of a set of combinations of ideal reactors (reactors in series / parallel) to maximize the conversion

CO4: Determine the volume of mixed flow reactor, adiabatic plug flow reactor, adiabatic recycle reactor, and plug flow reactor with optimum temperature progression

CO5: Plot C, E, and F curves and explain the concepts of residence time distribution and also define mechanism of catalysis and related concepts.

Unit 1: Kinetics of homogeneous reactions: Irreversible and reversible reactions, Equilibrium; Order and molecularity of reaction. Elementary and non-elementary reactions; Fractional conversion and equilibrium conversion. Rate of reaction based on all components of the reaction and their interrelation. Law of mass action, Rate Constant-Based on thermodynamic activity, Temperature dependency of rate Constant -Arrhenious law, Transition state theory and collision theory. Temperature and conversion profiles for exothermic and endothermic reactions

Unit 2: Batch Reactor Data: Batch reactor concept, Constant volume Batch reactor system; Design equation for zero, first, second order irreversible and reversible reactions, graphical interpretation of these equations and their limitations, Variable volume Batch reactors. Design equation for first and second order irreversible and reversible reactions, Graphical interpretation of their limitations, Multiple reactions-stoichiometry and rate equations for

series and parallel reactions, Non elementary single reactions Development of rate expression; Chain reactions development of rate expressions, Batch recycle reactors, Semi-batch reactor, related examples etc.

Unit 3: Flow Reactors: Types of flow reactors and their differences, space-time and space velocity, Design equation for plug flow reactor and CSTR; Size comparison of single reactors; Different reactor arrangements, optimum size determination; Performance of Recycle reactors, Auto-catalytic (recycle) reactors, Yield and selectivity, Best operating condition for mixed and plug flow reactors, Multiple reactions in CSTR and PFR reactors. Maximization of desired product rate in a plug flow reactor and back mixed reactor, product distribution in multiple reactions, related examples etc.

Unit 4: Temperature and Pressure Effects: Equilibrium Conversion, Optimum temperature progression, Adiabatic and non-adiabatic operations, Temperature and conversion profiles for exothermic and endothermic reactions and related examples etc.

Unit 5: Residence Time Distribution: Residence time distribution in reactors: E, F and C curve, and their relationship, conversion in reactors having nonideal flow; models for non-ideal flow: Dispersion model, dispersion number, Tank in Series model, Multi parameter model, mixing of fluids: Self-mixing of single fluid. Two parameter models.

Books Recommended:

1. O. Levenspeil, Chemical Reaction Engineering, 3rd Edition, John Wiley & Sons, 2001.
2. H. S. Fogler, Elements of Chemical Reaction Engineering, 3rd Edition, PHI, 2002.
3. S. D. Dawande, Chemical Reaction Engineering, 3rd Edition, Denett & Co, 2009.
4. S. M. Walas, Reaction Kinetics for Chemical Engineers, McGraw Hill, 1959.
5. J. M. Smith, Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1987.

Subject: CT-PCC-503T (BCE) **Mass Transfer I (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:

- The objective of this course is to understand the principles of diffusion, convective mass transfer, theories of mass transfer, gas absorption and distillation.
- This basic knowledge will be useful to design various mass transfer equipment's.

Course Outcomes:

After completion of the course, students will be able:

CO1: To understand concept and theories of diffusion.

CO2: To understand convective mass transfer, interphase mass transfer and theories of mass transfer and their applications.

CO3: To understand gas absorption in plate and packed column and design; absorption in wetted wall columns, packed tower and spray tower.

CO4: To understand absorption in tray towers, tray efficiencies, calculation of number of trays for absorption, Equipments for Absorption

CO5: To understand Batch distillation; continuous binary fractionation Azeotropic distillation multicomponent distillation and Methods of distillation

Unit 1: Constitutive laws of diffusion; unsteady state diffusion Introduction to mass transfer, concept of diffusivity, Molecular diffusion in gases, liquids and solids, diffusivities of gases and liquids, types of diffusion, Fick's and Maxwell law of diffusion, Eddy diffusion, Steady state molecular diffusion. Empirical equations used to determine diffusivity through gas and Liquid

Unit 2: Convective mass transfer, interphase mass transfer and mass transfer coefficients, mass transfer correlations Mass transfer theories/models Effect of chemical reaction on mass transfer Concept of mass transfer coefficients, their relationship, mass transfer under laminar and turbulent flow past solids, boundary layers, mass transfer at fluids surfaces correlation of mass transfer coefficients, J D , HTU, and NTU concepts, theories of mass transfer, interphase mass transfer and overall mass transfer coefficients, application to gas-liquid and liquid-liquid systems.

Unit 3: Equilibrium stages and transfer units: number and height of transfer units; stage efficiency. Gas absorption plate and packed column design; reactive absorption Mechanism of gas

absorption, equilibrium in gas absorption, absorption in wetted wall columns, estimation of transfer coefficient, absorption in packed tower and spray tower, calculation of HETP, HTU, NTU, calculation of height of packed and spray tower.

Unit 4: Absorption in tray towers, absorption and stripping factors, tray efficiencies, calculation of number of trays for absorption, Equipment for Absorption

Unit 5: Batch distillation; continuous binary fractionation Azeotropic distillation; use of steam Introduction to multicomponent distillation Vapour – liquid equilibria for ideal and non-ideal systems, positive and negative deviations from ideality, relative volatility. Methods of distillation - differential, flash, low pressure, batch rectification, Continuous rectification for binary system, multistage (tray) towers, Lewis – Sorel, McCabe Thiele Method, Multiple feeds, side streams, tray efficiencies, NTU, HTU, HETP concept and calculations concept of reflux, Underwood-Fenske equation, Partial and total Condensers, reboilers, Ponchon Savarit method Suggested

Books Recommended:

1. Binay K. Dutta, Principles of Mass Transfer and Separation Processes,2nd edition, Prentice Hall of India,2007
2. R. E. Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983.
3. E. D. Cussler, Diffusion - Mass Transfer in Fluid Systems, Cambridge University Press, Cambridge 1984.
4. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980.
5. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, Prentice Hall, India, 1993.

Subject: CT-CS-504T (BCHT) **Food Technology II (Theory)**

Food and Industrial Microbiology

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 familiarize the various types of food spoilage microorganisms and their growth factors.
- To understand the procedures and techniques of detection of microorganisms in foods.
- To develop an understanding of spoilage microorganisms and their effects on food.
- To integrate their basic knowledge of microbiology, chemistry, biochemistry, food processing.

Course Outcomes:

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

CO1: Understand and classify different types of microorganism which are present in the environment.

CO2: Describe the growth cycle of microorganisms and internal and external factors and predict microorganisms, which can cause food spoilage.

CO3: Interpret the mode of spoilage in various food products and type of spoilage microorganism.

CO4: Evaluate the measures required to control undesired microorganisms in food using heat. Predict the impact of food processing techniques on microbiology of food.

CO5: Evaluate the measures required to control undesired microorganisms in food using non thermal techniques. Predict the impact of food processing techniques on microbiology of food.

Unit 1: The Trajectory of Food Microbiology: Classification of microorganisms. Structure of typical bacterial cell. Study of bacteria, yeasts, and molds with respect to morphology, physiological requirements, reproduction. Introduction to viruses. Food Enzymes. Nutritional requirements of microorganisms. Composition of nutrient media. Comparison of natural, synthetic, differential, selective and enrichment media. Methods of isolation and characterization of microorganisms.

Unit 2: Microorganisms and Food Materials: Growth of microorganisms. Microbial growth and its quantification Factors affecting growth and survival of microorganisms in foods Role of

Predictive Microbiology. Overview of bioprocessing, Growth curve, Phases of growth curve. Specific growth rate and generation time. Synchronized and balanced growth. growth measurement, growth cultivation, Growth cultivation-batch and continuous type.

Unit 3: Microbiology of Food Commodities: Mode of Food Spoilage. Food Spoilage Micro-organisms. Overview of spoilage, Microbial spoilage of fruits and fruit juices, Microbial spoilage of vegetables. Microbial spoilage of cereals and bakery foods, Microbiology of meat, poultry, sea foods, Microbial spoilage of canned foods.

Unit 4: **Microbiology of Food Preservation (Thermal preservation):** Roles of Physical, Chemical and Microbiological factors in food spoilage, Thermal processing, Effect of temperature on growth of microorganisms. D10 value, F value, Z value and TDT curve. Effect of water activity on food preservation. Control of microorganisms by high and low temperature. Structure and operation of autoclave. Sterilization by dry and moist heat.

Unit 5: Microbiology of Food Preservation (Non -Thermal preservation): Non thermal processing Chemical methods, Natural antimicrobial compounds. Control of microorganism by physical and chemical methods., irradiation and chemicals on growth of microorganisms. Method of evaluation of antimicrobial agents.

Books Recommended:

1. Microbiology, Vol I & II by C B Powar and H F Daginawala
2. Microbiology by M J Pelczar, R D Reid and C S Chan, Tata McGraw Hill Pub.Co, Ltd, New Delhi
3. Food Microbiology by W C Frazier, Tata McGraw Hill Pub.Co.Ltd., New Delhi

Subject: CT-CS-504T (BCHT) Oil Technology II (Theory)

Quality Control Techniques & Fats Splitting

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 provide a complete knowledge on quality control & separation techniques applicable in field of oil technology.
- To describe the mechanism by which fat splitting is carried and to give chemical explanation of the problems encountered.
- The Technocrat in this field will have a in depth exposure to Specialty field in Oleo chemicals and glycerol processing Industries.
- To become able to calculate various parameters for fat splitting operation.
- To make students expert in making design of various pilot plants covered in this course

Course Outcomes:

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

CO1: Understand and Inculcate knowledge on various quality control techniques, & separation of fats & fatty acids methods like GC, HPLC, NMR, UV, IR etc...

CO2: Estimate the various analyses like, metal content of hydrogenated oils, Sulphur and phosphatide content of crude and refined vegetables oils etc...

CO3: Understand application of GC-MS, SFC-GC, LC-MS.

CO4: Understanding the well-grounded knowledge of various aspects in the field of oleo chemical industry as well as derived products from oils & fats by fat splitting operations. Old & advanced processes of fat splitting are also well explained.

CO5: Understand the technical concepts of glycerol & industrial uses of fats & oils.

Unit 1: Separation Techniques: Quality Control techniques, Enzyme hydrolysis, Dilatometric Measurements and their significance. Analysis of fatty acids. Techniques of separation of fats and fatty acids**:** Low temperature crystallization, Chromatographic methods of separation: Gas, liquid chromatography, High performance liquid chromatography(HPLC), Spectroscopic method: Infrared Red, ultraviolet Visible spectroscopy, Nuclear Magnetic Resonance (NMR)

Unit 2: Quality Control Methods: Specific quality control methods, metal content of hydrogenated oils, Sulphur and phosphatide content of crude and refined vegetables oils, wax content of vegetable oils, Testing of DOC. Polymorphism of fats and fatty acids. Application of TLC-FID analyser, GC-MS, SFC-GC, LC-MS, Induced Coupled Plasma – MS in the analysis of oils and fats

Unit 3: Technology of Fat Splitting: Chemistry of fat splitting, Hydrolysis of oils and fats, composition of partially split fats, Effect of temperature, pressure, catalyst and ratio of reactants in hydrolysis of fats; Degree of splitting, Plants and processes employed for fat splitting, Twitchell process, and enzymatic fat splitting. Semi, continuous and modern processes of fat splitting

Unit 4: Technology of Glycerol: Sources, properties, grades, and types of glycerol, recovery and purification of glycerine from fat splitting crudes and waste soap lye's, analysis and industrial uses of glycerol Synthetic glycerine

Unit 5: Industrial Uses of Fats and Oils: Leather, Textiles, linoleum, rubber, Factices, protective coatings, food, pharmaceutical, explosives, paper, water proofing, Industrial lubricants Bio-Lubricants, Lubricant additives, Plasticizers, biodiesel, Lubricating Greases, Manufacture, Properties, types, ingredients, additives, analysis. Fatty Alcohols and Amines

Books Recommended:

1. A. J. C. Anderson, "Refining of Oils and Fats for Edible Purposes," 2nd Edition, Pergamon Press, London, 1962, pp. 92-103.
2. Formulating and Processing for Applications, Third Edition By Richard D. O'Brien
3. Bailey's Industrial Oil and Fat Products, 6 Volumes, Wiley-Interscience Publication, New York 21
4. Edible Oils and Fats--A Global Overview of Technological Developments, Guinness Centre, Taylors Lane,, Ireland.
5. Vegetable Oils in Food Technology (Chemistry and Technology of Oils and Fats), Frank Gunstone, Wiley Blackwell; USA

Subject: CT-CS-504T (BCHT)

Petroleum Refining & Petrochemical Technology-II (Theory)

Petroleum Primary Processing Technology

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 familiarize the students about various hydrocarbons, present in Petroleum.
- To evaluate petroleum & various petroleum products.
- To introduce various operations & processes in the petroleum refining.
- To make the students to learn the primary refining operation of crude oil its treatment techniques.

Course Outcomes:

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

CO1: Know various hydrocarbons & non-hydrocarbons present in oil & gas and classify crude into different bases.

CO2: Understand different petroleum products obtained from the refinery and methods to evaluate various physio-chemical properties.

CO3: Gain the knowledge about the various unit operations in petroleum refinery.

CO4: Understand about lubricating oils & illustrate their manufacturing steps.

CO5: Discuss various petroleum specialty products & their applications.

Unit 1: General: Composition of Petroleum, Types of crudes, Characteristics and classification, Crude oil properties, Indigenous and imported crudes – Crude availability Vs demands, major petroleum fractions & products.

Unit 2: Crude Processing: Basic concepts of crude processing, Atmospheric distillation, Vacuum distillation & petroleum fractions obtained from ADU & VDU, Types of trays, flow pattern in the trays, Reflux types and its significance.

Unit 3: Testing of Petroleum Products: Standards & Testing of crude oil and its commercial Products with reference to physical, thermal, electrical, optical & other properties, Specifications and their Significance, Latest norms (Bharath stage IV, VI) for fuels.

Unit 4: Lube Distillate Production Techniques: Lubricating oil, classification & specification, characteristics, additives, techniques for vacuum distillates with different processes like solvent extraction De-asphalting, dewaxing, hydrofining, catalytic dewaxing and clay contact process for Production of lubricating oils.

Unit 5: Specialty Products and Finishing Processes: Asphalt manufacture, Air blowing technology, Bitumen Types and their properties, Acid gas removal and Sulphur removal techniques, Sulphur recovery, Specialty Products: Industrial Grease- Manufacture of Calcium Grease, Liquid Paraffin and Petroleum Jelly's. Polymer Gasoline: Feed Stock and Reactions of Polymer Gasoline

Books Recommended:

1. Ram Prasad, "Petroleum Refining Technology", Khanna Publishers.
2. Bhaskara Rao, B.K., "Modern Petroleum Refining Processes", 3rd edition, Oxford and IBH Publishing Company Pvt. Ltd.

References Books:

1. James H. Gary and Glenn E. Handwerk., "Petroleum Refining Technology and Economics", 4th Edition, Marcel Dekker Inc.,2001.
2. Nelson, W.L., "Petroleum Refinery Engineering", McGraw Hill Publishing Company Limited, 1985.
3. Hobson, G.D., "Modern Petroleum Refining Technology", 5th Edition, John Wiley Publishers, 1984

Subject: CT-CS-504T (BCHT) Pulp and Paper Technology II (Theory)

Raw Material Processing, Mechanical Pulping and Recycled Paper Process

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

Duration of Examination: 3 Hours

Course Objectives:

- Measurement of wood as raw material, transportation, stacking and storage
- Different equipments used to convert wood into chips and screening to obtain optimum chips for pulping.
- Defiberation of wood using thermomechnical, refiner mechanical and semi chemical pulping process.
- Conversion of wood to very cheap groundwood.
- Recycling of wastepaper and rags.

Course Outcomes:

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

CO1: To summarize the different methods of wood transportation and storage process undertaken by paper mill.

CO2: To distinguish the different wood chipping process and choose the optimal sized chips to make good quality pulp.

CO3: To associate various process to mechanically defibrate the wood chips into pulp

CO4: To relate pulp quality manufactured from groundwood pulping with wood morphology

CO5: To prioritize recycling of pulp from rags and secondary fibers process and discriminate the ink removal mechanism

Unit 1: Order of pulp wood operation, measurement, wood yard layout, wood preparation plant, debarking of pulp wood logs, pulp wood storage and conveying. Preparation of pulp wood chips handling and conveying chip storage.

Unit 2: Manufacture of mechanical pulp, woods used, types, grades and uses, advantages and limitations. Equipments for ground wood pulping process, pulp mill operations, variables affecting the process, power requirements, water and pulp showers.

Unit 3: Refiner Mechanical Pulping Process, pulp properties and uses, single-stage and two-stage processes, plate designs, steam cooking. Thermomechanical Process, variables, pulp

characteristics and applications. Hot sulfite chemimechanical process, variables, properties and uses, chemiground wood pulping, applications, properties and uses.

Unit 4: Semichemical pulping, NSSC process, wood preparation, digestors, fibrizing, washing, cleaning and chemical recovery and effluent disposal, properties and uses. Acid sulphite, semichemical pulping, bisulphate semichemical pulping, Kraft semichemical and cold soda semichemical processes.

Unit 5: Secondary fibers recycling, classification, pulping process, deinking processes and chemicals used, printing process and ink grades, various methods for bleaching of recycled fibers, Screening and centricleaning of recycled pulp, recycling of rag pulp and hand made paper.

Books Recommended:

1. Papermaking Science and Technology, Vol- 5 Mechanical Pulping, Joint Textbook Committee of TAPPI and Finnish Paper Association, TAPPI PRESS, 2002.
2. Papermaking Science and Technology, Vol- 7 Recycled Fiber and Deinking, Joint Textbook Committee of TAPPI and Finnish Paper Association, TAPPI PRESS, 2002.
3. Pulp and Paper Manufacture Vol. 1 Properties of Fibrous Raw Material and Their Preparation For Pulping, TAPPI PRESS, M. J. Kocurek(Ed), (1994).
4. Pulp and Paper Chemistry and Technology Vol.- 1, Wood Chemistry and Biotechnology, By Gunnar Henriksson, Goran Gellerstedt and Monika ek, De Gruyter, 2009.
5. The Handbook of Pulp and Paper Technology (Fourth edition) By Gary Smook, TAPPI PRESS, 2016.

Subject: CT-CS-504T (BCHT) Plastics and Polymer Technology II(Theory)

Polymer Materials

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 families of polymer and its members.
- To acquire the knowledge of polymer manufacturing.
- To understand the properties of polymers for selecting suitable polymer for given use.

Course Outcomes:

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

CO1: Synthesize and select suitable Polyolefin and Styrenic Polymer.

CO2: Synthesize and select suitable Vinyl and Acrylic Polymer.

CO3: Synthesize and select suitable Engineering Polymer.

CO4: Synthesize and select suitable Thermosetting Polymer.

CO5: Suggest appropriate high performance polymer for specific product.

Unit 1: Polyolefins and Styrenics: Preparation, properties and uses of commodity plastics: Polyethylene (HDPE/LDPE/LLDPE/HMWHDPE/UHMWPE/Chlorinated PE / Cross linked PE), Polypropylene, Styrenics- Polystyrene, High Impact Polystyrene, ABS.

Unit 2: Vinyl and Acrylic Polymers: Preparation, properties and uses of commodity plastics: Vinyl Plastics-Polyvinyl chloride, Polyvinyl acetate, Polyvinyl alcohol, Acrylics-Styrene acrylonitrile, Polymethyl methacrylate, Polyacrylonitrile, Polyacrylates, Polymethacrylates, Polyacrylamide, Poly (Acrylic Acid), Poly (Methacrylic Acid).

Unit 3: Engineering Plastics: Preparation, properties and uses of Engineering plastics: Nylons 6, Nylon 66, Polycarbonates, Polyacetals, Polysulfones, Polyethylene terephthalate, Polybutylene terephthalete, Polytetrafluoroethylene.

Unit 4: Thermosetting Plastics: Preparation, properties and uses of thermosetting plastics: Phenol Formaldehyde, Urea Formaldehyde, Melamine Formaldehyde, Polyurethane, Silicone, Unsaturated polyester, Epoxy, Vinyl ester

Unit 5: High Performance Polymers: Roles of Polymers for high tech areas like aerospace, defense, medical etc. Structure, Properties & Applications of : PEEK, LCP, super absorbent polymer,

Poly(Vinyl Acetal), Poly(Vinyl Ether), Poly(Vinyl Pyrrolidone), Polyvinylidene chloride, Polyvinyl fluoride, Polyvinylidene fluoride, Polyimides, Polysulfides, Polyether, Cellulosics-Rayon, Cellulose Nitrate, Cellulose Acetate.

Books Recommended:

1. Raw Materials for Industrial Polymer by Ulrich Henry, Hanser
2. Plastics Materials by J. A. Brydson, Butterworth
3. Plastics Technology Handbook by Chanda and Roy, Marcel Dekker
4. Polymer Science by V. R. Gowarikar, New Age Int (P) Ltd

Subject: CT-CS-504T (BCHT) Surface Coating Technology II (Theory)

Chemistry and Technology of Film Forming Materials- I

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

Duration of Examination: 3 Hours

Course Objectives:

- To understand chemistry, modification and application of natural resins in coatings as film-former
- To understand the chemistry, composition, synthesis, characteristics, and application of phenolic resins
- To understand the chemistry, composition, synthesis, characteristics, and application of amino resins
- To understand the chemistry, composition, synthesis, characteristics, and application of alkyd resins
- To understand the chemistry, composition, synthesis, characteristics, and application of polyester and polyamide resins

Course Outcomes:

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

CO1: Understand chemistry and technology of natural resins, their modification, and applications in coatings

CO2: Understand the chemistry and technology of phenolic resins, their composition and applications in coatings

CO3: Understand the chemistry and technology amino resins, their modifications and general applications in coatings

CO4: Understand chemistry and technology of alkyd resins, their manufacture, modifications, properties and application in coatings

CO5: Understand chemistry and technology of polyester and polyamide resins and their application is coatings

Unit 1: Natural Resins: Resins and resinous state. Classification of resins. Occurrence, composition, purification and uses of natural resins. Detailed study of resins like Rosin, Congo Copal, Sandarac, Damar and Shellac. Modifications of natural resins. Cashew Nut-Shell Liquid (CNSL) and Bhilwan Nut Shell Liquid (BNSL) resins and their industrial applications.

Unit 2: Phenolic Resins: Chemistry of phenol-formaldehyde resin. Types of Phenols and substituted phenols. Ratio of formaldehyde: phenol. Catalysts. Manufacture of phenolic resin. Novolac and Resole type phenolic resins. Modified phenolic resins such as Rosin modified Phenolics, Reactive and Non-reactive type 100% phenolics, Baking phenolics, Phenolic dispersion. Application of phenolic resins. Coumarone-indene and Petroleum resins.

Unit 3: Amino Resins: Chemistry of amino resins. Conditions of reaction and products. Formation of amino resins, Urea and Melamine- formaldehyde resins. Other amino resins. Manufacture of amino resins. Properties of amino resins. Modification of amino resins. Applications of amino resins in surface coatings.

Unit 4: **Alkyd resins**: General chemistry of alkyd resin, Raw materials. Functionality concepts and average functionality. Polyfunctional acids and alcohols and their effect on properties of alkyd resins. Oil length and classification of alkyd resin. Manufacture of alkyd resin by monoglyceride and fatty acid process. Fusion and solvent method. Properties and application of short, medium and long oil alkyds. Non-drying oil alkyds. Modification of alkyd resins and their applications.

Unit 5: Polyester and Polyamide resins: Polyester Resins: Classification of polyester resins. Raw material: poly-basic acids and polyfunctional glycols. Curing of resins through unsaturation of the resin/polymer backbone. Curing systems, catalysts and accelerators. Polyester based coating composition. Water reducible polyesters. High solid polyesters. Polyesters in powder coatings. Polyamide resins: Chemistry of polyamide resins, Structure of polyamides, Modifications, properties and application of polyamide in surface coatings.

Books Recommended:

1. Organic Coating Technology: H F Payne, Volume 1, John Wiley & Sons, New York, 1954
2. Paint Technology Manual: Vol 1, Vol 2 and Vol 3, Oil Colour Chemists Association, UK
3. Textbook of Polymer Science: W Billmeyer, Inter-science Publishers Inc. New York, 1962.
4. An Introduction to Polymer Chemistry: W R Moore, Aldine Publishing Co.
5. Organic Coatings Science and Technology Zeno W. Wicks, Jr. Frank N. Jones, S. Peter Pappas, Douglas A., John Wiley & Sons, Inc.
6. Resins for Surface Coatings Vol. II Alkyds & Polyesters P. Deligny N. Tuck Edited by PKT Oldring. SITA Technology, UK.
7. Paint and Surface Coatings: Theory and Practice, R Lambourne, T A Strivens, Woodhead Publishing Ltd.UK.
8. Alkyd Resin, Vol. 1, Encyclopaedia of Polymer Science and Technology, John Wiley & Sons, Inc.
9. Surface Coatings, Vol 1, Oil, Colour Chemists Association, Australia.

Subject: CT-OLE-505T (BCE)

Open Elective- I: Environmental Pollution and Control (Theory)

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

Duration of Examination: 3 Hours

Course Objectives:

- To understand the various physico-chemical unit processes and operations as applied to water and wastewater systems and designing of water supply and treatment system.
- To apply engineering concepts to Air Pollution Control and Environmental Management.
- To understand environmental policies and apply environmental management methods for case studies.

Course Outcomes:

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

CO1: Understand the concept of water quality. Classify the sources, types of environmental pollutant and fundamentals of pollution parameters.

CO2: Analyse the natural process of water purification and understand the importance of air pollution and estimation of design parameters of the equipment for industrial air pollution control.

CO3: Identify the sources of water pollution and estimation of design parameters of water treatment process.

CO4: Understand, classify and select the techniques for the processing of solid waste.

CO5: Assess the global and national environmental policies along with pollution control in selected process industries.

Unit 1: Environmental Pollutants: Sources & characterization of various pollutants. Concepts of biodegradability, biosorption, biomagnifications. Measurement: COD, BOD, TOD, ThOD, soluble, suspended, volatile solids, ammoniacal nitrogen. Mathematical model for BOD. Re-oxygenation and de-oxygenation in natural purification process.

Unit 2: Natural Process of Water & Air Pollution Control: Mathematical analysis by Streeter-Phelps of oxygen sag curve in natural purification of waste water. Determination of stack height and plume rise. Meteorological parameters and their effects on dilution/dispersion of pollutants present in flue/exhaust gases coming out from stationery and moving sources. Prediction of pollutant concentration downstream of discharge point. Plume behavior. Air Pollution Management: Basic design and operating principles of wet & dry equipments for removal of particulate and gaseous pollutants. Control of air pollution by process changes.

Unit 3: Water Pollution Management: Principles of primary secondary, tertiary and advanced treatment of waste water. Aerobic and anaerobic processes in ponds and lagoons. Basic process design and operating principles of various activated sludge (suspended growth) processes. trickling filter & rotating biological contactor (Attached growth). Special reactors.

Unit 4: Solid Waste Pollution Management: Solid waste management by dumping, landfill, incineration, composting, vermiculture; using bioremediation for specific pollutants like chromium. Mercury, ammonia / urea, phenolic sludge. E-waste. Hazardous waste management.

Unit 5: Pollution Control in Selected Process Industries & Major Issues: Pollution in fertilizer industries, petroleum refineries and petrochemical units, pulp and paper industries, Sugar industries, Dairy, Alcohol industries. Radioactive wastes. Case studies. Environmental impact assessment (EIA), Environmental audit, Major disasters, global environmental policies and national strategies.

Books Recommended:

1. Metcalf and Eddy, Wastewater Engineering: Treatment, Disposal and Reuse, Tata McGraw-Hill Pub.Co.Ltd., New Delhi, 1979.
2. S.P. Mahajan, Pollution Control in Process Industry, Tata McGraw Hill Publishers, 1987.
3. G.N. Pandey, G.C. Camey, Environmental Engineering, Tata McGraw-Hill Pub.Co.Ltd., 1992.
4. H.S. Peavy, D.R. Rowe, G. Tchobanoglous, Environmental Engineering, McGraw-Hill, 1986.
5. C.N. Sawyer, P.L. McCarty, G.F. Parkin, Chemistry for Environmental Engineering, Tata-McGraw-Hill Edition, 2003.
6. B.C. Punmia, A.K. Jain, A. K. Jain, Wastewater Engineering, Laxmi Publications, 2005.
7. S.K. Garg, Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 2010.
8. M.N. Rao, H.V. Rao, Air Pollution, McGraw-Hill Europe, 1989.

Subject: CT-OLE-505T (BCE)

Open Elective- I: Renewable Energy (Theory)

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

Duration of Examination: 3 Hours

Course Objectives:

- To understand the various forms of conventional energy resources and present energy scenario.
- To understand the need of energy conservation and various forms of renewable energy.
- To understand utilization of renewable energy sources for both domestics and industrial application and environmental aspects.

Course Outcomes:

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

CO1: Understand the use of solar energy and the various components used in the energy production.

CO2: Understand the use of wind energy and the various components used in the energy production.

CO3: Understand the concept of Bioenergy resources and their classification, types of biogas plants and applications.

CO4: Understand concept of hydrogen generation and storage and its application in fuel cells.

CO5: Understand geothermal, tidal and ocean as nonconventional energy generation sources; concept of energy audit and cost-effective analysis.

Unit 1: Solar-Energy: Solar radiation its measurements and prediction, solar flat plate thermal collectors concentrating collectors-applications-heating, cooling, desalination, power generation, drying, cooking etc. Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications: battery charger, domestic lighting, street lighting, and water pumping, power generation schemes.

Unit 2: Wind Energy: Atmospheric circulation- classification, factors influencing-wind shear-turbulence-wind speed monitoring-Aerodynamics of wind turbine rotor-site selection-wind resource assessment-wind energy conversion devices-classification, characteristics and applications. Hybrid systems-safety and environmental aspects.

Unit 3: Bio-Energy: Biomass resources and their classification, chemical constituents and physicochemical characteristics of biomass- Biomass conversion processes- Thermo chemical conversion: direct combustion, gasification, hydrolysis and liquefaction- biochemical conversion: anaerobic digestion, alcohol production from biomass- chemical conversion

process: hydrolysis and hydrogenation. Biogas- generation-types of biogas Plants applications.

Unit 4: Hydrogen and Fuel Cells: Thermodynamics and electrochemical principles-basic design, types and applications, production methods, Biophotolysis: hydrogen generation from algae biological pathways, storage gaseous, cryogenic and metal hydride an transportation. Fuel cell: principle of working, various types, construction and applications.

Unit 5: Other Types of Energy and Energy Audit: Ocean energy resources, principles of ocean thermal energy conversion systems, ocean thermal power plants, principles of ocean wave energy conversion and tidal energy conversion, hydropower, site selection, construction, environmental issues, geothermal energy, types of geothermal energy sites, site selection and geothermal power plants. Concept of energy of audit, analysis of the cost effectiveness of renewable energy sources, present status, comparison, forecast.

Books Recommended:

1. D. P. Kothari, K.C. Singal, R. Rajan, Renewable Energy Sources and Emerging Technologies, PHI Learning Pvt. Ltd, 2009.
2. G. D. Rai, Non-conventional Energy Sources, Khanna Publishers, 2007
3. J. Twidel, T. Wier, Renewable Energy Sources, Taylor & Francis Publishers, 2005
4. S. P. Sukhatme, Solar Energy, Tata McGraw Hill Publishing Company Limited, 2006
5. K. C. Khandelwal, S.S. Mahdi, Biogas Technology- A Practical Handbook, Tata McGraw Hill, 1986.
6. Y. P. Abbi, S. Jain, Handbook on Energy Audit and Environment Management, TERI, 2006.

Subject: CT-OLE-505T (BCE)

Open Elective- I: Energy Conservation and Recycling (Theory)

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

Duration of Examination: 3 Hours

Course Objectives:

- To understand the energy scenario in various sectors and need of energy conservation.
- To understand the planning of the energy conservation and management programs for effective utilization of energy in various sectors.
- To understand and analyse the energy conservation measures in both domestics and industrial sector.

Course Outcomes:

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

CO1: Understand the energy sources and its consumption pattern for the growth of nation.

CO2: Understand the use of energy in industrial sector and understand the effective energy conservation techniques.

CO3: Understand the planning of the energy conservation and management programs for learning the various elements of energy conservation and management.

CO4: Understand the various processes and guidelines for improving the process operation for effective utilization of.

CO5: Understand and study the various case studies related to chemical engineering for energy conservation and waste minimization.

Unit 1: **Energy Scenario**: Classification of energy sources, commercial and noncommercial energy, energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario. energy and environment, air pollution, climate change, energy security, energy conservation and its importance.

Energy Management and Audit: Definition, energy audit – need, types of energy audit, energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use requirement maximizing system efficiencies, optimizing the input requirements, fuel and energy substitution, energy audit instruments.

Unit 2: **Energy Available for Industrial Use:** Introduction, methodology for forecasting industrial energy supply and demand. New energy technologies and conservation, motivation of implementing conservation measures, evaluating costs and benefits of conservation measures.

Unit 3: **Management and Organization of Energy Conservation Programs**: Human aspect of energy conservation, involvement tree, elements of energy management program, romoting energy conservation, program planning, setting goals, setting priorities, allocation of resources, scheduling, measuring, monitoring and reporting, organization of energy conservation programs, plant level organization, division level organization, corporate level organization.

Unit 4: **Guidelines for Improving Process Operations for Energy Conservation**: Energy conservation checklist, potential energy conservation in boilers, chilled water plants and central air – conditioning system, compressors and fans, heat pumps and cooling systems, water heaters and coolers, lighting systems, motors and transformers, mixing vessels, heat exchangers, evaporators, distillations, housekeeping.

Unit 5: **Case Studies –Waste - Minimization and Resource Conservation**. Make detail study report for dairy industry, sugar industry, distilleries, fertilizer industry, food industry, cement, and petroleum. These must include-importance of waste minimization and its classification, housekeeping, process change, recycling, product modification, waste minimization methodology steps, benefits of waste minimization.

Books Recommended:

1. Industrial Energy Management and Utilization, Larry C. Witte, Philip S. Schmidt, Davis R. Brown. 1988
2. Handbook of Industrial Energy Conservation, S. David HU.
3. Energy Engineering and Management- Amlan Chakrabarti, PHI Learning-2011.
4. Guide book for National Certification Examination for Energy Managers and Energy Auditors-Book 1,2,3 and 4. Bureau of Energy Efficiency (BEE)
5. Energy Conservation in the Process Industries- W. F. Kenny, Academic Press Inc., 1984
6. Energy Conservation in the Chemical and Process Industries, Colin D. Grant, the Institution of Chemical Engineers. 1979
7. Solar Engineering of Thermal Processes, John A. Duffie and William A. Beckman, 3rd Edition-2006

Subject: CT -HSMC-HS -506T (BCE)

HASS III: Industrial Economics & Project Management (Theory)

Lecture	: 2 Hours	No. of Credits	: 2
University	: 35 Marks	College Assessment	: 15 Marks

Duration of Examination: 2 Hours

Course Objectives:

- To understand the fundamentals of industrial economics
- To understand standard market structure and evaluate profitability of projects
- To understand the complete project life cycle and role of project management in it

Course Outcomes:

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

CO1: Understand the scope of industrial economics and application of industrial efficiency

CO2: Understand standard market structure and conceptual framework for industrial economics

CO3: Estimating profitability criteria and understanding various theories of profit and financial ratios

CO4: Understanding various facets of project management and key competences of project manager

CO5: Understanding of processes involved in initiating, planning, executing. Monitoring and controlling and closing of projects

Unit 1: Scope for industrial economics, Industrial efficiency- concept & measurement

Unit 2: Standard forms of Market structure such as perfect competition, monopoly, monopolistic competition, oligopoly, market conduct and Conceptual framework

Unit 3: Determining profitability, theories of profit, analysis of financial ratios and relationships

Unit 4: Introduction to project management The Importance of Project Management, Relationship of Project, Program, Portfolio and Operations Management, role of project manager and project manager competencies

Unit 5: Processes involved in initiating, planning, executing. Monitoring and controlling and closing process groups

Books Recommended:

1. Baharwal R. R., Industrial economics:An introduction, New age international Pvt Ltd Publishers (2004)
2. Tirole, Jean, The theory of industrial oraganizations, The MIT Press, Cambridge Massachussets London

3. A guide to project management body of knowledge PMBOK® Guide 6th edition
4. M. S. Mahajan, Industrial organization and management, Nirali Publications
5. Harold R. Kerzner, Project Management A Systems Approach To Planning Scheduling And Controlling 12Th Edition by, John Wiley

Subject: CT-PCC-507P (BCE)

Chemical Reaction Engineering I 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 learn chemical reaction engineering principles and their practical applications in the areas of reaction engineering.
- To inculcate the ability to plan experiments, apply theoretical concepts for data analysis and interpretation
- Understand the experimental techniques related to chemical reaction engineering

Course Outcomes:

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

CO1: Understand and perform experiments related to ideal batch reactors

CO2: Understand and perform experiments related to CSTR

CO3: Understand and perform experiments related to Isothermal plug flow reactor

CO4: Understand, perform experiments and estimate parameters pertaining to various combinations of PFR and CSTR in series

LIST OF EXPERIMENTS:

Required to perform minimum 8 practicals from the list given below:

1. To study of a non-catalytic homogeneous second order liquid phase reaction (Equimolar) in an isothermal Batch Reactor at ambient conditions
2. To study of a non-catalytic homogeneous second order liquid phase reaction (non-equimolar) in an isothermal Batch Reactor
3. To determine the pseudo first order reaction rate constant for the selected reaction in a constant volume adiabatic batch reactor
4. To determine the Effect of Temperature on Reaction rate constant and to determine the Activation Energy for selected reaction in a Batch Reactor
5. To determine overall order of Reactions for bimolecular reactions in Semi-Batch Reactor
6. To Study the performance of **isothermal continuous stirred tank reactor** (CSTR) for selected reaction
7. To study the kinetics of selected reaction in **isothermal Plug Flow Reactor (PFR)**
8. To Study the performance of various combinations of PFR and CSTR in series for selected reaction

9. To study the performance of CSTRs in series for the selected reaction scheme

Books Recommended:

1. O. Levenspiel, Chemical Reaction Engineering, 3rd Edition, Wiley India, 2006.
2. H. S. Fogler, Elements of Chemical Reaction Engineering, 4th Edition, PHI, 2005.
3. J. M. Smith, Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1981.
4. S. D. Dawande, Principles of Reaction Engineering, Denett & Co, 2007
5. S. M. Walas, Reaction Kinetics for Chemical Engineers, McGraw Hill, 1959.

Subject: CT-CS-508P (BCHT) Food Technology I Lab (Practical)

Food Chemistry

Lecture	: 3 Hours	Tutorial: 0 Hour		No. of Credits	: 1.5
University	: 25 Marks			College Assessment	: 25 Marks

Duration of Examination: 6 Hours

Course Objectives:

- To provide an opportunity to the students in developing the concept and to learn various methods of estimation of macro nutrients
- Learn the various methods of estimation of micro nutrients like minerals and vitamins, pigments by spectrophotometric and chemical analysis.
- Able to identify methods and instruments that can be used to study of food chemistry
- To focus on the development of skills to control the quality of food.

Course Outcomes:

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

CO1: Identify methods and instruments that can be used to study of food chemistry.

CO2: Learn various methods of estimation of macro and micro nutrients of food.

CO3: Measure different food compositions by spectrophotometric analysis

CO4: Develop skills to control the quality of food and to prevent adulteration.

CO5: Evaluate data generated by experimental methods for chemical characterization of food materials.

LIST OF EXPERIMENTS:

1. Estimation of Reducing And Non Reducing sugar by Lane Eynon's method
2. Estimation of glucose by iodometry titration (Wills Statter method)
3. Analysis of Sugars by DNS
4. Analysis of Starch and Amylose content
5. Estimation of amino acid (glycine) by Sorenson formal titration method
6. Analysis of Proteins by Biuret Method
7. Analysis of Proteins by Flowrin Lowry Method
8. Estimation of Properties of oil and Fats (AV, SV, IV, PV)

9. Estimation of iron
10. Estimation of Phosphorus
11. Estimation Of Calcium
12. Estimation of ascorbic acid (vitamin c) by titration method
13. Qualitative analysis of Carbohydrate

Subject: CT-CS-508P (BCHT) Oil Technology I Lab

(Practical)

Basics of Oil Chemistry

Practical	: 3 Hours	Tutorial: 0 Hour		No. of Credits	: 1.5
University	: 25 Marks			College Assessment	: 25 Marks

Duration of Examination:6 Hours

Course Objectives:

- This programme provides a thorough knowledge about different testing & analysis in the field of Oil Technology.
- Student is made completely aware of why analysis is required, what exactly analytical values indicates, how they are useful in our field of oils & fats.
- To provide them a platform to cross check their theoretical knowledge practically.
- Learners are able to find out quality standards and adulteration particles.

Course Outcomes:

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

CO1: Understand basic analysis like AV, SV, IV, PV etc.

CO2: Estimate the various analytical techniques for determining the purity of oils and fats

CO3: Understand application of analytical techniques of industrial importance.

CO4: Understanding how theoretical concepts are related with practical analytical values.

CO5: Understand the conceptual knowledge for converting theoretical concepts related to practical analytical values.

LIST OF EXPERIMENTS:

1. Determination of Moisture Content and Refractive Index of Oil and Fat
2. Determination of Acid Value and Free Fatty Acid content of Oil and Fat
3. Determination of Saponification Value of Oil and Fat
4. Determination of Iodine Value of Oil and Fat
5. Determination of Peroxide Value of Oil and Fat
6. Estimation of Adulteration in cotton seed oil using Halphens Test
7. Estimation of Adulteration in Sesame oil using Boudin’s Test
8. Determination Melting point of Fats by theils tube Method
9. Determination Smoke and Flash Point of Oil and Fat

10. Detection of Colour by Tintometer Method
11. Estimation of Unsaponifiable Matter in oil
12. Estimation of RM and Polenske Value
13. Determination of metal content of oils & fats
14. Analysis of essential oils and waxes

Subject: CT-CS-506P (BCHT)

Petroleum Refining & Petrochemical Technology I Lab (Practical)

Petroleum Testing Laboratory

Practical	: 3 Hours	Tutorial: 0 Hour	No. of Credits	: 1.5
University	: 25 Marks		College Assessment	: 25 Marks

Duration of Examination: 6 Hours

Course Objectives:

- To get introduced with ASTM standards of fuels.
- To get familiarize with various petroleum product testing equipment's.
- To become proficient in carrying out various IP/ASTM tests for various petroleum products.

Course Outcomes:

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

CO1: Estimate the ASTM properties of petroleum products.

CO2: Evaluate & analyze various petroleum products based on their ASTM properties.

CO3: Understand national & international standards of petroleum products and compare them accordingly.

CO4: Describe & evaluate the significance of various ASTM/IP tests.

LIST OF EXPERIMENTS:

(Minimum of 15 experiments to be conducted)

1. ASTM distillation of Gasoline, Diesel and Kerosene fractions
2. Fluid viscosity and viscosity Index determination: Determination of Redwood / Saybolt numbers, kinematic viscosity and viscosity index of Lubricating oils
3. Carbon residue determination by Ramsbottom and Conradson Carbon Residue
4. Karl-Fisher Conductometer Apparatus for water estimation
5. Fluid density and API Gravity
6. Aniline point and Diesel Index
7. Corrosion testing of petroleum oils and copper
8. Freezing point of Aqueous Engine coolant solution
9. Fire point- Flash point by Abel, Penskey Martin and Cleaveland Method

10. Gas Colorific value determination
11. Liquid or solid Colorific value determination
12. Smoke point determination
13. Cloud and pour point determination
14. Softening point determination
15. Ductility of bitumen
16. Penetration index determination
17. Dropping point of grease and Melting point of Wax
18. Water content by Dean and Start method
19. Electrical Strength of a Transformer Oil
20. De-emulsification number
21. Oxidation Stability Test

Subject: CT-CS-506P (BCHT) Pulp & Paper Technology I Lab (Practical)

Fibrous Raw Material Proximate Analysis

Practical	: 3 Hours	Tutorial: 0 Hour		No. of Credits	: 1.5
University	: 25 Marks			College Assessment	: 25 Marks

Duration of Examination: 3 Hours

Course Objectives:

- Selection of proper raw material for paper making process
- Procedure to do proximate analysis of raw material
- Understand the significance of each paper making component.
- Calculate the raw material entering the system and finished production estimate.

Course Outcomes:

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

CO 1: To choose appropriate raw material for paper making process

CO2: To evaluate the proximate analysis of different raw material used in paper making process

CO3: To discriminate between different paper making components

CO4: To calculate raw material requirement and finished production estimation.

LIST OF EXPERIMENTS:

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

Subject: CT-CS-508P (BCHT)Plastics and Polymer Technology I Lab (Practical)

Polymer Synthesis and Characterization

Practical	: 3 Hours	Tutorial: 0 Hour		No. of Credits	: 1.5
University	: 25 Marks			College Assessment	: 25 Marks

Duration of Examination: 6 Hours

Course Objectives:

- To understand the laboratory manufacture of polymer.
- To understand the methods of polymer characterization.

Course Outcomes:

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

CO1: Prepare laboratory setup for polymer synthesis.

CO2: Follow standard procedure for laboratory synthesis of polymer.

CO3: Characterize the polymer obtained by laboratory synthesis.

CO4: Apply suitable type of polymerization reaction and technique for synthesis of polymer.

LIST OF EXPERIMENTS:

1. Preparation of Urea formaldehyde resin by bulk technique of polymerization.
2. Preparation of Phenol formaldehyde resin: Novolak.
3. Preparation of Urea formaldehyde resin by solution technique of polymerization.
4. Preparation of Polystyrene by bulk technique of polymerization.
5. Preparation of Phenol formaldehyde resin: Resol.
6. Solution polymerization (Precipitation polymerization) of Acrylonitrile.
7. Preparation of copolymer of Butyl acrylate and Methyl Methacrylate by emulsion polymerization technique.
8. Preparation of Polymethyl methacrylate by suspension polymerization.
9. Preparation of Epoxy resin.
10. Preparation of Polyurethane pre-polymer.
11. Determination of molecular weight of polymer by viscometry.
12. Determination of K value of PVC resin.
13. Determination of acid value of polymer.

14. Determination of bulk density of plastic granules/powder.

15. Identification of polymer by flame and solvent test.

Books Recommended:

1. Experiments in Polymer Science by Hundiwale, Athawale, Kapadi, Gite

Subject: CT-CS-508P (BCHT) Surface Coating Technology I Lab (Practical)

Analysis of Coating Materials

Practical	: 3 Hours	Tutorial: -		No. of Credits	: 1.5
University	: 25 Marks			College Assessment	: 25 Marks

Duration of Examination: 6 Hours

Course Objectives:

- To characterize the drying oils and allied material used in the surface coatings
- To characterize the pigments and extenders used in the coating formulations
- To characterize the solvents used in the coating formulations.
- To evaluate purity of raw materials used in the preparation of varnishes/resins, etc.

Course Outcomes:

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

CO1: Analysed drying oils and allied products

CO2: Characterized the pigments and extenders

CO3: Analysed solvents used in the coatings

CO4: Determined the purity of raw materials required in the synthesis of varnishes, resins, and allied products

LIST OF EXPERIMENTS:

1. Determination of Density of oil.
2. Determination of Refractive Index of Oil.
3. Determination of Acid value of oil/oleoresins/rosin.
4. Determination of Iodine value of oil/oleoresins/rosin.
5. Determination of Saponification value of oil/oleoresins.
6. Determination of Hydroxyl value of oil/oleoresins.
7. Determination of Physical and Chemical characteristics of Natural resins.
8. Determination Oil Absorption of Pigment.
9. Determination of Bulk density of Pigment.
10. Determination of Tinting Strength/Reducing power of Pigment.
11. Determination of Moisture Content in pigment
12. Determination of Density of solvent.

13. Determination of Boiling Range of Solvent
14. Determination of Rate of Evaporation of Solvent
15. Determination of % Residue in Solvent
16. Determination of Aromatic Hydrocarbon Content in Solvent.
17. Determination of Flash point of Solvent
18. Determination of Purity of Phenol
19. Determination of Purity of Formaldehyde
20. Determination of Purity of Phthalic anhydride

Subject: CT-PCC-509P (BCE) **Heat 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 conduction as heat transfer mode and estimate various process parameters
- To perform experiments related to convection as heat transfer mode and estimate/ compare heat transfer coefficient using semi-empirical equations
- To perform experiments related to unsteady state heat transfer and estimate various process parameters
- To perform experiments related to radiation as heat transfer mode and application of Stefan – Boltzman law
- To perform experiments to study the effectiveness of fin

Course Outcomes:

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

CO1: Understand and perform experiments related to conduction and apply Fourier's law of heat conduction for estimation of parameters

CO2: Understand and perform experiments related to convection and estimation/comparison of heat transfer coefficients

CO3: Understand and perform experiments related to radiation & fins

CO4: Understand, perform experiments and estimate parameters pertaining to industrially relevant heat transfer equipment

List of Experiments:

Required to perform minimum 8 practicals from the list given below:

1. To determine total thermal resistance and thermal conductivity of composite wall
2. To determine thermal conductivity of lagging material
3. To study the heat transfer in a pin fin in natural convection
4. To study the heat transfer in a pin fin in forced convection
5. To determine Stefan – Boltzmann constant for radiation heat transfer
6. To determine overall heat transfer coefficient in shell and tube heat exchanger
7. To study plate type heat exchanger and determine overall heat transfer coefficient
8. To plot the temperature vs time response of three pipe (Heat Pipe Demonstrator)

9. To determine heat transfer coefficient for heating in jacketed agitated kettle
10. To evaluate the material and heat balance, capacity and economy at steady state condition for single effect evaporator
11. To study the heat transfer phenomena in vertical condenser and horizontal condenser
12. To study of radiation heat transfer by black plate and test plate (emissivity measurement apparatus)
13. To determine the experimental and theoretical heat transfer coefficient for drop wise and film wise condensation.
14. To study boiling phenomenon in a jacketed kettle with and without stirring.
15. To find heat transfer coefficient and heat transfer rate from vertical cylinder in natural convection

Books Recommended:

1. C. J. Geankoplis, Transport Processes and Separation Process Principles, 4 Edition, Prentice Hall, 2003
2. 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
3. B. K. Dutta, Heat transfer Principles and Applications, PHI Private Limited, 2001
4. S. D. Dawande, Principles of Heat Transfer and Mass Transfer, Denett & Co, 2009
5. D. S. Kumar, Basics of Heat & Mass Transfer, Eight Edition, S. K. Kataria & Sons, 2010

Subject: MC

Constitution of India/Essence of Indian Traditional Knowledge (Audit Course)

Lecture : 2 Hours No. of Credits : Nil

College Assessment :

The Constitution of India is the supreme law of India. Parliament of India cannot make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368; however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America.

The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement, however, few critics have argued that it does not truly incorporate our own ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world".

Course contents:

Meaning of the constitution law and constitutionalism, Historical perspective of the Constitution of India, Salient features and characteristics of the Constitution of India, Scheme of the fundamental rights, The scheme of the Fundamental Duties and its legal status, The Directive Principles of State Policy – Its importance and implementation, Federal structure and distribution of legislative and

financial powers between the Union and the States, Parliamentary Form of Government in India – The constitution powers and status of the President of India, Amendment of the Constitutional Powers and Procedure, The historical perspectives of the constitutional amendments in India, Emergency Provisions: National Emergency, President Rule, Financial Emergency, Local Self Government – Constitutional Scheme in India, Scheme of the Fundamental Right to Equality, Scheme of the Fundamental Right to certain Freedom under Article 19, Scope of the Right to Life and Personal Liberty under Article 21.

Books Recommended:

Introduction to the Constitution of India, D. D. Basu, Lexis Nexis, 25th Edition

Rashtrasant Tukadoji Maharaj Nagpur University

Faculty of Science & Technology

Syllabus for

Sixth Semester B.Tech. Chemical Technology

Subject: CT-PCC-601T (BCE) Chemical Reaction Engineering II (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:

- Basic Concepts of Catalysis
- Kinetics and Mechanistic aspects of Catalysts
- Design and Rating of Catalytic Reactors
- Design Aspects of Gas-Liquid Reactors

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

CO1: Determine the rate laws for heterogeneous non-catalytic gas-solid and gas-liquid reactions using proper model equations

CO2: Solve the problems on tower design for gas-liquid reactions and fluidized bed reactor design for gas-solid reactions

CO3: Determine the rate laws for heterogeneous catalytic reactions and design the contactor (reactor) for given gas-solid-liquid catalytic reactions

CO4: Develop the kinetic models for step growth polymerization and free-radical polymerization reactions

CO5: Solve the problems on non-isothermal continuous flow reactor and non-adiabatic reactor operations.

Unit 1: Fluid-Particle and Fluid-Fluid Reactions (Non-Catalytic Systems): Selection of a model for gas-solid non catalytic reaction, Un-reacted core model, Shrinking core model, Rate controlling resistances, Determination of the rate controlling steps, Various contacting patterns and their performance equations, Application of models to design problems. Introduction to heterogeneous fluid - fluid reactions, Rate equation for instantaneous, Fast and slow reaction, Equipment used in fluid- fluid contacting with reaction, Application of fluid - fluid reaction rate equation to equipment design, Towers for fast reaction, Towers for slow reactions

Unit 2: Solid Catalyzed Reactions: Catalysis in homogeneous and heterogeneous reactions, catalyst classification, preparation, poisoning and regeneration, Promoters and inhibitors, Catalyst deactivation, Mechanism of deactivation, catalyst effectiveness, related examples etc. The Rate Equation for Surface Kinetics, Pore Diffusion Resistance Combined with Surface Kinetics, Porous Catalyst Particles, Heat Effects During Reaction, Performance Equations for Reactors Containing Porous Catalyst Particles, Experimental Methods for Finding Rates, Product Distribution in Multiple Reactions, The Packed Bed Catalytic Reactor

Unit 3: Gas-Liquid Reactions on Solid Catalyst: Trickle Beds, Slurry Reactors, Three Phase Fluidized Beds, The General Rate Equation, Performance Equations under various conditions, selection of various types of Contactors, Applications

Unit 4: Polymerization Reaction Systems: Pseudo-Steady-State Hypothesis (PSSH), Searching for a Mechanism, Step Polymerization, Free-Radical Polymerization, Development of Rate Laws for the Net Rate of Reaction, Modeling a Batch Polymerization Reactor, Molecular Weight Distribution and Properties of Distribution, Design Aspects

Unit 5: Steady State Non-Isothermal Reactor Design: The Energy Balance, Non-isothermal continuous flow reactors, equilibrium conversion, non-adiabatic reactor operations, multiple steady states, non-isothermal multiple chemical reactions

Books Recommended:

1. O. Levenspiel, Chemical Reaction Engineering, 3rd Edition, Wiley India, 2006.
2. H. S. Fogler, Elements of Chemical Reaction Engineering, 4th Edition, PHI, 2005.
3. J.M. Smith, Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1981.
4. S.D. Dawande, Principles of Reaction Engineering, Denett & Co, 2007
5. S. M. Walas, Reaction Kinetics for Chemical Engineers, McGraw Hill, 1959.

Subject: CT-PCC-602T (BCE) Process Equipment Design (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 understand the design procedure and material of construction for equipment in chemical process industries.
- To understand and apply the design procedure for low and high pressure vessels.
- To understand, analyse and estimate the design parameters for agitators, storage tanks and reaction vessels
- To understand various codes and standard applicable to process equipment

Course Outcomes:

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

CO1: Understand the basic design consideration and selection of material for pressure vessel

CO2: Estimate the different stresses and thickness of pressure vessel subjected to internal and external pressure and understand design of thick-walled pressure vessel

CO3: Understand, analyse and estimate the design parameters for various types of support, nozzles. flanges and gaskets of a pressure vessel

CO4: Understanding the design considerations for cylindrical and spherical storage tanks

CO5: Understand the codes and standard for shell and tube heat exchanger and discuss various types of agitators along with estimation of power consumption of agitator

Unit 1: Basic considerations in design, design pressure, design temperature, design stress, Code and standards for pressure vessels (IS:2825:1969), and their significance, review of fabrication techniques. Principal stresses, theories of failure, Materials of construction for process equipment, linings and coatings for equipment.

Unit 2: Design procedure for pressure vessels subjected to internal pressure, and combined loading, closures for pressure vessels, Pressure vessels subjected to external pressure, Design of thick cylinder, pre-stressing, Analysis and design of high-pressure vessels: mono-block and compound (multilayer)

Unit 3: Introduction and classification and design of skirt, bracket & saddle supports. Design of jackets, coils for pressure vessels. Opening/ nozzles, manholes, Nozzle reinforcement design, etc. Flanged joints, classification of flanges, design of non-standard flanges, types of Gaskets their selection, and design. Bolt design and selection

Unit 4: Losses in storage vessels, Various types of roofs used for storage vessels, manholes, nozzles and mountings. storage tanks for solids and its design procedure,

Unit 5: Types of agitators, their selection, use of baffles & power consumption, Codes and standards for heat exchangers, Design of shell and tube heat exchangers as per IS: 4503 and TEMA standards

Books Recommended:

4. Introduction to Chemical Equipment Design – Mechanical Aspects by B.C. Bhattacharyya, CBS Publications.
5. Chemical Project Economics, Mahajani V. V. and Mokashi S. M., MacMillan India Ltd. 2005
6. Process Equipment Design-Vessel Design by Lloyd E. Brownell and Edwin Young, John Wiley, NewYork 1963
7. Plant Design and Economics for Chemical Engineers, Max Peters, Klaus Timmerhaus, Ronald West, McGraw Hill International Edition, 2013
8. Process Equipment Design Vol 1 & 2, S. D. Dawande, Denett Publication Seventh Edition, 2015

Subject: CT-PCC-603T (BCE)

Process Dynamics & Control (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 understand the concept of control system block diagram and its elements
- To be able to apply the concept for obtaining the transfer function for Multi capacity control system.
- To be able to interpret the working of various types of controllers.
- To analyze and evaluate the direct digital feedback control for various unit operation and unit processes and to understand the working principles of various measuring instruments

Course Outcomes:

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

CO1: Understand & apply the concept of control system block diagram and its elements.

CO2: Apply the knowledge base to solve the problems of First order control systems and servo and regulatory control.

CO3: Apply the knowledge base to solve the problem of dynamics of second order control systems and estimation of various parameters

CO4: Understand, Analyse & apply the knowledge base in selection of various modes of controller for Chemical Process Industries

CO5: Evaluating the performance of Direct digital feedback control system. Understand the working mechanism of various instruments

Unit 1: Response of First and Second Order Systems: Process Dynamics—A Chemical Mixing Scenario, Mathematical Tools for Modeling. Solution of Ordinary Differential Equations (ODEs). Partial Fractions, Qualitative Nature of Solutions, Transfer Function, Transient Response, Forcing Functions, Step Response, Impulse Response, Ramp Response, Sinusoidal Response, Examples of First-Order Systems, Linearization, Noninteracting System, Interacting System, Second-Order System, Transportation Lag

Unit 2: Linear Closed Loop Systems: Components of a Control System, Development of Block Diagram, Mechanisms, Ideal Transfer Functions, Block Diagram of a Chemical-Reactor Control System, Standard Block-Diagram Symbols, Overall Transfer Function for Single-Loop Systems, Overall Transfer Function for Multiloop Control Systems, Transient Response

of SimpleControl Systems, Proportional Control for Set Point Change, (Servo Problem—Set Point Tracking), Proportional Control for Load Change (Regulator Problem—Disturbance Rejection), Proportional-Integral Control for Load Change, Proportional-Integral Control for Set Point Change, Proportional Control of System with Measurement Lag,

Unit 3: Stability, Frequency Response: Definition of Stability (Linear Systems), Stability Criterion, Routh Test for Stability, Concept of Root Locus, Substitution Rule, Bode Diagrams, Tank Temperature Control System, The Bode Stability Criterion, Gain and Phase Margins, Ziegler-Nichols Controller Settings.

Unit 4: Process Applications and Microprocessor-Based Controllers: Cascade Control, Feedforward Control, Ratio Control, Dead-Time Compensation (Smith Predictor), Internal Model Control, Controller Tuning and Process Identification, Control Valve Construction, Valve Sizing, Valve Characteristics, Valve Positioner, Control of a Steam-Jacketed Kettle, Dynamic Response of a Gas Absorber, Distributed-Parameter Systems, Historical Background, Hardware Components, Tasks of a Microprocessor-Based Controller, Special Features of Microprocessor-Based Controllers, Distributed Control.

Unit 5: Instrumentation: Classification of Measurement, Classification of Instruments, Characteristics of Instruments, Classification of Transducers, primary and secondary, analog, digital, active and passive transducers Temperature measurement instruments, glass thermometer, pressure thermometer, liquid in metal thermometer, platinum resistance thermometer, thermistors, Thermocouples, Radiation and Optical pyrometer, Pressure measurement instruments, Ionization gauge, Pirani gauge, Bell differential pressure gauge, Pneumatic pressure meter, Level measurement instruments, float and shaft, float and tape, linear and rotary potentiometer, radiation and laser level unit.

Books Recommended:

1. D. R. Coughanowr and Steven E. LeBlanc, Process System Analysis and Control, 3rd Edition, McGraw Hill publication, 2009.
2. G. Stephanopoulos, Chemical process control: An introduction to theory and practice, Prentice Hall of India private limited, 2008.
3. F.G. Shinskey, Process control systems, 2nd Edition, McGraw Hill book Company publication, 1979.
4. R.P. Vyas, Process control and Instrumentation, Seventh Edition, Denett & Co. publication, 2015.
5. R.P. Vyas, Measurement and Control, Denett & Co. Publication 2010.

Subject: CT-CS-604T (BCHT) **Food Technology III (Theory)**

Principles of Food Preservation

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 students, different principles involved in food preservation and processing
- To make them aware about different concepts involved in food spoilage and
- Food preservation by using different food preservation principles and technologies.

Course Outcomes:

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

CO1: Describe unit operations and heat application taken to maintain foods with the desired properties or nature for as long as needed.

CO2: Develop the knowledge on application of dehydration techniques and its effect on nutritional and sensory parameters

CO3: Develop basic understanding of low temperature methods of food preservation and their effects on food.

CO4: Understanding for selection of proper membranes, hurdle operations with respect to type of food product to be process.

CO5: Apply preservation methods that make use of acid, added chemicals, controlled air, pressure, and high-energy radiation.

Unit 1: Material Handling and Unit operations in Food Industry: Food materials handling and process control. Primary, Secondary and Tertiary level of Food Processing. Basic principles and unit operation in food processing & preservation. **Preservation by application of heat** – Cooking, Blanching, Pasteurization and Sterilization. Thermal Processing of Foods: Thermal conductivity of foods. Rate of heat penetration. Microwave heating of Food. Calculation of process time. Unit operations in canning.

Unit 2: Principles of Thermal Preservation Techniques: Dehydration – Role of water activity in food. Calculation of drying rate. Methods of dehydration. Drying equipments and potential applications. Drying effects on foods. Evaporation – Principles of Evaporator operation.

Boiling point estimation. Evaporator performance. Type of evaporators. Evaporation with feed preheating.

Unit 3: Principles of Low Temperature Preservation Techniques: Freezing – Unit operations in freezing. Calculation of freezing time. Slow and fast freezing, cold storage, chilling of foods. Freezing equipments. Effect of freezing, frozen storage and thawing on the food quality. Storage & transportation of frozen foods. Freeze drying. Freeze Concentration – Principles of freeze concentration. Equipments used in freeze concentration. IQF. Application of freezing in food industry.

Unit 4: **Principles of Non -Thermal Preservation Techniques:** Membrane concentration – Driving forces for membrane processes. Types of membranes and equipments. Applications in food industry. Principles of high pressure technology and hurdle technology. Application of filtration techniques in food.

Unit 5: Preservation by Chemical and Physical Methods: Extraction processes- super critical extraction, solid liquid extraction, liquid-liquid extraction. Irradiation – Effect of irradiation on food. Preservation by ionizing radiations, ultrasonics. Preservation by chemicals – Role of chemicals in food preservation. Classification of preservatives and their role in various food.

Books Recommended:

1. Principles of Food Science, Part II – Principles of Food Preservation. Edited by Owen R. Fennema. Printed in the United States of America.
2. Food Processing Technology – Principles and Practice by Dr. P. Fellow. Published jointly by Ellis Horwood Limited, Chichester, England and VCH Verlagsgesellschaft mbH, Weinheim Federal Republic of Germany.
3. Fundamental of Food Engineering by Charm SE. AVI Publishing Company Inc. Westport, Connecticur, USA.
4. Food Microbiology by W.C. Frazier. Tata Mc Graw Hill Publishing Co. Bombay.

Reference Books:

1. Food Processing Operation by M.A. Josyln and J.L. Heid. AVI publishing Company Inc. Westport, Connecticut, USA
2. Practical Canning by Lock A. Food Trade Press Garrick Street, W.C. 2, London.
3. Technology of Food Preservation by Desrosier Norman W. AVI Publishing Company Inc. Westport, Connecticut.

4. The Freezing Preservation of Foods, Vol. I, II, III, IV. Edited by Eople M.J. and Tressler D.K. AVI Publishing Company Inc. Westport, Connecticut, USA.
5. Food Dehydration, Vol. I, II by Copley. M.J. and Van Arsdel W.B. AVI Publishing Company Inc Westport,

Subject: CT-CS-604T (BCHT) **Oil Technology III (Theory)**

Extraction &Refining of Oils and Fats

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

University : 70 Marks College Assessment : 30 Marks

Duration of Examination: 3 Hours

Course Objectives:

- This programme makes students capable to manage or control oil processing unit at industrial level.
- They learn the value of various by products obtains after refining & the way industry run on it.
- The course will cover all types of various refining steps in detail with changing oil & fat processing.
- They learn various chemical engineering operations with respect to oil technology.
- Prepare students capable to develop & design oil processing units.

Course Outcomes:

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

CO1: Understand pre-treatments and various extraction processes for oil & fats.

CO2: Differentiate with minor or major changes in refining process for different oil & fats.

CO3: Develop stages of refining according to oil & requirement of end products.

CO4: Capable of designing the plants and machineries for the new projects in this field of oil refining.

CO5: This course will make students able to find all numerical values related oil refinery processing parameters.

Unit 1: Pre-treatment and Extraction Methods of Oils & Fats: Domestic and world production of oil seeds and oils, handling, drying, storage, sampling and grading, pre-treatment of oil seeds prior to oil extraction Analysis of oil seeds and oil cakes, Utilization of by-products from oil processing industries viz., isolation of proteins, oil cakes, distillates, acid oil, spent bleaching agents, effluent treatment.

Unit 2: Extraction Methods of Oils & Fats: Mechanical, solvent & enzymatic extraction of oil seeds, plants and processes involved newer methods in extraction of oil seeds.

Physical andchemical refining methods, degumming of oils, neutralisation, Lecithin recovery, Batch and continuous methods, Effects of operating variables in chemical refining, dewaxing and winterisation

Unit 3: Bleaching and Deodorization: Bleaching and deodorization of oils and fats, different colouring matters in oils, theory & significance of adsorptive bleaching, various bleaching agents, batch and continuous plants, recovery of oil from spent bleaching agents. Deodorization column specifications and equipment process variables, Deodorized distillate utilization

Unit 4: Calculations in Refining Process: Equipment's used with their specification and significance, various process parameters calculation viz., calculation of pressure in various columns, dosing of acids, degumming calculation, temperature controlling parameters, flow rates of oil feed and other material dosed, energy conservation in oil processing industries.

Unit 5: Hydrogenation of Oils and Fats: Hydrogenation oils and fats, pre-treatment prior to hydrogenation, methods of production and analysis of hydrogen gas and nickel catalyst for hydrogenation Different methods of hydrogenation, their advantages and disadvantages Quality control in hydrogenated products. Designing and processes engineering aspects of hydrogenation

Books Recommended:

1. A. J. C. Anderson, "Refining of Oils and Fats for Edible Purposes," 2nd Edition, Pergamon Press, London, 1962, pp. 92-103.
2. Fats and Oils, D O'Brien, Third Edition, CRC Press,London
3. Bailey's Industrial Oil and Fat Products, Volume 2, Edible Oil and Fat Products: Edible Oils, Part 1, 6th Edition
4. Confectionery Fats Handbook: Properties, Production and Application, by Ralph E. Timms.
5. Vegetable Oils in Food Technology: Composition, Properties and Uses, 2nd Edition by Frank Gunstone (Editor).

Subject: CT-CS-604T (BCHT) Petroleum Refining & Petrochemical Technology III (Theory) : Petrochemical Derivatives

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 introduce to various operations & processes practiced in the Petrochemical plants
- To familiarize about Petrochemicals obtained by various processes.
- To learn process parameters used in Petrochemical plants.

Course Outcomes:

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

CO1: Upon completion of this course, the students will know the sources and production methods of petrochemicals and the methods of manufacture of different petrochemicals from additives to electronic chemicals.

CO2: Identify various routes for production petrochemicals

CO3: Describe process parameters used in petrochemical plants

CO4: Analyze and evaluate physio-chemical properties of polymeric products

CO5: Gain the knowledge about the various unit operations and process practiced in Petrochemical plants

Unit 1: Processors: Alternate routes with flow diagram for production of methane, ethane, propane, ethylene, propylene, butylenes, acetylene, naphthalene. Chemicals from methane, ethane, propane, ethylene, propylene, butylenes, acetylene.

Unit 2: First Generation Petrochemicals: Alternate routes with flow diagram for production of butadiene, related dienes, aromatics – Benzene, toluene, xylene – Chemicals from butadiene, related dienes, aromatics – Benzene, toluene, xylene.

Unit 3: Second Generation Petrochemicals: Alternate routes with flow diagram for production of ethylene glycol, VCM, acrylonitrile, phenol, caprolactum, adipic acid, hexmethylene diamine, DMT, TPA, maleic anhydride, styrene.

Unit 4: Transitions in Polymers: First and second order transitions – Glass transition, Tg – multiple transitions in polymers – experimental study – significance of transition temperatures – crystallinity in polymers – effect of crystallization – in polymers – factors affecting crystallization crystal nucleation and growth – relationship between Tg and Tm – Relationship between properties and crystalline structure.

Unit 5: Third and Fourth Generation Petrochemicals: Polymerization – Modes and techniques – Production of polyethylene – LDPE, HDPE, polypropylene, poly butadiene rubber, SBR, polystyrene, SAN, ABS.

Polyacrylonitrile, polyvinyl chloride, polycarbonates, nylon 6, nylon 66, polyesters, formaldehyde resins, explosives, dyes.

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.

Reference Books:

1. Margaret Wells, "Handbook of Petrochemicals and Processes", 2nd Edition, Ash Gate Publishing Limited, 2002.
2. Sami Matar, and Lewis F. Hatch., "Chemistry of Petrochemical Processes", 2nd Edition, Gulf Publishing company, 2000.
3. Dryden, C.E., "Outlines of Chemical Technology", 2nd Edition, Affiliated East-West Press, 1993

Subject: CT-CS-604T (BCHT) Pulp & Paper Technology III

(Theory) Chemical Pulping and Chemical Recovery Process

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

Duration of Examination: 3 Hours

Course Objectives:

- Fundamental knowledge of various pulping processes
- Cyclic nature of Kraft pulping process
- Analysis of process parameter affecting on efficiency of blow tank and washing
- Development of suitable recovery process

Course Outcomes:

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

CO1: To discuss and demonstrate the alkaline pulping process of paper making raw material

CO2: To discover the cyclic nature of kraft pulping process and variables affecting pulp manufacturing.

CO3: To calculate the energy requirement in pulp blowing and understanding the pulp processing techniques in pulp mill

CO4: To analyze the concentration of black liquor and study the recovery of chemicals in recovery furnace

Unit 1: Chemical Pulping, general considerations, various chemicals used, Alkaline pulping origin, alkali as delignification agent, Soda process, Sulfate or Kraft pulping process, flowsheet, description, unit operations and unit processes, composition of liquor, role of sodium oxide in alkaline pulping, standard kraft pulping terms. Cyclic nature of Kraft pulping, variables associated with wood and pulping process, kinetics of Kraft process, batch and continuous digesters, direct and indirect cooking.

Unit 2: Blow tank operation, knotters operation, pulp washing, modern washers and it's uses, dilution factor calculation, soda losses during washing, mechanism of pulp screening and centri-cleaning, factors affecting screen and hydrocylone operation, calculation of efficiency of screening, energy balance calculations of digester, blow tank.

Unit 3: Sulfite pulping, outline of the process, delignification, raw materials and technology, sulfur burning, sulfur dioxide absorption system, standard terms in the process, recovery of heat. Digesters, steam requirements, pulping variables, sodium, ammonium and magnesium based pulping recovery systems

Unit 4: Introduction to chemical recovery process, flow diagram, unit operations and unit processes. Single and multiple effect evaporation, problems associated with the concentration of black liquor, optimization of steam pressure to evaporators, different feed arrangements, design considerations of multiple effect evaporators, cascade/ direct contact evaporators, recovery of tall oil and rosin.

Unit 5: Combustion of black liquor, recovery furnace operation, composition of smelt, flue gases, salt cake reduction, heating value of black liquor solids, various heat losses during combustion, evaluation of thermal efficiency of a recovery furnace, steam generation capacity. Characteristics of green liquor, optimizing the causticization, lime mud washing, calcining of lime, lime kiln optimization, Analysis of liquors.

Books Recommended:

1. Papermaking Science and Technology, Vol- 6, Chemical Pulping Part -1, Fiber Chemistry and Technology, Joint Textbook Committee of TAPPI and Finnish Paper Association, TAPPI PRESS, 2002.
2. Papermaking Science and Technology, Vol- 7, Chemical Pulping Part -2, Recovery of Chemical and Energy, Joint Textbook Committee of TAPPI and Finnish Paper Association, TAPPI PRESS, 2002.
3. Black Liquor Evaporation, by Jim Frederick and Niko DeMartini, TAPPI PRESS 2019.
4. Chemical Recovery in the Alkaline Pulping Processes Revised Edition, by Co-edited by Robert P. Green and Gerald Hough, TAPPI PRESS, 1992.
5. Kraft Pulping, by A. Mimms, M.J. Kocurek, J.A. Pyatte, and E.E. Wright Tappi Press 1990.
6. Kraft Recovery Boilers, Third Edition, by T.N. Adams, W.J. Frederick, T.M Grace, M. Hupa, A.K Jones, W. B. A. Sharp, D. Singbeil, H. Tran, TAPPI PRESS, 2018.

Subject: CT-CS-604T (BCHT) Plastic and Polymer Technology III (Theory)

Elastomer Technology

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 preparation, properties and application of natural and synthetic rubber.
- To acquire the knowledge of additives and compounding for rubber formulations.
- To understand the methods for processing and testing of rubber.

Course Outcomes:

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

CO1: Select suitable rubber for specific purpose.

CO2: Suggest appropriate additive and equipment for rubber compounding.

CO3: Apply appropriate vulcanization technique to obtain desirable properties.

CO4: Formulate and manufacture rubber product.

CO5: Evaluate properties of rubber by suitable method.

Unit 1: Natural and Synthetic Rubber: Molecular requirements of rubber, Sources of natural rubber, Latex technology- tapping, collection, preservation, processing of latex. Grades of natural rubber-conventional grades, TCR, TSR, applications of natural rubber. Manufacturing, properties and applications of- Nitrile Rubber, Styrene Butadiene Rubber, EPM and EPDM Rubber, Neoprene Rubber, Silicone Rubber, Butyl Rubber, Thermoplastic elastomers- need, advantage, types.

Unit 2: Compounding: Role, mechanism, classification, and examples of Processing aid - peptizer, plasticizer, lubricant and flow promoter, wetting and dispersing agent, viscosity controlling agent, Antidegradant - antioxidants, antiozonants, metal decomoposer, UV stabilisr, antiskinning agent, biocide, Filler, coupling agent, flame retardant, blowing agent, thixotropic agent, colorant, antistatic agent, antifoaming agent, slip agent.

Unit 3: Formulations and Manufacture: Construction and working of compounding equipment- Sigma mixer, Two roll mill, Banbury mixer, High speed mixer, Kneader, twin screw extruder,

cavity mixer, pin mixer, planetary gear mixer, CRD mixer. Principle and need of mastication. Compound recipes formulation and manufacturing of tyre, belt, hose, pipe, tube, footwear, cable, tennis ball, seal, paints, adhesive, cellular products, and latex products such as dipped goods, Methods of incorporation of reinforcements, chords and fabrics.

Unit 4: Vulcanization: Need and Effect of Vulcanization, Vulcanization types-Sulphur, accelerated sulphur, peroxide and metal oxide vulcanization. Vulcanization Techniques Injection moulding, Compression moulding, Transfer moulding. Open cures- Autoclave, Microwave vulcanization. Stress-strain relation for vulcanized rubber, kinetics of vulcanization, chemical reactions, factors affecting rate of vulcanization. Accelerators- classification according to cure rate, criteria for selection, mode of functioning,

Unit 5: Testing and Analysis: Purpose, Standards and specifications. Standard producing organizations- ASTM, DIN, ISI, ISO. Determination of cure rate of rubbers, testing and analysis of raw rubber, testing of finished rubber products, permeability and cure adhesion, test methods for determination of free sulfur, ash content and total solid content, tear resistance, heat resistance, flex fatigue resistance, compression set, resilience, accelerated ageing, ozone resistance. Working principle of analytical techniques- IR, UV-Vis, NMR Spectroscopy, GPC, Mass Spectroscopy, XRD, SEM, TGA, TMA, DMA.

Books Recommended:

1. Rubber Technology by Blow, Multitech.
2. Rubber Technology by Moris Morton, Arnold.
3. Rubbery Materials by Brydson, NIIR.
4. Fundamentals of Polymers (Raw materials to finish products) by Karak PHI
5. Fundamentals of Plastics Testing by Nayak, Springer.
6. Plastics Testing Technology Handbook by Vishu Shah, Wiley Interscience
7. Rubber Technology by Morell, Appl. Sci.

Subject: CT-CS-604T (BCHT) Surface Coating Technology III (Theory)

Chemistry and Technology of Film forming Materials-II

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

Duration of Examination: 3 Hours

Course Objectives:

- To understand the chemistry of Epoxy, Polyurethane, Cellulosic, Natural and synthetic Rubber, Vinyl, Acrylic and Silicone resins
- To understand the modification of Epoxy, Polyurethane, Cellulosic, Natural and synthetic Rubber, Vinyl, Acrylic and Silicone resins for coatings
- To understand the composition and synthesis of Epoxy, Polyurethane, Cellulosic, Rubber, Vinyl, Acrylic and Silicone resins
- To understand the general characteristics and applications of Epoxy, Polyurethane, Cellulosic, Natural and Synthetic Rubber, Vinyl, Acrylic and Silicone resins in coatings

Course Outcomes:

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

CO1: Understand the chemistry and technology Epoxy, Polyurethane, Cellulosic, Natural and synthetic Rubber, Vinyl, Acrylic, Silicone resins

CO2: Understand the modification of Epoxy, Polyurethane, Cellulosic, Natural and synthetic Rubber, Vinyl, Acrylic and Silicone resins for coatings

CO3: Understand the composition and synthesis of Epoxy, Polyurethane, Cellulosic, Synthetic Rubber, Vinyl, Acrylic and Silicone resins

CO4: Understand the general characteristics of Epoxy, Polyurethane, Cellulosic, Natural and Synthetic Rubber, Vinyl, Acrylic and Silicone resins in coatings

CO5: Understand the general characteristics and applications of Epoxy, Polyurethane, Cellulosic, Natural and Synthetic Rubber, Vinyl, Acrylic and Silicone resins in coatings

Unit 1: Epoxy resins: Chemistry of epoxy resin. Raw materials. Classification of epoxy resins. Ratios of reaction components and their effect on the properties. Taffy and Advancement process in synthesis of epoxy resins. Manufacture of epoxy resins. Curing of the epoxy resin.

Curing agents. Two-pack and one-pack epoxies. Modified epoxides & epoxy resins for coating.

Unit 2: Polyurethane Resins: Basic Chemistry of polyurethanes. Basic components of polyurethane resins. Reactions of isocyanates with various other functional groups. Effect of di-isocyanates and polyols on properties. Selection criteria of di-isocyanates and polyols, General characteristics of polyols, Polymeric polyols, Synthesis of polyurethanes. Application of polyurethanes in surface coatings. Urethane Oils.

Unit 3: Vinyl and Acrylic resins: Composition, substituted ethylene and copolymers. Methods of polymerization and processes. Polyvinyl chloride resins. Vinyl chloride-vinyl acetate copolymers. Vinyl ester latexes. Acrylic resins: Chemical composition and properties. Methods of polymerization. Thermoplastic and thermosetting acrylics. Hydroxy-functional and other acrylic resins. Water reducible thermosetting acrylics. Acrylic resin latexes/emulsions. Applications of vinyl and acrylic resins in coatings.

Unit 4: Cellulose and Rubber derivatives: Cellulose Derivatives: Cellulose nitrate and type. Nomenclature of different types of cellulose nitrates. cellulose acetate, ethyl and methyl cellulose. Preparation, manufacture and properties of cellulose nitrate, cellulose acetate, ethyl and methyl cellulose. Properties and applications of cellulose derivatives in coatings. Natural and synthetic rubber. Preparation and properties of rubber resins. Chlorinated, cyclized and synthetics rubber and their properties. Use of rubber resins in coatings.

Unit 5: Miscellaneous Resins: Silicone resins. Structure of silicones. Silicone Rubbers and Resins. Silicone-Modified Resins. Reactive Silanes. Orthosilicates. Preparation of silicone polymers for surface coatings. Ethyl silicates and Titanium esters. Bituminous materials: introduction, classification, properties and uses.

Books Recommended:

1. Organic Coating Technology by H F Payne, Vol I, John Wiley & Sons, New York, 1954
2. Paint Technology Manual Vols I, II and III, Oil Colour Chemists Association, UK
3. Textbook of Polymer Science, Billmeyer W, Inter-science Publishers Inc., New York, 1962
4. An Introduction to Polymer Chemistry, Moore W R, Aldine Publishing Co, Chicago, US
5. 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.
6. Paint and Surface Coatings: Theory and Practice R Lambourne, T A Strivens Elsevier.
7. Surface Coatings, Vol 1, Oil, Colour Chemists Association, Australia.
8. Surface Coatings: Science and Technology, Swaraj Paul

9. Basics of Paint Technology, Part 1 & 2, V. C. Malshe & Meenal Sikchi.
10. Waterborne and Solvent based Acrylics and their end user applications, Volume 1, Edited by P Oldring and P. Lam, SITA Technology Ltd., UK.
11. Resins for Surface Coatings: Acrylics and Epoxies, Volume 1, H. Coyard, P. Deligny, N. Tuck, Edited by PKT Oldring, SITA Technology Ltd. UK.

Subject: CT-CS-605T (BCHT) **Food Technology IV (Theory)**

Processing of Stable Food Commodities

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 provide the students an opportunity to gain knowledge about the storage procedure of different cereals, sugar confectionary and coffee
- To provide the students an opportunity to gain knowledge about the storage procedure of different chocolate processing.
- To help students to understanding the different procedure of production of various cereal based, bakery products.

Course Outcomes:

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

CO1: Understand the Processing and storage of cereals.

CO2: Gain knowledge on the ingredients, process and machinery involved in bakery products and to evaluate the function, properties and interaction of raw materials during manufacturing, to illustrate the technical knowledge for the development of Bakery

CO3: Know about the production and refining of vegetable oil, The changes occurs during storage of fats and oils and preservation methods.

CO4: Describe compositions, types and process techniques for Tea, coffee and Chocolate processing.

CO5: Gain knowledge on the ingredients, process and machinery involved in Confectionery products, to illustrate the technical knowledge for the development of Confectionary industry

Unit 1: Process Technology of Cereal processing: Introduction to cereal grains, legumes and oilseeds: Structure and composition of cereal grains, legumes and oilseeds. Composition of cereal grains & their fractions. Process technology of milling of wheat, rice & corn. Isolation, processing and applications of starch from different cereal sources. By products of milling industry. Processing of malt.

Unit 2: Process Technology of Bakery and Snack Foods: Role and quality parameters of raw materials, Rheology of dough. Changes during dough formation, fermentation & baking. Technology of bread, biscuits, cookies, crackers, cakes, wafers manufacturing. Manufacture of breakfast cereals, puffed cereals. Extrusion process & extruded products

Unit 3: Process Technology of Pulses, Legumes & Oilseeds Processing: Milling of Pulses, Milling of legumes. Processing of oilseeds. Oil extraction, refining & hydrogenation. Manufacture of margarine, shortening agents, Lecithin & GMS. Edible oilseed flour, Protein concentrate and Protein isolate.

Unit 4: **Process Technology of Leaves and Beans Processing:** Composition & processing of tea & coffee. Tea leaf processing Flavour& aroma development & evaluation. Specialty tea products, Coffee: Types and characteristics Coffee processing, Instant coffee. Process Technology of Cocoa & Chocolate**:** Processing of cocoa beans, and production of cocoa powder. Types of chocolates, Production of Milk crumb and chocolates. Quality control in chocolates.

Unit 5: Process Technology of Sugar Confectionary: Sugar crystallisation& its control. Types of confectionary products. Production of fondant, fudge, toffee, pulled confections, lozenges. Chewing gums and bubble gums, Standardization and processing of traditional sweets, such as batasha, pedha, sandesh, Rasogolla, chikki and flour based sweets.

Books Recommended:

1. Cereal technology by Matz Samuel A, AVI publishing co. Inc Westport Connecticut 1970
2. Modern Cereal Chemistry by Kent Jones W.D. & Amos A.J., Food Trade Press Ltd. London 1976
3. Snack food technology Matz S.A, AVI publishing Co.1976.
4. Bakery technology Matz Samuel
5. Sugar confectionary &chocalate manufacture by E.B Jackson & Lees R, Leonard Hill Books 24, market sqareAylesbury.
7. Processed plant protein food stuff edited by Aultschul A.M., Academic press London 1958
8. Wheat chemistry & technology, edited by Pomeranz Y. American Association of cereal chemists, Minnesota 1978
9. Bakery materials & methods by Daniel A.R., Mc Larene& sons Ltd.London 1947
10. Manufacture of biscuits cakes & wafers by Fritsch J. &Grosspicrre, London 193

Subject: CT-CS-605T (BCHT) Oil Technology IV (Theory)

Technology of Soaps, Detergents & Surfactants

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

University : 70 Marks College Assessment : 30 Marks

Duration of Examination: 3 Hours

Course Objectives:

- This programme provides a thorough knowledge about different surfactant system in cleaning and allied industries, all types of Soaps and full knowledge in Detergent industry. Students will learn and acquire knowledge on different methodologies in this field.
- The course will cover all types of raw material for different formulations in this industry and makes student capable of writing an equation to represent the formation of these products.
- Describe the mechanism by which Soaps and Detergent exert their cleansing action giving chemical explanation of the problems encountered.
- Educate and train Oil Technologist to acquire a meaningful picture of Chemical industries.
- Prepare students for professional participation in these industries so as to adapt themselves to jobs of problem solving and Plant / Process development.

Course Outcomes:

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

CO1: Understand the fundamental of Surfactant Systems, Soaps and Detergents including various plants and processes involved.

CO2: Differentiate the principles behind the physio-chemical, analytical techniques in estimation of quality parameters of Surfactant Systems, Soaps and Detergents.

CO3: Devise the concepts of use of surfactant system in formulation of Soaps and Detergents.

CO4: Capable of designing the plants and machineries for the new projects in this field enhancing their entrepreneurial ability also.

CO5: This course gives well-grounded knowledge of various aspects in the field of Surfactants, Soaps and Detergents.

Unit 1: Surfactants: Concept and Theory of Surface action, structure of surfactant molecule, Hydrophilic – lipophilic balance, methods for measurement of surface activity. Significance of HLB& its calculations. Classification of surfactants, Anionic, Cationic, Non-ionic and Amphoteric surfactants, their manufacture, evaluation and industrial applications.

Unit 2: Detergents: Raw materials used in the manufacture of synthetic detergents and their functions. Manufacture and testing of household synthetic detergents, plants and processes employed for powders, liquids and cake detergents. Recent trends and modern developments in the Detergent industry. Analysis of detergents.

Unit 3: Soap: Cleansing action of soaps, General principles of soap making, chemistry of soap boiling, Raw materials for soaps, their Classification and selection of oils and fat, Selection of builders, fillers and other auxiliary raw materials and their functions. Manufacturing of soap by batch and Continuous processes. Phase separation in soap boiling, various types of soaps and cleaning Preparations, Analysis of soaps and detergents**:** BIS methods of testing,

Unit 4: Soaps, Surfactants & Allied Products: Metal salts of fatty acids of alkaline earth Metals, their methods of preparation, analysis and applications, Use of Surfactant System in formulation of Hair Conditioners, After shave products, Brilliantine's, Bath and shower products, Floor cleaner, etc

Unit 5: Processing and Plant details: Introduction to various sulphonate, methyl ester sulphonate, chemistry of sulphonate process, industrial processing of methyl ester sulphonate. Various process plant Equipment's required for manufacturing of surfactants and detergents, recent trends, significance and technological advancement of MES in various cleaning agents.

Books Recommended:

1. The Handbook of Soap Manufacture by H. A. Appleton and W. H. Simmons
2. Powdered Detergents Edited By Michael S. Showell,1st Edition,1998.
3. Handbook of Detergents: Formulation (PDF) by Michael S. Showell
4. Synthetic detergents by Davidson, A; Milwidsky, B. M. (Benjamin Max), 1923
5. Soaps; Their Chemistry and Technology by Kane, Jagannath Govind.

Subject: CT-CS-605T (BCHT)

Petroleum Refining & Petrochemical Technology IV (Theory)

Petroleum Refining Technology

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 get familiarize with downstream refining processes practiced in refineries.
- To evaluate the need & importance of downstream processing.
- To get introduced with various quality & quantity upgradation processes of petroleum products.

Course Outcomes:

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

CO1: Describe various downstream refining processes.

CO2: Understand various thermal & catalytic processes practice in refineries.

CO3: Categorize various refining processes.

CO4: Compare & choose among various refining processes for quality & quantity upgradation of petroleum products.

CO5: Predict the product pattern of various refining processes.

Unit 1: Thermal Cracking and Coking: Need and significance, types and functions of Secondary Processing. Cracking, Thermal Cracking and Visbreaking. Different Feed Stocks, Products Yields, Qualities and Recent Development. Methods of Petroleum Coke Production – Koppers, Thermal Cracking, Delayed Coking, Fluid Coking and Contact Coking, Case-Study Problem: Delayed Coker.

Unit 2: Catalytic Cracking and Hydro cracking: Catalytic Cracking, Commercial Catalyst, Feedstock and Catalytic Cracking Conditions, Types and Processes- Fixed Bed Cracker, Fluid Catalytic Cracking (FCC), Flexi Cracking. Case-Study Problem: Catalytic Cracker.

Hydro Cracking- principles, reactions in Hydro Cracking, Catalyst, Hydro Cracking Reaction Conditions, Iso Max Processes and Hydro Desulphurization Processes.Case-Study Problem: Hydrocracker.

Unit 3: Hydroprocessing and Resid Processing: Composition of Vacuum Tower Bottoms, Processing Options, Hydroprocessing, Expanded-Bed Hydrocracking Processes, Moving-Bed Hydroprocessors, Solvent Extraction, Summary of Resid Processing Operations. Hydro treating, Hydro treating Catalysts, Aromatics Reduction, Reactions, Process Variables, Construction and Operating Costs, Case-Study Problem: Hydrotreaters. Supporting Processes, Hydrogen Production and Purification, Gas Processing Unit, Acid Gas Removal, Sulphur Recovery Processes etc.

Unit 4: Catalytic Performing: Theory, Reaction Conditions and Catalyst for Catalytic Reforming, Platforming, Houdri Forming, Rhein Forming, Power Forming, Selecto Forming. Ultra Forming and Rex Forming. Naphtha Cracking, Feedstock Selection and Effect of Steam. Case-Study Problem: Naphtha Hydrotreater, Catalytic Reformer, and Isomerization Unit.

Unit 5: Alkylation and Isomerization: Feed Stocks and Reactions for Alkylation Process- Cascade Sulphuric Acid Alkylation, Hydrofluoric Acid Alkylation. Isomerization Process- Isomerization with Platinum Catalyst and Aluminium Chloride Process. Case-Study Problem: Alkylation and Polymerization.

Books Recommended:

1. Gary, J.H. & Handwerk,, G.E., "Petroleum Refining – Technology & Economics", 5th Edition, CRC Press.
2. Jones, D.S.J. and Pujadó, P.R., Handbook of petroleum processing, Springer, The Netherlands,2006
3. Nelson, W. L "Petroleum Refinery Engineering", McGraw Hill Publishing Company Limited,1985.

References Books:

1. Parkash, S., Refining processes handbook, Gulf Professional Publishing,2003

Hobson, G. D "Modern Petroleum Refining Technology", 4th Edition, Institute of Petroleum, U. K.1973.

Subject: CT-CS-605T (BCHT) Pulp and Paper Technology IV (Theory)

Bleaching & Stock Preparation of Pulp

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

Duration of Examination: 3 Hours

Course Objectives:

- Fundamental knowledge of Bleaching processes
- Importance of stock preparation in Pulp and Paper manufacture industry
- Analysis of organic andinorganic additives used in paper making process

Course Outcome:

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

CO1: To demonstrate the mechanism of bleaching of pulp and understand the factors controlling it.

CO2: To prioritise the use of different chemical bleaching process and analyze the quality of pulp manufactured

CO3: To relate the need for stock preparation in order to manufacture good quality paper

CO4: To apply the concepts of colloidal chemistry to impart resistance to penetration of paper by sizing

CO5: To select organic and inorganic additives addition in paper so that desired properties are imparted in paper.

Unit 1: Bleaching of wood pulp, basic principles of chlorination and alkali extraction, oxidation bleaching agents- hypochlorite, chlorine dioxide, peroxide and other bleaching agents, reducing agents, acidification and combination stages, determination of bleach requirements.

Unit 2: Modern bleaching processes : Oxygen, Ozone, Per acetic acid, Enzyme and chelating agents. Their reactions, process variables, pulp properties, advantages, disadvantages and equipment selections. Toxic pollutants generated in traditional bleach plant, ECF and TCF Bleaching, and economics of bleaching.

Unit 3: Stock preparation, beating and refining, effect on fiber structure, theory of beating, factors affecting beating, stock proportioning systems. Filling and loading: objectives, survey of filler properties, manufacture of fillers, preparation and addition of fillers, adverse effects of fillers, properties of commercial filling and loading materials.

Unit 4: Internal sizing of paper, rosin size and synthetic sizes, fortified sizing, wax emulsions, asphalt emulsions, theory of internal sizing, mechanism of alkaline sizing, role of retention aids in size development, types of retention aids and their chemistry in sizing, sizing measurement.

Unit 5: Special additives for wet and dry strength agents in paper, coloring of paper, theory, terms used, dyes and pigments, fastness test, methods of coloring special papers, drainage aids use, defoamers types and uses, slimicide use.

Books recommended:

1. Principles of Wet End Chemistry, by *William E. Scott, TAPPI Press, 1996.*

2. Starch and Starch Products for Wet End Application, by Hans W. Maurer, TAPPI Press, 2007.

3. 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.
4. The Bleaching of Pulp, Fifth Edition, by Alan W. Rudie, Ph.D., and Peter W. Hart, TAPPI Press, 2010.
5. Papermaking Science and Technology, Vol- 6, Chemical Pulping Part -1, Fiber Chemistry and Technology, Joint Textbook Committee of TAPPI and Finnish Paper Association, TAPPI PRESS, 2002.

Subject: CT-CS-605T (BCHT) Plastics and Polymer Technology IV(Theory)

Polymer Processing

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 working principle of various moulding machines.
- To elaborate the features of various processing techniques with their applications.
- To quote specification of moulding machines.
- To understand trouble shooting during polymer processing.

Course Outcomes:

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

CO1: Select suitable process to manufacture given polymer product.

CO2: Set-up and optimize process parameters for the process.

CO3: Identify, analyse and solve the various processing defects.

CO4: Operate tools and machinery involved in processing of polymer.

CO5: Judge the quality of manufactured products.

Unit 1: Extrusion and Calendaring: Extrusion: Introduction, design features of extruders, Zones in extruders, mechanism of extrusion, compression ratios, screen changers, single screw and twin screw extruder, effect of material properties, process parameters and their effect on product quality, process control in extrusion, extrusion processes- pipe, blown film, sheet, flat film, tape, monofilament, profile, coating and lamination.

Calendaring: Introduction to calendaring, types of calendar units, 2, 3, 4 roll calendars, Z type calendar, L type calendar, heating systems, temperature control and process control parameters, roll bending, calendaring lines- film and sheet lines, laminating and embossing lines, applications and advances in calendaring.

Unit 2: Injection Moulding: Basic process, materials, moulding cycle, Machines for injection moulding: Parts and function, Terminology, Effect of processing parameters on quality of product, Advantages and limitations of injection moulding, Moulding defects, causes and

remedies. Advances in injection moulding: Injection Moulding of thermosets, Gas assisted injection moulding, Reaction Injection moulding-basic process, materials and applications.

Unit 3: Blow and Rotational Moulding: Blow moulding: extrusion blow moulding, injection blow moulding, stretch blow moulding, preform, parison, parison programming, Single and multilayer injection blow moulding, single and multi layer extrusion blow moulding, process controls for blow moulding machine, trouble shooting in blow moulding.

Rotational moulding: Basic process, materials and products parameters, cycle time, temperature, speed, cooling effect on product quality, control system, multilayer rotational moulding, batch type and continuous type machines, trouble shooting in rotational molding.

Unit 4: Thermoforming: Basic process, materials and applications, Methods of Thermoforming, trimming methods. Machines for thermoforming Process variables: air, temperature, mould temperature, plastic memory, hot elongation / strength, Remedies and causes of defects in thermoforming, Advantages and limitations of thermoforming, Comparison of thermoforming with injection moulding.

Unit 5: Compression and Transfer Moulding: Compression Moulding: Basic process and moulding compounds, Type of machine - hand operated / automatic / semiautomatic, Effects of bulk factor, flow properties, curing time, temperature and pressure on the quality of product, Effects of preheating and preforming, Preforming machine and Preheaters (Hot air circulatory oven, high frequency and infra-red), Advantages and limitations of compression moulding, Moulding defects, their causes and remedies**.**

Transfer moulding: Introduction, transfer moulding cycle, process parameters, types of transfer moulding, advantages, limitations, troubleshooting.

Casting: Introduction, types of castings, solvent casting of PVC film.

Cellular Plastics: Expandable polystyrene foam moulding, structural foam moulding.

Books Recommended:

1. SPI Plastic Engineering Handbook by Berins, Chapman & Hall
2. Polymer Extrusion by Rauwandel, Hanser.
3. Compression and Transfer Moulding by Butler.
4. Handbook of Thermoforming by Throne
5. Rotomoulding by Bruins

Subject: CT-CS-605T (BCHT) Surface Coating Technology IV(Theory)

Chemistry and Technology of Pigments

Lecture : 3 Hours Tutorial: - No. of Credits 3

University : 70 Marks College Assessment : 30 Marks

Duration of Examination: 3 Hours

Course Objectives:

- To understand the classification of pigments and extenders
- To understand the general methods of manufacturing of inorganic and metallic pigments.
- To understand the characteristics of pigments, extenders, metallic pigments and organic pigments
- To understand the colour and colour theory.

Course Outcomes:

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

CO1: Classify and understand the general characteristics of pigments and extenders

CO2: Understand the characteristics and role of metallic and extender pigments in coatings

CO3: Understand the composition, properties, occurrence, manufacture and applications white and black pigments

CO4: Understand the composition, properties and composition and applications of coloured inorganic pigments

CO5: Understand the chemistry, composition and characteristics of organic pigments and colour theory.

Unit 1: Pigments: Classification of pigments and extenders. Composition of pigments. General characteristics such as appearance, colour, hiding power, tinting strength and reducing power, oil absorption, specific gravity, bulking value, pigments flooding and floating, size and shape of pigments particles. Reactive and non-reactive pigments. Permanence to light, sensitive to baking temperature, resistance to chemicals, solvents, etc.

Unit 2: Metallic Pigments and Extenders: Metallic pigments: Aluminium powder and paste, bronze powders, lead powder and paste, metallic stearates. Testing and evaluation of metallic pigments. General characteristics of extenders. Role of extenders in coatings. Composition, manufacture and properties of calcium carbonate extenders, precipitated calcium carbonate, calcium sulphate extenders, barium sulphate extenders, silica and silicate extenders, hydrous calcium silicate, silica flatting agent, talc, mica, asbestine, clay, calcined clay, etc.

Unit 3: White and Black pigments: White Pigments: Composition and comparison of properties, occurrence and manufacture of titanium dioxide, zinc oxide and sulphide, white lead, lithophone and antimony oxide, etc. Black pigments: Comparison of various black pigments and their composition. Manufacture, properties and application of thermal, furnace, channel, and lamp black.

Unit 4: Coloured Inorganic Pigments: Classification of inorganic coloured pigments. Comparison of properties and their composition. Methods of manufacture. Natural earth colour. Synthetic iron oxide pigments, Chrome yellow and orange pigments. Molybdate orange pigments, Venetian red. Red lead pigments. Cadmium coloured pigments. Mercadmium pigments. Copper maroon pigments. Ultramarine blue. Iron blue pigments. Chromium oxide green and hydrated chromium oxide.

Unit 5: Organic Pigments and Colour Theory: Toners and Lakes. General characteristics. Colour in organic materials. chromophores and auxochrome. Raw materials and intermediates. Coupling reaction. Organic dyes and pigments containing nitro and nitroso groups. azo groups, anthraquinone, phthalocyanine, etc. Colour: Perception of colour, Attributes of colour, Nature of light. Light sources and light interactions. Trichromatic colour system. Munsell colour system. Measurement of Colour. Practical applications of colour measurement. Colour standardization. Metamerism. CIE System. Colour aesthetics.

Books Recommended:

1. Organic Coating Technology, Volume I, by H F Payne, John Wiley and Sons, New York, 1954
2. Organic Coating Technology, Volume II, by H F Payne, John Wiley, New York, 1954
3. Protective and Decorative Coatings, Vol II, by J J Matellio, John Wiley and Sons, New York
4. Protective and Decorative Coatings, Vol III by J J Matellio, John Wiley and Sons, New York
5. Paint Technology Manual, Vol. 1, Oil Colour Chemistry Society, UK
6. Surface Coatings, Vol 1, Oil, Colour Chemists Association, Australia.
7. Surface Coatings: Science and Technology, Swaraj Paul
8. Organic Coatings Science and Technology Zeno W. Wicks, Jr. Frank N. Jones, S. Peter Pappas, Douglas A., John Wiley & Sons, Inc.
9. Paints, Coatings and Solvents, W. Freitag, and D. Stoye (Eds.) Second Edition, WILEY VCH Verlag GmbH & Co.
10. Industrial Inorganic Pigments, G. Buxbaum, Second Edition, WILEY-VCH Verlag GmbH & Co.

Subject: CT -HSMC-HS -606T (BCE)

HASS IV Industrial organization & Entrepreneurship Development (Theory)

Lecture	: 2 Hours	No. of Credits	: 2
University	: 35 Marks	College Assessment	: 15 Marks

Duration of Examination: 3 Hours

Course Objectives:

- To motivate students and inculcate entrepreneurial skills in them
- To provide exposure to different aspects of industrial organization & entrepreneurship
- To understand roles and responsibilities of different organs of organization
- To understand the synergy between different department for a successful business setup

Course Outcomes:

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

CO1: Understand various facets of entrepreneurship

CO2: Understand the behavioural aspects of management and identify roles and responsibilities of various organs of company management

CO3: Identify and understand different organizational structure and it legal aspects along interpreting various financial statement and project reports

CO4: Identify & understand aspects of material management and apply methodologies such as ABC analysis, EOQ etc. for inventory control

CO5: Understand the different aspects of marketing, business management and dealing with business crises

Unit 1: Entrepreneur, Enterprise & Entrepreneurship. Charms of being an entrepreneur. Motivation. Entrepreneurial competencies. Goal setting. Different types of goals.

Unit 2: Behavioural aspects of Management, Functions of management, organs of company management and their functions (shareholders, board of directors, CEO, managing director, manager, secretary), Personal management, Business crises

Unit 3: Benefits and types of organizational structure Different types of business structure in India - advantages disadvantages and its legal aspects, Sources of finance, financial statement, Project report/ Business plan

Unit 4: Material, management: Classes of materials, Purchasing, objectives of purchasing. Functions of purchase department. Inventory management and control. Economic Order Quantity (EOQ), ABC analysis

Unit 5: Marketing for small business, marketing research, Advertising & sales promotion, Channels of distributions. Managing your business for successful growth. Seven business crisis and techniques to beat them

Books Recommended:

1. Basu, S. K., Sahu, K. C., Rajiv Industrial organization and management-, B PHI learning private limited, New Delhi
2. P. C. Jain, Handbook for new entrepreneur, Oxford University Press, 2012.
3. V. G. Patel, The Seven-Business Crisis. How to beat them? Tata McGraw-Hill Co. Ltd, 1995.
4. Gupta C. B. and Srinivasan P., Entrepreneurship Development, Sultan Chand and Sons, New Delhi
5. M. S. Mahajan, Industrial organization and management, Nirali Publications
6. Khanka S. S., Entrepreneurial Development, S. Chand & Co. Ltd New Delhi, 1999
7. Philip Kotler, Marketing Management, Prentice Hall of India, New Delhi
8. Rathore B. S. and Dr. Saini J. S., A Handbook of Entreprenuership, Aapga Publications, Panchkula (Haryana).
9. EDII - Faculty & External experts - A Hand Book for new Entrepreneurs, Entrepreneurship Development Institute of India, Ahmedabad, 1986.

Subject: CT-PCC-607P (BCE)

Chemical Reaction Engineering II 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 learn chemical reaction engineering principles and their practical applications in the estimation of design parameters of reactors.
- Understand the experimental techniques related to chemical reactor design.
- To inculcate the ability to plan experiments, apply theoretical concepts for data analysis and interpretation

Course Outcomes:

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

CO1: Understand and perform experiments related to Non ideal reactors (CSTR and PFR)

CO2: Understand and perform experiments related to Industrial reactors like, trickle bed reactor, packed bed reactors, fluidized bed reactor etc.

CO3: Understand the significance of reaction rate constant & the role of catalyst in chemical reactions

CO4: Understand, perform experiments and estimate parameters pertaining to mas transfer with chemical reaction and the solid fluid reactions and arrive at the regime of operation.

LIST OF EXPERIMENTS:

Required to perform minimum 8 practicals from the list given below:

1. To study Residence Time Distribution (RTD) of CSTR and determine the dispersion number
2. To study residence time distribution (RTD) in a Plug Flow Reactor and to find out Peclet Number.
3. To study residence time distribution (RTD) in a Trickle Bed Reactor and to find out Peclet number.
4. To study residence time distribution (RTD) in a Packed Bed Reactor and to find out Peclet Number.
5. Finding conversion and rate of polymerization reactions using gravimetric method
6. Studies in recycle bed reactor.
7. To study the performance of a fluidized bed reactor.
8. To study the heterogeneous catalysis in the fixed bed reactor
9. RTD Studies in a Series of CSTRs
10. Investigation of the absorption process (mass transfer with chemical reaction) when separating gas mixtures in a packed column and to determine the effectiveness factor and regime of operation.

11. Advanced oxidation with hydrogen peroxide and UV light
12. Kinetics of Solid Fluid Reaction: To study the decomposition of calcium carbonate ($CaCO_3$) in a muffle furnace
13. To determine void volume, solid density and porosity of a catalyst particle
14. To investigate the Industrial Reactors

Books Recommended:

1. O. Levenspiel, Chemical Reaction Engineering, 3rd Edition, Wiley India, 2006.
2. H. S. Fogler, Elements of Chemical Reaction Engineering, 4th Edition, PHI, 2005.
3. J.M. Smith, Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1981.
4. S.D. Dawande, Principles of Reaction Engineering, Denett & Co, 2007
5. S. M. Walas, Reaction Kinetics for Chemical Engineers, McGraw Hill, 1959.

Subject: CT-PCC-608P (BCE)

Process Equipment Design and Drawing 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 understand various design aspects of process equipment
- To understand designing and representation of vessel supports
- To impart skill in drawing and interpretation of various process equipments
- To understands various aspects such as analysers, control logic, safety logic of P&ID of any process

Course Outcomes:

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

CO1. To identify and apply various symbols used in equipment and process design

CO2. To identify and apply various vessel connections such as nozzles, flanges, jacket and various vessel supports

CO3. To understand and apply various control logics, safety logics, analysers, dimensions of pipe etc used in a P&ID

CO4. To be able to design basic equipment on softwares such as AutoCAD/ Solid works

LIST OF EXPERIMENTS: Minimum 8 sheets related to design and drawing mentioned below should be drawn. Out of 8, two drawing should be performed/demonstrated on AutoCAD.

1. Design of Pressure Vessels
2. Design of Vessel Supports
3. Design of Storage Tanks
4. Design of Heat Exchangers
5. Design of Tray Towers
6. Design of Packed Towers
7. Process Flow Symbols
8. Process Flow Diagram
9. Piping & Instrumentation Diagram
10. Equipment Layout
11. Use of AutoCAD

Subject: CT-PCC-609P (BCE)

Process Dynamics & Control 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 dynamics of First order and second order systems.
- To perform the experiments on transient response of control systems using PID controllers under Servo and Regulator problem.
- To perform experiments related to computer operated linear and non-linear level control.

Course Outcomes:

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

CO1: Understand and analyse physical and chemical phenomena involved in various process response for first order system.

CO2: Understand and analyse the response of multi capacity systems

CO3: Apply various analogous/ digital controller to control the system.

CO4: Evaluate the transient response of control system using PID controllers under Servo and Regulator problem.

LIST OF EXPERIMENTS:

Required to perform minimum 8 practical from the list given below:

1. To determine the time constant of mercury in glass thermometer.
2. To determine damping coefficient, decay ratio, overshoot and characteristics time for step response of mercury manometer.
3. To study the dynamic response of liquid level in single tank system.
4. To study the dynamic response of liquid level in two tanks non-interacting liquid level system and to compare experimental and theoretical responses.
5. To study the dynamic response of liquid level in two tank interacting liquid level system and to compare experimental and theoretical responses.
6. To determine the characteristics pneumatic control valve.
7. Use of MATLAB/Scilab/DCS Trainer for performing experiments
8. To study the level control process by means of level transmitter.
9. To study the flow control process by means of flow sensor.
10. To study the cascade control with level.

11. To study the ratio control with flow.
12. To study the behavior of P, I and D on the process control.
13. To study the open loop or manual control.
14. To study the proportional control.
15. To study the Two mode (P+I) control for linear level control
16. To study the Two mode (P+D) control for linear level control
17. To study the Three mode (PID) control for linear level control.
18. To study the tuning of controller (Open loop method) using Zeigler-Nichols method for linear level control.
19. To study the stability of the system using the BODE PLOT for linear level control.
20. To study the autotuning of controller for linear level control
21. To study principles of nonlinear level control

Books Recommended:

1. D. R. Coughanour, Process system analysis and control, 2nd Edition, McGraw Hill publication, 1991.
2. G. Stephanopoulos, Chemical process control: An introduction to theory and practice, Prentice Hall of India private limited, 2008.
3. F.G. Shinskey, Process control systems, 2nd Edition, McGraw Hill book Company publication, 1979.
4. R.P. Vyas, Process control and Instrumentation, Seventh Edition, Denett & Co. publication, 2015.
5. R.P. Vyas, Measurement and Control, Denett & Co. Publication 2010.

Subject: CT-CS-610P (BCHT) **Food Technology II Lab (Practical)**

Food Analysis and Quality Control

Practical	: 3 Hours	Tutorial: 0 Hour	No. of Credits	:1.5
University	: 25 Marks		College Assessment	: 25 Marks

Duration of Examination: 3 Hours

Course Objectives:

- To help the students to measure the acidity, ash, sugar content, moisture, total solid content, viscosity,
- To measure the unsaturation, volatile fatty acid, hydrolytic rancidity, oxidative rancidity of the food samples
- To help the students understand various methods of isolation, characterization and screening of bacteria, fungi and other related organisms
- Apply different preservation techniques relative to food safety and spoilage

Course Outcomes:

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

CO1: Develop practical skill in analysing various food components available in various food materials.

CO2: Measure the acidity, ash, sugar content, moisture, total solids of various food samples.

CO3: Estimate various nutritional parameters e. g. Carbohydrate, fat, protein, vitamin etc

CO4: Explain various methods of isolation, characterization and screening of bacteria, fungi and other related organisms.

CO5: Identify which organisms would be likely to grow in a specific food product.

LIST OF EXPERIMENTS:

1. Proximate Analysis of Food (Estimation of Moisture, ash, protein, fat and Fibre).
2. Analysis of Jam, Jellies and concentrates
3. Analysis of Squash and SO_2 content.
4. Analysis (ash content, moisture content, bulk density, Polyphenol content, total extractive) of tea.
5. Analysis of Honey
6. Analysis of Vinegar

7. Analysis of Cereals (Wheat Flour)
8. Analysis od salt content in pickles
9. Quality control Analysis (ash content, moisture content, crude fibre content, loaf volume only for bread) of Bread, biscuits, cake, cookies.
10. Microbiological analysis of Food Products (Preparation and Sterilization of media)
11. Inoculation and Counting of Microorganisms, SPC
12. Estimation of quality parameters of Milk, Milk Powder and Milk products.
13. Estimation of Rate of Fermentation of flour.

Subject: CT-CS-610P (BCHT) **Oil Technology II Lab (Practical)**

Analysis and Synthesis of Oleochemical Derived Products

Practical	: 3 Hours	Tutorial: 0 Hour		No. of Credits	: 1.5
University	: 25 Marks			College Assessment	: 25 Marks

Duration of Examination: 3 Hours

Course Objectives:

- Identification of fatty acids in oils and fats by use of laboratory techniques.
- Processing of fats and fat- allied products and their analysis.
- Refining of crude extracted oil by laboratory techniques
- Analysis of processed oil products & by-products
- Demonstrate practical proficiency in processing & analysis in Oil laboratories.

Course Outcomes:

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

CO1: To understand the techniques to be used for processing and analysis of soaps & detergent formulations.

CO2: Estimate to provide knowledge about principles in oil extraction methods.

CO3: Understand the principle involved in quality control analysis methods by higher analytical procedures other than common laboratory procedures.

CO4: Understanding To develop the practical proficiency in use of Equipment's used in chromatography and other spectral analysis.

CO5: Understand the conceptual knowledge for converting theoretical concepts related to practical analytical values.

LIST OF EXPERIMENTS:

1. Determination of fatty-acid content by spectrometric methods
2. Analysis of de-fatted matter
3. Extraction of oil by Soxhlet Method
4. Extraction of essential oil by Clevenger's Assembly
5. Laboratory Preparations Of:

a. Toilet/ Laundry Soap

b. Transparent Soap

c. Metallic Soap
d. Liquid Soap
e. Medicated Soap
6. Analysis of Household and toilet soaps for:
a. Active matter
b. Moisture and volatile matter
c. Free alkali & Total Alkali
d. Total Fatty matter
e. Alcohol Soluble and Insoluble
f. Glycerol Content
7. Laboratory Degumming and dewaxing of Crude oil
8. Alkali refining of crude oils and miscella -alkali deacidification
9. Bleaching of crude oil using different adsorbents
10. Analysis of spent bleaching agents.
11. Treatment of gums for Lecithin recovery and its purification method.
12. Analysis of processed oils and oil products for –
a. Soap Content
b. Phosphatides Content
c. Wax Content

Subject: CT-CS-610P (BCHT) Petroleum Refining & Petrochemical Technology II Lab (Practical)

Petrochemical Analysis Laboratory

Practical	: 3 Hours	Tutorial: 0 Hour		No. of Credits	: 1.5
University	: 25 Marks			College Assessment	: 25 Marks

Duration of Examination: 6 Hours

Course Objectives:

- To get introduced with ASTM standards of fuels.
- To get familiarize with various petroleum product testing equipments.
- To become proficient in carrying out various IP/ASTM tests for various petroleum products.

Course Outcomes:

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

CO1: Identify the standard properties of petroleum products & petrochemicals.

CO2: Evaluate & analyze the energy content of various petroleum products.

CO3: Understand national & international norms for effective handling of petroleum products before & after use.

CO4: Describe & evaluate the significance of various ASTM/IP tests.

LIST OF EXPERIMENTS: (Minimum of 15 experiments to be conducted)

1. Sulphur content determination
2. Flue gas Analysis – Orsat Apparatus
3. Aromatic Content determination
4. Determination of Lead, Acid and Salt content
5. Analysis of petrochemicals using UV spectrophotometer
6. Analysis of petrochemicals using NMR with MS
7. Analysis of petrochemicals using Gas chromatography
8. Biodegradation of petrochemicals
9. Bioremediation of petrochemicals
10. Refractive index of petrochemicals

11. Determination of moisture content – KF Titrator
12. Total acidity determination
13. Dynamic viscosity measurement
14. Calorific value of fuels
15. Bromine Number by Color Indicator and Electrometric method
16. Ash from Petroleum
17. Molecular Weight determination
18. Determination of acid value and iodine value of oils
19. Determination of COD of water samples

Subject: CT-CS-610P (BCHT) Pulp and Paper Technology II Lab (Practical)

Analysis of Non-Fibrous Materials

Practical	: 3 Hours	Tutorial: 0 Hour		No. of Credits	: 1.5
University	: 25 Marks			College Assessment	: 25 Marks

Duration of Examination: 6 Hours

Course Objectives:

- Selection of proper non fibrous raw material for paper making process
- Procedure to do purity analysis of non fibrous raw material
- Understand the significance of each paper making component.
- Calculate the percentage chemical applied in the system.

Course Outcomes:

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

CO1: To select appropriate chemical for pulp making process.

CO2: To measure the purity of different non fibrous raw material used in paper making process

CO3: To discriminate between different paper making components

CO4: To hypothize raw material requirement and finished production estimation

LIST OF EXPERIMENTS:

1. Analysis of caustic soda as Na_2O.
2. Analysis of Soda ash as Na_2O
3. Analysis of lime
4. Analysis of limestone
5. Analysis of Alum as combined and total Alumina
6. Analysis of rosin for acid no. and saponification no.
7. Analysis of Bleaching powder as available chlorine
8. Analysis of hypo solution
9. Analysis of Salt-cake as Na_2O
10. Analysis of filler and loading materials such as Calcium Carbonate, Clay, TiO_2
11. Preparation and analysis of White liquor.
12. Preparation and analysis of Black liquor.
13. Preparation and analysis of Green liquor
14. Analysis of waste water for COD, Suspended solids and dissolved solids

Subject: CT-CS-610P (BCHT) Plastics and Polymer Technology II Lab (Practical)

Polymer Processing

Practical	: 3 Hours	Tutorial: 0 Hour		No. of Credits	: 1.5
University	: 25 Marks			College Assessment	: 25 Marks

Duration of Examination: 6 Hours

Course Objectives:

- To understand the working of polymer processing machines.
- To set process parameters on control panel of machines.
- To operate the machine with safety precautions.

Course Outcomes:

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

CO1: Carry out standard start and shut down procedure..

CO2: Arrange requirements for producing a product.

CO3: Choose and set the process parameters.

CO4: Conduct trial on machine to manufacture product.

LIST OF EXPERIMENTS:

1. Manufacture of plastics part by hand injection moulding process.
2. Manufacture of plastics product by automatic injection moulding process.
3. Manufacture of plastics product by blow moulding process.
4. Manufacture of strands by extrusion process.
5. Manufacture of thermoformed product by vacuum forming.
6. Manufacture of compression moulded product from thermoset.
7. Preparation of FRP product by hand layup.
8. Determination of matrix and fibre content.
9. Preparation of Alkyd Resin.
10. Preparation of a paint and evaluation of its properties.

Subject: CT-CS-610P (BCHT) Surface Coating Technology II Lab(Practical)

Processing and Synthesis of Film-formers

Practical	: 3 Hours	Tutorial: -		No. of Credits	: 1.5
University	: 25 Marks			College Assessment	: 25 Marks

Duration of Examination: 3 Hours

Course Objectives:

- To analyze raw materials used in the synthesis of polymers/resins
- To calculate the composition of raw materials used in the synthesis of different resins/polymers.
- To synthesize the polymers/resins adopting different polymerization methods and techniques.
- To evaluate and characterize the resins/polymers using different characterization techniques.

Course Outcomes:

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

CO1: Analysed raw materials used in the synthesis of resins/polymers to be used as film-formers

CO2: Calculate the composition of raw materials used in the preparation of resins/polymers to be used as film-formers

CO3: Synthesized of polymers/resins using different polymerization techniques

CO4: Characterized polymers/resins to be useful as film-former in coatings applications

LIST OF EXPERIMENTS:

1. Preparation and Evaluation of Stand Oil.
2. Preparation and Evaluation of Blown Oil.
3. Preparation and Evaluation of Alkyd Resin by Mono-glyceride process.
4. Preparation and Evaluation of Alkyd Resin by Fatty acid process.
5. Preparation and Evaluation of Urea-formaldehyde resin.
6. Preparation and Evaluation of Melamine formaldehyde resin.
7. Preparation and Evaluation of Epoxy resin
8. Preparation and Evaluation of Phenolic resin.
9. Preparation and Evaluation of Polyamide/polyesteramide resins
10. Preparation and Evaluation of Polyester resin.
11. Preparation and Evaluation of Polyurethane resin
12. Preparation and Evaluation of Urethane oils.
13. Preparation Acrylic resin by Bulk, Emulsion, Suspension, and Solution polymerization techniques.

14. Preparation and Evaluation of Rosin ester/Ester gum.
15. Preparation and Evaluation of Short oil/Long oil Resin Varnishes
16. Preparation and Evaluation of Cellulose Esters
17. Preparation and Evaluation of Synthetic Rubber, Chlorinated Rubber, etc.

Subject: CT-PCC-611P (BCHT)

Summer Internship (3-4 weeks) (Practical)

College Assessment : Evaluation in 7th Semester No. of Credits : Nil

Course Objectives:

- To offer the opportunity for the young students to acquire on job the skills, knowledge, attitudes, and perceptions along with the experience needed to constitute a professional identity.
- To provide means to immerse students in actual supervised professional experiences which will provide an insight into the working of the Chemical Industries.
- To appreciate the linkages among different functions and departments of chemical industries to develop perspective about business organizations in their totality.
- To help the students in exploring career opportunities in their areas of interest.

Course Outcomes:

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

CO1: construct the company profile by compiling the brief history, management structure, products / services offered, key achievements and market performance for his / her organization of internship.

CO2: determine the challenges and future potential for his / her internship organization in particular and the sector in general by assessing the Strengths, Weaknesses, Opportunities and Threats (SWOT) of the organization.

CO3: apply the chemical engineering fundamentals in practical situations and analyze and recommend changes for improvement in processes during the internship period.

CO4: apply various soft skills such as time management, positive attitude and communication skills during performance of the tasks assigned in internship organization.

After the end of the sixth semester examination and before the start of the seventh semester, every student will have to undergo Summer Internship. The Summer Internship will be for an individual student to work in industry for 3 to 4 weeks under the guidance of departmental faculty of the institute and respective industrial expert. The Summer Internship (preferably Industrial Internship) would be assigned to the student by the Departmental Internship Coordinator, with the approval of Head of the Department and the Institute.

The Summer Internship will involve the application of the fundamentals learned in the curriculum at industrial/pilot level. The Summer Internship could be of the following forms: (i) industrial internship in a company involved in R&D / design / manufacturing/ marketing / finance / consultancy/Technical services/ Engineering / Projects, etc. (ii) research internship in reputed Institutes like, ICT, IITs, NITs, IISC, NCL, IICT etc.

At the end of the Summer Internship, each student will submit a written report (2 copies) based on the work carried out during the Summer Internship in the given format. The report will 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 consisting of two faculty members from the respective Chemical Technology Department. Students will be assigned a grade based on the written report and a presentation; evaluated by a committee of faculty members.