SYLLABI PRESCRIBED FOR FOUR YEAR DEGREE COURSE
B. TECH (CHEMICAL TECHNOLOGY) (FOOD, PULP & PAPER, OIL & PAINT AND PETROCHEMICAL TECH.,) SEMESTER PATTERN (NEP-2020) New
SEMESTER: FIFTH B. TECH.

5CT220PC/ 5CH220PC: **Heat Transfer (**PCC-I**)**

Subject Code	**Title**	**Credits-03**		
5CT220PC/5CH220PC	**Heat Transfer**	L	T	P
Semester: V	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

- Understand fundamental heat transfer mechanisms.
- Apply concepts to industrial equipment like heat exchangers, boilers, condensers.
- Develop problem-solving skills for real-world heat transfer applications.
- Introduce energy-efficient and sustainable heat transfer practices.
- Enhance employability through exposure to industrial case studies and software tools.

Course Outcomes (COs)

After completion, students will be able to:

- CO1: Explain conduction, convection, and radiation principles.
- CO2: Solve steady and transient heat transfer problems.
- CO3: Design and analyze heat exchangers used in industries.
- CO4: Evaluate heat transfer performance in industrial processes.
- CO5: Apply energy-saving and optimization techniques.

SECTION A

UNIT I: Importance of heat transfer in chemical process industries. Modes of heat transfer, steady state conduction in one dimension. Fourier's law. Heat transfer through plane, cylindrical and spherical walls, compound resistance in series, thermal insulation, critical and economic thickness. Extended surface equipment's, types, their design and operation. (**7)**

UNIT II: Heat transfer by convection, film concept, individual and overall coefficients and factors affecting them. Natural and forced convection. Dimensional analysis applied to heat transfer. Dittus-Boelter equation, Limitations and application. Theories of heat& Mass transfer & analogy between momentum & heat transfer. (**7)**

UNIT III: Heat transfer by parallel and counter current flow, concept of log mean temperature difference, rate of heat transfer. Heat transfer by film wise and drop wise condensation in horizontal & vertical tube. Process design of condenser **(7)**

SECTION-B

UNIT IV: Heat exchange equipment's and their design, double pipe, parallel, counter current, shell and tube heat exchangers, fouling factors, concepts of transfer units in heat exchangers, NTU concept for heat exchangers. Compact Exchangers, plate, plate fin, Spirals etc construction, features advantages, limitation & their process design aspects. **(7)**

UNIT V: Boiling and Evaporators: Theory of boiling. Classification, types and field applications of evaporators. Single & multiple effect evaporators. Heat transfer in agitated vessels, jackets, coils etc. **(7)**

UNIT VI: Heat transfer by radiation, concept of black body, Kirchhoff's law, Stefan's law, Black and gray body radiation, view factors luminous and non-luminous gases. Heat transfer in packed and fluidized beds. Recent developments and technological forecasting in heat transfer. **(7)**

Text Books :

1) Heat Transfer by Sukhatme.
2) Heat Transfer by McAdams
3) Process Heat Transfer By Kern D. Q.
4) Process Heat transfer By G He.

Reference Books:

1) Unit Operations of Chemical Engineering by McCab and Smith
2) Chemical Engineering by Coulson & Richardson, Vol. I
3) Heat Transfer by R.C. Sachdeva
4) Process of Heat Transfer: D. Q. Kern, TATA McGraw-Hill(1997).
5) Basic Heat Transfer: NecatiOrisik, McGraw-Hill., Kogakusha.
6) Heat Transfer: J. P. Holman, S. Bhattacharya, 10thEd. TATA McGraw-Hill (2011).
7) Unit Operations of Chemical Engineering: W. J. McCab, J. Smith, P. Harriot 6^{th} Ed. McGraw Hill (2005)
8) Introduction to Chemical Engineering: Bedger and Banchero.
9) Chemical Engineering: Coulson & Richardson, Vol. I (ELBS, Pergamon Press, Latest Edition)
10) Heat Transfer: Gebhart, McGraw-Hill, 2^{nd} edition, Latest Edition
11) Fundamentals of Engineering: R. C. Sachdeva, Wiley Eastern.
12) Heat Transfer: R. C. Sachdeva.
13) Heat & Mass Transfer: S. D. Dawande, Central Techno Pub., Nagpur
14) Fundamental of Heat and Mass Transfer: M. Thirumaleshwar, Pearson
15) Computational Heat Transfer and Fluid Flow: Murlidhar & Sunder Rajan, Narosa
16) Thermal Engineering: M.L. Mathur & F.S. Mehta, Jain Publications
17) A Course in Heat & Mass Transfer: V.M. Domkundwar, Dhanpat Rai & Co.
18) Process Heat Transfer & Chemical Equipment Design: D. C. Sikdar, Khanna Publishing House
19) Heat Transfer Principles and Applications : B.K. Dutta, PHI
20) Bejan, A., A. D. Kraus, Heat Transfer Handbook, John Wiley (2003).

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
  - ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
  - ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
  - ✓ Teaching Evaluation Components : 10Marks (Viva Voce / Assignments / Report Writing etc.)
  - ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

5CT221PC/ 5CH221PC: **Industrial Waste Treatment (**PCC-II**)**

Subject Code	**Title**	**Credits-03**		
5CT221PC/5CH221PC	**Industrial Waste Treatment**	L	T	P
Semester: V	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

- Understand sources and characteristics of industrial wastes
- Learn treatment methods for liquid, solid, and gaseous wastes
- Apply cost-effective and sustainable solutions
- Develop skills for pollution control and regulatory compliance
- Promote environmental responsibility and circular economy concepts

Course Outcomes (COs)

After completion, students will be able to:

- **CO1:** Identify industrial waste sources and characteristics
- **CO2:** Analyze wastewater using standard parameters
- **CO3:** Select and design suitable treatment methods
- **CO4:** Understand air and solid waste management techniques
- **CO5:** Apply environmental regulations and sustainability practices

SECTION - A

UNIT I: Disposal Effects on Environment:

Effects of industrial wastes on environment (streams, land, and air); water quality criteria and effluent standards; waste minimization strategies including good housekeeping, volume and strength reduction, material and process modification, recycle, reuse and by-product recovery; environmental audit; environmental legislation. (7)

UNIT II: Effluent Treatment:

Conventional methods of industrial wastewater treatment and disposal; equalization and neutralization; solid–liquid separation (sedimentation and filtration); coagulation and flocculation; chemical precipitation and oxidation; Physio-chemical treatment methods; removal of dissolved impurities; residue/sludge management; combined treatment of industrial and municipal wastes. (7) **UNIT III: Biological Treatment Methods**:

Biological Treatment Methods: Principles and methods for the removal of suspended impurities and biodegradable organic matter; aerobic and anaerobic decomposition processes; treatment systems including stabilization ponds, activated sludge process, and oxidation ditch. (7)

SECTION - B

UNIT IV: Advanced Waste Water Treatment:

Nitrogen removal, Phosphorous removal, Removal of refractory Organics, Removal of dissolved inorganic substances, Chemical precipitation, ion exchange, Reverse Osmosis, Electrodialysis. (7)

UNIT V: Industrial Waste Water Treatment – I:

Sources and classification of industrial effluents; wastewater treatment for the following industries: Textiles, Tanneries, Pulp and Paper, Pharmaceuticals, Sugar, Distilleries. (7)

UNIT VI: Industrial Waste Water Treatment – II:

Wastewater treatment for the following industries: Food Processing, Fertilizers, Steel, Thermal Power Plants, Petrochemical and Refineries, Dairy, Pesticide and Agrochemical, Cement, Paint and Dye Manufacturing (7)

Text Books:

1. Rao.M.N. and Dutta, Waste Water Treatment, Oxford and IBH Publishing Ltd., Calcutta,2008.
2. Ecken Felder, W, Industrial Waste Pollution Control, McGraw Hill Book Co., New Delhi, 2003.
3. S C Bhatia, Managing Industrial Pollution.

Reference Books:

1. Nemerow, N.L., Theory & Principles of Industrial Waste Treatment, Addison Wesley, Reading Mass, 1993.
2. Wastewater Engineering Treatment & Reuse, Metcalf & Eddy Inc.

3. Dr. S. P. Mahajan: Environmental Pollution Control
4. Matcaff and Eddy: Wastewater Treatment
5. Rao & Datta: Wastewater Treatment
6. V. V. Kafarov : Waste less Chemical Processing

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

5FT222PC & 5FT226PC: FOOD TECHNOLOGY SP. TECH-II

Subject Code: 5FT222PC	**Title: Food Technology Sp. Tech-II**	**Credits = 04**		
		L	**T**	**P**
Semester: V	**Total contact hours: 5 hrs/week**	**03**	**-**	**02**

COURSE OBJECTIVES:

The main objective of this course is for student to learn and develop concept of biochemistry and significance the application of biochemistry. Nucleic acid and biochemical analysis. The importance of nutrition, malnutrition, and national program on nutrition. Student will have knowledge about fortification and enrichment of food.

COURSE OUTCOMES:

After successful completion of this course student will be able to

- To understand organization cell and digestion absorption and metabolism of nutrients.
- Ability to know structure and function of nucleic acid.
- To know the techniques used in biochemical analysis.
- Aware about nutrition, balance diet and modified diet and RDA for individual.
- Aware about malnutrition and the national nutrition programme.
- To know about fortification and enrichment.

UNIT I: Bioenergetics, Organization cell and cellular constituents prokaryotic and eukaryotic cell. Digestion, absorption and metabolism of carbohydrate, fat, protein. (10hrs)

UNIT II: Nucleic acid structure of mononucleotide, basis found in nucleic acid, function and structure of RNA and DNA, difference between RNA and DNA. (10hrs)

UNIT III: Techniques of biochemical analysis, Principle of Chromatography and Chromatography types (Partition, absorption and HPLC), Electrophoresis, Photometer and spectrophotometer, Ultracentrifugation, Radioimmuno assay. (10hrs)

UNIT IV: Nutrition: The five-food group, importance of nutrient, Balance diet, Principle and advantages of meal planning, factor affecting meal planning. Recommended Dietary Allowances (RDA) and estimated average requirement of protein, fat, carbohydrate, vitamin and minerals, factor affecting and use of RDA, Energy requirement of body (Energy metabolism). BMR and its measurement, factor influencing BMR. (10hrs)

UNIT V: Malnutrition and nutrition programs, Protein Energy Malnutrition (PEM), Marasmus, kwashiorkor, vitamin, and mineral deficiencies. Current national nutrition programs (Integrated Child Development Service Programme (ICDP), Mid-Day Meal Program, National Nutrition Anemia Control Programme, Vitamin A prophylaxis program and National Iodine Deficiency Disorder Control Programme) (10hrs)

UNIT VI: Effect of different cooking method on nutritive value of food. Food fortification and enrichment; types of fortification. Formulation of diet and foods for specific needs. Antinutritional

factor of food, Toxic compounds, food allergy. (10hrs)

5FT226PC: Food Technology Sp. Tech-II PRACTICALS: Based on above syllabi

A. BIOCHEMISTRY

- Estimation of carbohydrates and proteins by various methods.
- Qualitative demonstration of enzyme with salivary amylase.
- Study of rate of enzyme reaction, effect of environmental factors on rate of enzyme action.
- Detection of trypsin inhibitor.
- Assay of vitamins / Minerals
- Isolation of Chloroplast from spinach leaves
- Chromatographic separation of carbohydrates and amino acids.
- Simple histological studies on plant tissue.
- To measure the absorbance of standard solution by Spectrophotometry (UV-VIS, IR)
- To separate cream from milk / juice from pulp using centrifugation

B. MICROBIOLOGY

- Preparation and sterilization of nutrient media.
- Study the morphological structure of starch under microscopy.
- Cultivation and morphological study of common species of bacterial yeasts and moulds.
- Isolation of pure culture from natural sources.
- Enumeration of bacteria Haemoeytometer, standard plate count MBRT tests for milk.
- Bacteriological analysis of water.
- Microbial spoilage of various foods and effect of extrinsic and intrinsic factors on food spoilage.

Text Books/ Reference Books:

- Outlines of Biochemistry: E. E. Conn & P. K. Stump, Wiley Eastern Pvt. Ltd., New Delhi.
- Biochemistry of Foods: N.A. Eskin, H. M. Handerson, H.M. & R. J. Town End, Academic Press, NY.
- Cell Physiology: A. C. Giese, Sanders & Company, Toppan, Japan.
- Integrated Biology: L. Hill, D. Bellamy, I Chester, Jones Chapman& Hall Ltd., London, EC4.
- Principles of Enzymology for the Food Science: J. R. Whitaker, Marcel Dekker, INC, NY.
- Applied Nutrition: R. Rajalaxmi, Oxford & IBH Publishing Co., NY.
- Heinz Handbook of Nutrition: Benzamin T. Burton, McGraw Hill. Book Company, NY.
- Nutrition-An Integrated Approach: R. C. Pyke & M.L. Brown, Wiley Eastern Pvt. Ltd., New Delhi.
- Hawk's Physiological Chemistry: Edited by Bernard L. Oser, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Biochemistry: A. White, P. Handler, E. L. Smit., McGraw Hill, Tokyo.
- Text Book of Biochemistry: H. R. Mahler & E. H. Chordes, Harper & Row Publisher, NY.
- Microbiological Methods: C.H. Collinse, P. M. Lyme, Butterworth Co. Ltd. London
- Microbes if Action-A Laboratory manual of microbiology: H.W. Seeley (JR), P. J. Von. Denmark Taraporewala I., W. Pvt. Ltd. Bombay
- Introduction to Practical Biochemistry: D.T. Plummer, Tata McGraw Hill Co. New Delhi

5PT222PC & 5PT226PC: PULP & PAPER TECHNOLOGY SP. TECH II

Subject Code: 5PT222PC	**Title: Pulp & Paper Technology Sp. Tech II**	**Credits = 04**		
		L	**T**	**P**
Semester: V	**Total contact hours: 5 hrs/week**	**03**	**-**	**02**

COURSE OUTCOMES:

After successful completion of this course student will be able to

- Detail knowledge of pulping processes such as mechanical pulping, semi chemical pulping and semi mechanical pulping
- Understanding comparative pulping methods such as sulphite pulping, alkaline pulping

UNIT-I: Collection grading and storage of various raw materials, wood preparation for pulping, units for measuring wood handlingwood barking chipping, Screening, chip, handling and storage, relationship between wood and quality. (10 hrs)

UNIT-II: Introduction to pulping, Fiber separation commercialprocesses, types of pulping processes. Advances and trends in pulping. (8 hrs)

UNIT-III: Manufacture of mechanical pulp: Types, grades, and uses ofmechanical pulp stone ground wood process, types of grinders, theory of grinders, theory of grinding. Variable inground

wood process, characteristics of ground wood pulp, pulp mill operations control, practice and testing methods, whole woodfiber manufacture. ground wood from pretreatedwood, refiner mechanical pulping scheme, thermomechanical pulping. (12 hrs)

UNIT-IV: Semichemical pulping and Semimechanical pulping: Neutralsulfite semichemical pulping, bisulfite semichemical pulping,craft semichemical pulping. cold soda semichemical pulping,hot sulfite chemo mechanical semichemical pulp. (10 hrs)

UNIT-V: Sulfite pulping: Description of various sulfite processes,sulfite liquor preparation. variables in sulfite pulping.mechanics and kinetics of sulfite pulping. delignification,digestion in sulfite process. characteristics of sulfite pulp (10 hrs)

UNIT-VI: Alkaline pulping: General description of alkaline pulpingprocess. alkaline digestion, chemical reactions during alkalinedigestion. Variables in alkaline pulping process, digester operation, material and heat balance bamboo, reeds, hemp, jute, etc. Recent advances in the field. (10 hrs)

5PT226PC: Pulp & Paper Technology Sp. Tech II PRACTICALS: Based on above syllabus.

Analysis of fibrous materials;

Pulp analysis

Determination of moisture

Determination of ash content, permanganate number, copper number, kappa number of pulps 2, B, V, cellulose, solubilityof pulp in alkali.

Analysis of non-fibrous materials:

Analysis of black, green,and white liquors, bleaching powder, soda ash, caustic soda,lime stone etc.

BOOKS RECOMMENDED:

- Pulping processes: A. Rydholm. Interscience Pub., John Wiley &Sons Inc., NY.
- Pulp & Paper: Chemistry & Chemical Technology, 3rd Ed., Vol I :James P. Casey, John Wiley & Sons, NY
- Pulp and Paper Manufacture, 2nd Ed., Vol I: Ronald G. McDonald.
- Pulp and Paper Science Technology. Vol. I : C. E. Libby. McGrawHill Co.
- Hand book of Pulp & Paper Technology 2nd Ed.: Bitt VanNostrad. Reinhold Co. NY.
- Technology of Textile Properties: M. A. Taylor,
- Identification of Textile Materials, 7th Ed., Textile Inc., Manchester,7.
- Analytical methods for a Textile Lab., 2nd Ed., AATCC Monog No.3Research Triangle Park. North Carolina, Printed in USA
- ISI Standards for Textile Testing
- Textile Testing by Sinkale.

5OT222PC & 5OT226PC: OIL & PAINT TECHNOLOGY SP. TECH-II

Subject Code: 5OT222PC	Title: Oil & Paint Technology Sp. Tech-II	Credits = 04		
		L	T	P
Semester: V	Total contact hours: 5 hrs/week	03	-	02

COURSE OBJECTIVES:

Study of oils & fats along with its derivatives, their nature, reactions, instrumental methods of analysis of oils, fats & their derivatives. Metabolism of oils & fats

COURSE OUTCOMES: After successful completion of this course student will be able to

To know how about the metabolism of oils, fats & their derivatives.

UNIT I: Techniques of separation of fats and fatty acids: Low temperature crystallization, esterification, urea adducts, counter current distribution, chromatographic methods of separation with special reference to thin layer chromatography and gas-liquid chromatography. (11 hrs)

UNIT II: Methods for quantitative investigation on the component, fatty acids of natural fats and processed fats. Lipase hydrolysis, X-ray diffraction and polymorphism of glycerides and other fatty acids and their derivatives. Dilatometric measurements and their significance. (11 hrs)

UNIT III: Analysis of Oils, Fats & derivatives, Reichert-Missel and Polanske and Krischner values. Advanced method of analysis of fats, fatty acids, and glycerides. (8 hrs)

UNIT IV: Chemical reactions pertaining to the manufacture of fatty acid derivatives including metal salts other than alkali metals. (8 hrs)

UNIT V: Quantitative investigation of component triglycerides of natural fats. Theories of fatty acid distribution in natural fats. Effect of fatty acid distribution on the physical properties. (10 hrs)

UNIT VI: Polymorphism of fats and fatty acids. Biosynthesis of fatty acids, phosphlipids and triglycerides in plants and animals. Elongation and desaturation of acyl chain. Biological utilization of fats. Fat Assimilation. Essential fatty acids. Recent advances in the field. (12 hrs)

5OT226PC: Oil & Paint Technology Sp. Tech II PRACTICALS: Based on above syllabus.

- Analysis of nickel catalyst and acids oils,
- Preparation of mixed fatty acids and determination of composition.
- Analysis of commercial fatty acids.
- Preparation of pure fatty acids.
- Determination of mono, di and triglycerides.
- Analysis of soaps and detergents.
- Detection of Adulteration.
- Analysis of Oils by thin layer and column chromatography.

Text Books/ Reference Books:

- Industrial Oil and Fat Products: A. E. BaiIey: Interscience Publishers, New York, Latest Edition.
- Fatty Acids: K.S. Markley (5 Volumes), lnterscience Publishers, New York, Edn., Latest Edition.
- Structure and Utilization of Oil Seeds : J. G. Vaughon.
- Melting and Solidification of Fats : A. E. Bailey, Interscience Publishers, New York, Latest Edition..
- The Analysis of Fats and Oils: V. C. Mehlenbacher : The Garrard Press Champing, Edn., Latest Edition..
- Progress on the Chemistry of Fats and other Lipids: T. T. Homan, W.O. Lundberg and T. Malkia, Pergamon Press, New York, Latest Edition (7 Vols.)
- The Chemical Constitution Natural Fats: Wiley Books Publishers, New York, Latest Edition..
- Vegetable Fats and Oils: G. S. Jamiesan, Renehold Publishers, New York, Latest Edition..
- Vegetable Fats and Oils: E. W. Eckey : Renehold Publishers, New York, Latest Edition..
- Gas-Liquid Chromatography - Theory and Practice: S. Dal Nagore and R. S Juvent; Interscience Publishers, New York, Latest Edition.
- Lipid Chromatographic Analysis: C. V. Marinelt.
- Fatty Acid Synthesis and Application: N. E. Bednareyk & W. L. Erickson.
- The Lipids: H. D. Dauel: Interscience Publishers, New York, Latest Edition.
- Analysis and Characterization of Oil, Fats Products: H. A. Bookenoogen.
- Thin-layer Chromatography: Babbit

5PC222PC & 5PC226PC: PETROCHEMICAL TECHNOLOGY SP. TECH II

Subject Code: 5PC222PC	Title: Petrochemical Technology Sp. Tech II	Credits = 04		
		L	T	P
Semester: V	Total contact hours: 5 hrs/week	03	-	02

COURSE OBJECTIVES: After completion of this course, the students are expected to learn about:

- Introduction to Basic Refining operations.
- Classification of refining processes.
- Introduction to Quality Control of Petroleum Products.
- Types of impurities and their treatment. Production of lube base stocks, Lube oil processing.
- Thermal, Catalytic cracking and hydrocracking processes, mechanism involved.
- Catalytic reforming, isomerization, alkylation and polymerization processes.

COURSE OUTCOMES: After successful completion of this course student will be able to:

- Understand the objective of petroleum refining.
- Understand various refining operations, processes, and integration of processes.
- Understand the importance of Quality Control of Petroleum Products, tests, and specifications of petroleum products.
- Understand the concepts and technology involved in various refining operations and processes.
- Understand the importance of refinery utilities, pollution control in petroleum refineries and

Corrosion control in refining processes.

- Understand the importance of conservation of petroleum and petroleum products.

UNIT I: Introduction to petroleum refining. Basic refinery processes-operations. Product pattern. Classification of refining processes. Important properties of crude oil: Specific gravity, Sulfur content, TAN number. Improving distillate yields and production of high value products. Classifying refineries by configuration and complexity, Nelson's complexity, and its determination. Integrated refinery. Refinery classes and characteristic Yield patterns. Descriptive account of atmospheric and vacuum distillations. Features of primary conversion processes. Features of primary upgrading processes. Treating (Hydrotreating) processes. Separation processes, Utilities and support operations, Product blending. Petroleum refining industry in India, Vision of refining industries in India. Worldwide trends & challenges before Indian refineries. (10hrs)

UNIT II: Introduction to Quality control of petroleum products. Commercial petroleum products, quality requirements, Indian specifications, purpose of these standards, vehicle emission standards. Fuel requirements, composition, tests, testing methods and their significance. Composition, properties, and specifications of Compressed Natural Gas (CNG), LPG, ATF, Kerosene, Transformer oil, Bitumen, Waxes, Greases etc. Solvents, functions, and properties of solvents. The basic function of lubricants, physical properties, chemical properties, factors considered while manufacturing/formulating the lubricating oils, essential properties of lubricants used in IC engines, essential properties of lubricants used in gear oils, essential properties of transformer oils, factors affecting oil consumption, up gradation of lubricants, lubricant composition, role of base oil and additives in finished lubricants, Chemically inert additives, chemically active additives. (10hrs)

UNIT III: Treatment techniques (process description, process variables, typical operating conditions). Types of impurities, Sulphur, nitrogen and oxygen in petroleum, purposes for desulfurization, order of difficulty of sulfur removal. Dehydration of natural gas, Dehydration and desalting processes for crude oil, conditioning of crude oil. Caustic processes, Liquid solvents for H_2S removal from sour gases, Solid adsorbents for H_2S. Cascade system of gas cooling, Turbo Expander natural gas liquefaction process, Production of LPG based on the principle of separation. Diethanolamine treatment of LPG fraction, Copper chloride process, Merox process, Caustic methanol process, Doctor treatment, Hot potassium carbonate process, Sulfuric acid treatment, Hydrodesulfurization. Treatment of kerosene: Liquid Sulfur dioxide, DMF and DMSO extraction process. (10hrs)

UNIT IV: Production of lube base stocks, Lube oil processing (process description, process variables, typical operating conditions). Propane deasphalting process. Solvent extraction of lube oil fractions: purpose of solvent extraction, comparison of solvents. Phenol-Furfural-NMP extraction processes, Duo-Sol (Selecto) Extraction Process. Dewaxing processes: Chilling and pressing process. Solvent dewaxing processes, selection of solvents, ketone dewaxing processes, propane dewaxing process. Modern catalytic dewaxing process. Hydro finishing process. Asphalt technology. (10hrs)

UNIT V: Thermal and Catalytic cracking processes (process description, process variables, reactions involved, typical operating conditions). Mechanism of thermal cracking, most probable thermal reactions for various types of hydrocarbon compounds. Thermal cracking processes: Visbreaking, Coil visbreaker, Soaker visbreaker Dubs two coil cracking. Types of coking process: Delayed coker, Hot oven coking, Fluid coking, Contact coking, CDE, CCR. Mechanism of catalytic cracking, catalytic cracking processes: fixed bed catalytic cracking, moving bed catalytic cracking, fluidized bed catalytic cracking processes. Hydrocracking process, Advantages of hydrocracking. (10hrs)

UNIT VI: Catalytic reforming processes: Continuous catalyst regeneration (CCR Platforming) process, semi-regenerative process. Isomerization processes, Alkylation processes, Polymerization processes (process description, process variables, reactions involved, typical operating conditions). Refinery utilities, Environmental pollution control in petroleum refineries. Corrosion control in refining processes. Conservation of petroleum products. (10hrs)

5PC226PC: Petrochemical Technology-II (Sp. Tech.-II) PRACTICALS: Based on above syllabus.

List of Experiments:

- Determination of Diesel Index of given petroleum sample.
- Determination of Conradson Carbon Residue of given petroleum sample.
- Determination of Ductility of bitumen sample.
- Determination of dropping point of given lubricating grease sample.
- Determination of Rolling stability lubricating grease sample.
- Determination of Resistance of lubricating grease sample to water spray.
- Determination of water washout characteristics of lubricating grease sample.
- Determination of Softening point of bitumen sample by Ring and Ball method.
- Determination of kinematic viscosity of given petroleum samples
- Determination of ASTM Distillation characteristics of gasoline and diesel samples.

Recommended Books:

Reference Book:

- Fundamentals of Petroleum and Petrochemical Engineering by Uttam Ray Chaudhuri
- Modern Petroleum Technology Volume-I Upstream Edited by Richard A. Dawe
- Fundamentals of Petroleum Refining by Mohamed A. Fah Im, Taher A. Alsahhaf, and Amal Elkilani
- Handbook of Petroleum Processing Edited by David S. J. "Stan" Jones and Peter R. Pujad´O
- Petroleum Refining Technology and Economics by James H. Gary and Glenn E. Handwerk

Text Books:

- Modern Petroleum Refining Processes by B. K. Bhaskara Rao, Latest Edition.
- Petroleum Refining Technology by Dr. Ram Prasad
- Chemistry of Petrochemical Processes by Sami Matar, Lewis F. Hatch
- The Chemistry and Technology of Petroleum by James G. Speight
- Handbook of Petroleum Product Analysis by James G. Speight

5CT223PE/5CH222PC: **Computer Programming & Application (**PEC-I**)**

Subject Code	**Title**	**Credits-03**		
5CT223PE/5CH222PC	**Computer Programming & Application**	L	T	P
Semester: V	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)

- Develop basic programming skills for engineering problems
- Apply programming in chemical engineering calculations
- Use tools for data analysis and visualization
- Introduce simulation and automation basics
- Improve industry readiness

Course Outcomes (COs)

After completion, students will be able to:

- **CO1:** Write simple programs for engineering calculations
- **CO2:** Solve numerical problems using programming
- **CO3:** Analyze and visualize data
- **CO4:** Use programming tools for process applications
- **CO5:** Apply basic automation and simulation concepts

SECTION-A

UNIT I: Numerical solution of first order differential equations with initial condition, Euler's method, Runge-Kutta method. **(7)**

UNIT II: Systems of linear equations, solution by the method of determinants, matrix inversion for the solution of linear equations, Gausses limitation method. **(7)**

UNIT III: Roots of algebraic and transcendental equation, iteration methods, Regula-Falsi method, Newton-Raphson method, roots of simultaneous and solution set of transcendentals & algebraic equations. Development of equations for heat transfer, fluid mechanics & reaction engineering problems. **(7)**

SECTION-B

UNITIV: Regression analysis - Least Square, error approach, approximation by Chebyshev orthogonal polynomial. **(6)**

UNIT V: Elements of optimization techniques, single variable function, optimization-direct search,

with and without acceleration, method of regular intervals and Fibonacci search method, gradient methods.**(7)**

UNIT VI: Computer programming in modular form, use of subroutine libraries, Block diagrams of preliminary aids in programming, capacity optimization. **(7)**

Text Book: Digital Computation for Chemical Engineering by Leon Lapidus, McGraw Hill.
VBA and Macros : Microsoft Excel 2010
www.scilab.in (Free Books for Chemical Engineering)

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

5CT224PC/ 5CH226PC: Heat Transfer Lab. (PCC-I Lab.)

Subject Code	**Title**	**Credits- 01**		
5CT224PC/ 5CH226PC	Heat Transfer Lab	L	T	P
Semester: V	Total Contact Hours: 2 Hrs / Week	0	0	2

List of experiments:

1. Heat Conduction
2. Natural convection
3. Thermal radiation-determination of emissivity
4. Double pipe heat exchanger
5. Shell and tube heat exchanger
6. Plate Heat exchanger
7. Heat transfer in agitated vessels
8. Double effecte vaporator
9. Open pane vaporator
10. Heat pipe demonstrator
11. Fluidized bed heat transfer

All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

Evaluation Scheme:

- **Internal Assessment** : **25 Marks**
- ✓ Teaching Evaluation Components : 20Marks
- ✓ Class Attendance : 05Marks

- **External University Practical Examination** : **25 Marks**

5CT225PC/ 5CH227PC : Industrial Waste Treatment Lab. (PCC-II Lab.)

Subject Code	**Title**	**Credits- 01**		
5CT225PC/5CH227PC	Industrial Waste Treatment Lab	L	T	P
Semester: V	Total Contact Hours: 2 Hrs / Week	0	0	2

1. Study of sampling and preservation methods.
2. To determine pH, TDS & Conductivity of the given sample.
3. To illustrate the various operations involved in gravimetric analysis and to determine the various categories of solids that are commonly defined in water and wastewater.

4. To Measure mineral and phenolphthalein acidity
5. Measurement of phenolphthalein alkalinity and total alkalinity using dye indicators
6. To determine the DO content of given sample of water.
7. To Determine chloride ion concentration in a water sample by Mohr's method.
8. To determine COD value for determining organic strength of solution.
9. To determine Optimum Coagulant Dosage by Jar Test & its relation with pH.
10. To determine the efficiency of cyclone separator.
11. To study the reverse osmosis system.
12. To study standard curve with UV spectrophotometer.

All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

Evaluation Scheme:

- **Internal Assessment** : **25 Marks**
- ✓ Teaching Evaluation Components : 20Marks
- ✓ Class Attendance : 05Marks

- **External University Practical Examination** : **25 Marks**

5CT227M & 5CT229M: MULTI DISCIPLINARY MINOR-III

Subject Code: 5CT227M	**Title: Multi-Disciplinary Minor-III (MDM-III) Emerging Technologies in Renewable Energy Sources**	**Credits = 03**		
		L	**T**	**P**
Semester: V	**Total contact hours: 4 hrs/week**	**02**	**-**	**02**

UNIT I: Energy Sources, Indian & Global Scenario, Classification, New Emerging Technologies, Prospects and Achievements of Non-Conventional Energy Sources (10 hrs)

UNIT II: Wind Energy Fundamental, Types of Winds, Classification of different type of Wind mills, Wind Turbine Components, Wind Characteristics (10 hrs)

UNIT III: Ocean Thermal Electric Conversion, Geothermal Energy, Tidal Energy, Solar Distillation, hybrid systems. (10 hrs)

Recommended Books:

- Rai, G. D., & Rai, C. D. *Non-conventional energy sources*. Khanna.
- Sukhatme, S. P. Text Book of Solar Energy Engineering. *Mc GeawHill*,
- Tiwari, G. N., & Tiwari, A. *Handbook of solar energy* (Vol. 498). Singapore: Springer.
- Maczulak, A. E. *Renewable energy: sources and methods*. Infobase Publishing.
- Márquez, F. P. G., Karyotakis, A., & Papaelias, M. (Eds.). (2018). *Renewable energies: Business outlook 2050*. Springer.

5CT229M: MULTI DISCIPLINARY MINOR-III (LAB): case studies & performance based on syllabus

5CT228M: MULTI DISCIPLINARY MINOR-IV

Subject Code: 5CT228M	**Title: Multi-Disciplinary Minor-IV (MDM-IV) Environmental impact Assessment**	**Credits = 02**		
		L	**T**	**P**
Semester: V	**Total contact hours: 2 hrs/week**	**02**	**-**	**--**

COURSE OBJECTIVES:

- Inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse.
- Predict the environmental impacts of a project in the pre-planning stage itself so that decisions can be taken to reduce the adverse impacts.

COURSE OUTCOMES:

After successful completion of this course student will be able to

Students will learn criteria for selecting method for impact assessment, overview of methods,

parameters for public participation ad technique for writing reports.

UNIT I: Introduction to Environment Management & EIA, Legal, Policy & Regulatory Framework (10 hrs)

UNIT II: EIA Procedure - Scoping & Screening and Establishing Baseline Conditions**,** EIA Methodologies, Impact Management - Mitigation & Preparation of Environment Management Plans (EMP) (10 hrs)

UNIT III: Connectedness: connected spaces and subspaces, Connectedness of the real line, Intermediate value theorem, EIA Methods, Tools and Techniques**,** Public Involvement in EIA (10 hrs)

Text Books/ Reference Books:

- Wathern P., "Environmental Impact Assessment: Theory and Practice", Routledge Publishers,1990
- Marriott B., "Environmental Impact Assessment: A Practical Guide", McGraw-Hill Publication,1997
- Shrivastava A.K., Baxter Nicola, Grimm Jacob, "Environmental Impact Assessment", APH Publishers, 2003
- Anjaneyulu Y., Manickam Valli, "Environmental Impact Assessment Methodologies", CRC Press 2011

5CT230OE: OPEN ELECTIVE-III

Subject Code: 5CT230OE	**Title: Open Elective-III** **Quality Control of Petroleum product**	**Credits = 02**		
		L	**T**	**P**
Semester: V	**Total contact hours: 2 hrs/week**	**02**	**-**	**--**

Course Objectives: After completion of this course, the students are expected to learn about:

- Quality control of petroleum products.
- Quality requirements of petroleum products
- Composition, properties and specifications of petroleum products.

Course Outcomes:

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

- Understand the importance of quality control for petroleum products.
- Understand the importance of product specifications from the performance of petroleum products as a fuel and environment point of view.
- The basic function of lubricants, composition, formulations etc.

Unit-I: Introduction to Quality Control of Petroleum Products. Commercial petroleum products, quality requirements. (6 hrs)

Unit-II: Indian specifications, purpose of these standards, vehicle emission standards. Fuel requirements, composition, tests, testing methods and their significance. (8hrs)

Unit-III: Composition, properties and specifications of Compressed Natural Gas (CNG), LPG, gasoline, ATF, Kerosene, Diesel, Transformer oil, Bitumen, Waxes, Greases etc. Solvents, functions and properties of solvents. (6hrs)

Unit-IV: The basic function of lubricants, Physical properties, Chemical properties, factors considered while manufacturing/formulating the lubricating oils, essential properties of lubricants used in IC engines, essential properties of lubricants used in gear oils, essential properties of transformer oils, factors affecting oil consumption, up gradation of lubricants, lubricant composition, role of base oil and additives in finished lubricants. (10 hrs)

Text Books/ Reference Books:

1) Fundamentals of Petroleum and Petrochemical Engineering by Uttam Ray Chaudhuri

2) Modern Petroleum Technology Volume-I Upstream Edited by Richard A. Dawe
3) Fundamentals of Petroleum Refining by Mohamed A. Fah Im, Taher A. Alsahhaf, And Amal Elkilani
4) Handbook of Petroleum Processing Edited by David S. J. “Stan” Jones And Peter R. Pujad´O
5) Petroleum Refining Technology and Economics by James H. Gary and Glenn E. Handwerk

Text Books:

1) Modern Petroleum Refining Processes by B. K. BhaskaraRao, Latest Edition.
2) Petroleum Refining Technology by Dr. Ram Prasad
3) Chemistry of Petrochemical Processes by Sami Matar, Lewis F. Hatch
4) The Chemistry and Technology of Petroleum by James G. Speight
5) Handbook of Petroleum Product Analysis by James G. Speight

SYLLABI PRESCRIBED FOR FOUR YEAR DEGREE COURSE
B. TECH (CHEMICAL TECHNOLOGY) (FOOD, PULP & PAPER, OIL & PAINT AND PETROCHEMICAL TECH.,) SEMESTER PATTERN (NEP-2020) New
SEMESTER: SIXTH B. TECH.
6CT231PC & 6CT236PC: MASS TRANSFER

Subject Code: 6CT231PC	Title: Mass Transfer (MT)	Credits = 04		
		L	T	P
Semester: VI	Total contact hours: 5 hrs/week	03	-	02

Course Objectives:

- To learn basic concept of mass transfer, staged and continuous contact equipment design, gas absorption and distillation.
- To learn basic knowledge of mass transfer equipment's.
- To design mass transfer equipment's.
- Unit operation based on mass transfers

Course Outcomes:

Students will be able to ….

- Explain the basic mechanism of mass transfer including diffusion and convective mass transfer.
- Find the mass transfer coefficient and solve problems related to interphase mass transfer.
- Explain the gas-liquid contacting process and solve related problems.
- Solve problems on VLE and problems related to design calculation of distillation column.
- Familiar with special distillation techniques such as steam distillation and azeotropic distillation.

UNIT I : Introduction to mass transfer and applications, principles of molecular diffusion, Fick's Law: Diffusivity, Diffusion in solids, Concepts of flux and derivation of flux equation, resistance, driving force, equilibrium, direction of mass transfer.

Convective mass transfer, interphase mass transfer, Theories of Mass Transfer, individual and overall, of mass transfer coefficient for liquid and gas phase. Analogy between momentum, heat and mass transfer. Concept of stage wise contact processes, controlling phase concept, mass transfer in turbulent flow, empirical equations. Schmidt's no, shearwood no, applications and problems. (10 hrs)

UNIT II: Mechanism of absorption and stripping, equipment for Gas-Liquid contact. Calculation of no. of stages, Kremser equation, plate and packed tower internals, packed tower design, HETP, HTU, and NTU concepts, height of column based on conditions in the gas film, liquid film and overall coefficients. Plate type towers, number of plates, plate efficiency, absorption factor. (10 hrs)

UNIT III: Types of distillation, relative volatility, azeotropes, enthalpy, concentration diagram, operating line equations, single flash vaporations and partial condensation. Differential distillation for binary systems.

Equilibrium curve for V-L system, fractionation McCabe-Thiele and Panchon-Savarit methods for multi stage operation. Reflux ratio, optimum reflux ratio and other operating parameters. Reboilers, total and partial condenser. Azeotropic and extractive distillation. Introduction of multicomponent distillation. (10 hrs)

UNIT IV: Extraction and Leaching: Ternary diagram, calculation of number of stages analytically and graphically, solvent selection, operating point, material balance of extraction for different solvent conditions (Miscible and immiscible). Introduction to solid liquid extraction, solid liquid equilibria, stage efficiency. Equipment for leaching, extraction, their sizing and design consideration. (10 hrs)

UNIT V: Drying and Crystallization: Principles of drying, phase equilibrium, cross circulation drying, suspended particles drying, rate of drying curve, dryers for solids and pastes, dryers for solutions and slurries i.e. various types of dryers. Material balance across dryer.

Principles of crystallization, Equilibrium, calculation of yield, heat effects, crystal growth, properties of crystals nucleation, fractional crystallization, caking of crystals, various types of crystallizes and their applications.

Membrane separation process (microfiltration, ultra filtration, nano filtration, reverse osmosis) (10 hrs)

Unit VI: Adsorption and Humidification: Adsorption equilibria, types of adsorptions, properties of adsorbents, single and multi-stage adsorption, adsorption isotherms, principles of adsorption, break through curves, adsorption of liquids, basic equations, adsorption equipment's and design aspect.

Humidification: Definitions, wet bulb temperature, dry bulb temperature, types of humidity, Adiabatic saturation temperature, study of temperature humidity chart, enthalpy-humidity charts,

Determination of humidity and concept of dehumidification. Equipment's for humidification operations. (10 hrs)

6CT236PC: MASS TRANSFER (LAB): Based on above syllabi

- To study drying characteristics of a given material under a constant drying condition and determine critical equilibrium moisture content.
- To measure tower characteristics parameter for various liquid for air flow rate in a counter current force draft cooling tower. To determine the effect of (L/G) and (KaV/L) and estimate the value of mass transfer coefficient Ka for value of (L/G).
- To verify Reyleigh equation for simple distillation.
- To estimate diffusivity of vapor in air.
- Adsorption in packed column.
- To analyze the performance of lab scale bubble cap column to obtain a desire separation of an alcohol waste product.
- To determine thermal evaporative efficiency.
- To determine reaction rate constant.
- To steady the evaluation of HETP and HTU for separation of mixture into its component by distillation in packed column.

RECOMMENDED BOOKS

- Principles of Mass Transfer and Separation Processes: Binay K. Dutta, 2nd edition, Prentice Hall of India, 2007.
- Mass Transfer Operations: R. E. Treybal, 3rd edition, McGraw. Hill. 1983.
- Heat & Mass Transfer: S. D. Dawande, Central Techno Pub., Nagpur
- Unit Operation in Chemical Engineering: W. L. McCabe & J. C. Smith, McGraw. Hill.
- Mass Transfer in fluid system: E.D. Cusseler, Cambridge.
- Principles of Unit Operation: S. Foust 2nd edition, Wiley, New York 1980.
- Separation Process Principles-Chemical and Biochemical Operations, J. D. Seader, Ernest J. Henley, D. Keith Roper, 3rd Ed., John Wiley & Sons, Inc.
- Mass Transfer: T. K. Sherwood, R. I. Pigfor
- Chemical Engineering: Coulson & Richardson

REFERENCE BOOKS:

- Transport processes and Separation Process Principles, C.J. Geankoplis, Prentice Hall of India, 4th Ed. 2004.

6FT232PC: FOOD TECHNOLOGY SP. TECH-III

Subject Code: 6FT232PC	Title: Food Technology Sp. Tech-III	Credits = 03		
		L	T	P
Semester: VI	Total contact hours: 3 hrs/week	03	-	--

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 and control.

COURSE OUTCOMES: After successful completion of this course student will be able to…

- Understand and classify different types of microorganism which are present in the environment.
- Describe the growth cycle of microorganisms and internal and external factors and predict microorganisms, which can cause food spoilage.
- Interpret the mode of spoilage in various food products and type of spoilage microorganism.
- 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.
- Understand microorganism in sanitation and food control

UNIT I: **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.

(10hrs)

UNIT II: 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. (10 hrs)

UNIT III: **Microbiology of Food Commodities:** Mode of Food Spoilage. Food Spoilage Microorganisms. 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 (10 hrs)

UNIT IV: 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. (10 hrs)

UNIT V: 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 radiation, microwave processing (10 hrs)

UNIT VI: **Microbiology in food sanitation and food control:** Microbiological criteria for foods, microbiology of food product, Good Manufacturing Practice (GMP), HACCP. International and federal agencies. (10 hrs)

Recommended Books:

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

6PT232PC: PULP & PAPER TECHNOLOGY SP. TECH-III

Subject Code: 6PT232PC	Title: Pulp & Paper Technology Sp. Tech-III	Credits = 03		
		L	T	P
Semester: VI	Total contact hours: 3 hrs/week	03	-	--

Course Outcomes:

- Knowledge on pulp washing, bleaching and recovery of spent chemical used in pulping process
- Understand the importance of recovery of chemicals in different pulping process
- Comprehensive knowledge on multistage bleaching and environmental aspects of bleaching chemicals

UNIT-I: Pulp Washing, Bleaching and Recovery of Spent Chemicals, Washing of Pulp: Delibration of sulphate pulp, brown stock washing, screening and clearing of sulphate pulp, washing of sulphite pulp, screening and clearing of sulphite pulp, screening and clearing of other pulps. (10 hrs)

UNIT-II: Recovery of spent chemical: Liquor recovery in alkaline pulping, evaporation of kraft liquors, recovery furnace, recausticizing treatment to digester and evaporator condensates, recovery of alkalining sulphate, turpentine, tall oil and other alkaline pulping by products. (10 hrs)

UNIT-III: Recovery process in sulfite pulping, Calcium, Magnesium,Ammonia and Sodium bases recovery, other sulfitex recoverymethods, recovery of by-products from sulfite process, wholespent liquor and ligoo sulfonates. (10 hrs)

UNIT-IV: Vaniline and alcohol fromsulfite spent liquor, fermentation of sulfite spent liquor to produce proteins. (10 hrs)

UNIT-V: Bleaching: History of Bleaching, bleaching of mechanical pulps, semichemical pulps, chemi-mechanical and chemical pulps, multistage bleaching, control procedures in bleachingprocess, colour reversion of bleaching pulps, environmental aspects of Bleaching chemicals. (12 hrs)

UNIT-VI:Recent advances in the field. (8 hrs)

BOOKS RECOMMENDED:

- Pulping Processes: S. A. Rydholm.
- Pulp & Paper Chemistry and Chemical Technology: James P. Casay, 3rd Ed., Vol. I.
- Pulp & Paper Manufacture: R. P. McDonald, 2nd Ed., Vol.-I.
- Hand Book of Pulp & Paper Technology: K. W. Britt, 2nd Ed.

6OT232PC: OIL & PAINT TECHNOLOGY SP. TECH-III

Subject Code: 6OT232PC	Title: Oil & Paint Technology Sp. Tech-III	Credits = 03		
		L	T	P
Semester: VI	Total contact hours: 3 hrs/week	03	-	--

COURSE OBJECTIVES: Study of oils & fats along with their seeds, their nature, storage process, reactions, Extraction, Refining, Bleaching & Deodouration & their byproducts after process

COURSE OUTCOMES: To know how about the various seeds of oils, fats; their storage & extraction process up to valuable end products. After successful completion of this course student will be able to work in oil industries.

UNIT I: Domestic and World production of oil seeds and oils, storage, sampling, Grading of oil seeds and oils. Pre-Extraction treatments of oil seeds. (10 hrs)

UNIT II: Mechanical expression, solvent extraction and other methods of recovery of oils and fats. Economic aspects of these processes, processes and plants employed for refining, bleaching, deodorization. (10 hrs)

UNIT III: Hydrogenation of oils and fats. Manufacture of butter, Ghee, margarine, vanaspati and Confectionary fats. Trans esterified oils, fats, winterization of oils. Cooking and salad oils, plastic shortening agents. (10 hrs)

UNIT IV: Environmental aspects in Oils seeds and oil processing units. Effective control according to Indian Standard specification. (10 hrs)

UNIT V: Non-Glyceride Constituents, general method of upgrading and utilization of oils and fats, oil-cakes and other products. Synthetic fatty acids and glycerides. Recent advances in the field (10 hrs)

UNIT VI: Manufacture and evaluation of ancillary materials such as activated earths, activated carbons, nickel catalyst for hydrogenation (10 hrs)

Recommended Books:

- Cottonseed and Cottonseed Products: A. B. Bailey, Interscience Publishers, New York, Latest Edition.
- Industrial Oil and Fat Products: A. E. Bailey, Interscience Publishers, New York, Latest Edition.
- Soyabeans and Soyabean Products: K. B. NarkIev, Interscience Publishers, New York, Latest Edition.
- Hydrogenation of Fatty Oilseeds: Waterman, Lquosevier Publishers, New York, Latest Ed.
- Fatty Acids: K. S. Markely (5 Vols.), Interscience Publishers, New York.
- Continuous Processing of Fats: M. K. Schwitzer, Latest Edition.
- Refining of Oils and Fats for Edible Purposes: A.J.C. Anderson, Academic Press, New York.
- Vanaspati Industry: G. S. Hattangadi
- Practical Treaties on Vegetable Ghee Manufacture: Varma & Jaidev.
- Solvent extraction of Vegetable Oils: H. Y. Parkb.
- Refining and Technology of Oils and Fats: T. N. Mahatte, Small Business Publication, New Delhi.
- Food Oils and their Uses: T. J. Weiss, Latest Edition.
- Bleaching Earths: M. K. H. Siddiqui, Latest Edition.
- Progress in the Chemistry of Fats and other Liquids: R. T. Holman,
- M. O. Luadberg & T. Malkin, Pergamon Press, New York (7Vols.)
- Vegatable Fats and Oils: E. W. Eckay, Rinehold Publishers, New York, Latest Edition.
- The Chemistry, Flavouring and Manufacture in Chocolate, Confectionary and Cocoa: H. P Jenson, Blackiston Publishers, Philadelphia, Latest Edition.
- The Butter Industry: O. F. Huzoker, Latest Edition.
- Margarine: A. J. C. Anderson, Academic Press, New York, Latest Edition

6PC232PC: PETROCHEMICAL TECHNOLOGY SP. TECH-III

Subject Code: 6PC232PC	Title: Petrochemical Technology Sp. Tech-III	Credits = 03		
		L	T	P
Semester: VI	Total contact hours: 3 hrs/week	03	-	--

COURSE OBJECTIVES:

- Vaporization and Condensation operations and their applications in petroleum refinery operations.
- Evaluation of crude oil and its fractions for quantity and quality

- Pressure-Temperature-Percent vaporized relationships of petroleum fractions
- Brief overview of the design steps involved in the design of a crude distillation tower
- Steps involved in Designing of tube still heaters and analysis and evaluation of heat transfer
- Calculation of net heating value, Use of sensible heat chart for gases, analysis of flue gas from fuel analysis, heat balance of furnace

COURSE OUTCOMES: After successful completion of this course student will be able to:

- Learn refinery engineering calculations.
- Understand equilibrium relations between liquids and vapors, Partial pressures of vapor components, partial vapor pressures of liquid components.
- Characterize crude oil and its fractions and plan the process parameters to process these raw fractions.
- Construct successive flash vaporization curves Phase diagram.
- Learn important variables in the design of crude oil distillation columns.
- Understand design of Tube Still Heaters and calculations involved.
- Learn combustion of petroleum fuels and calculations involved.

UNIT I: Vaporization and Condensation, Effect of partial vaporization and condensation at the boiling point, Mechanism of vaporization, Differential or batch vaporization, Equilibrium or flash vaporization, Phase behaviour of multicomponent hydrocarbon systems. Commercial vaporization, Distillation curves- The equilibrium flash vaporization (EFV) curve, ASTM distillation curve, TBP distillation curve. Equilibrium condensation, Equilibrium relations between liquids and vapors, Partial pressures of vapor components (Dalton's law), partial vapor pressures of liquid components (Rault's law), Equilibrium composition for an ideal binary gas system and multicomponent systems: derivations-problems. K-values and their estimates for complex mixtures, K-value correlations. Calculations of bubble and dew Points for complex mixtures. (10 hrs)

UNIT II: Evaluation of crude oil: Crude Oil Assay Analysis, Crude oil properties-sulfur, nitrogen, and metals content, properties appropriate for certain boiling point ranges, additive and non-additive properties. Objective of Crude Oil Characterization. Typical distillation range of fractions in petroleum assays. Types of assays, TBP-ASTM-EFV distillation apparatus. Comparison of ASTM-TBP-EFV distillation and distillation curves. Factors affecting the efficiency of TBP apparatus. Use of gravity mid percent curves, specific gravity mid percent curve, yield curves. Cut point, End point and Mid boiling point of petroleum fraction. Mid percent curves. Mid-boiling point components. Mid-volume percentage point components. Calculation procedure for characterizing crude oils. Average boiling points. Calculation of characterization factor (K) for whole crude oil. Thermo physical properties of petroleum fractions. (10hrs)

UNIT III: ASTM-TBP-EFV distillation curves. Computation of the ASTM-TBP-EFV distillation Curves by Edmister and Nelson's method. Construction of Successive flash vaporization curves for complex mixtures. Pressure effect on EFV curves, Phase diagram construction for petroleum fractions. Pressure-Temperature-Percent vaporized relationships of petroleum fractions. (10 hrs)

UNIT IV: Distillation: Arrangement of towers- Top Tray Reflux, Pump back reflux, Pump around Reflux. Important variables in the design of crude columns. Degree of separation, Degree of difficulty of separation, Separation capability (F), degree of fractionation, ASTM gap, TBP overlap. Significance of flash zone, flash zone conditions, concept of overflash. ASTM gaps followed in practice in petroleum refineries. Steam stripping. The typical usual dimensions and operating data for an atmospheric distillation column. Vacuum distillation unit (VDU), Vacuum column operating data. Fundamentals of multidrum tower. Factors affecting efficiencies of plates. Brief overview of the design steps involved in the design of a crude distillation tower. Number of trays in various sections of the tower. Column overhead temperature, bottom stripping. Material and energy balance in topping tower. Cold reflux, hot reflux, circulating reflux, side draw temperature. (10 hrs)

UNIT V: Tube still heaters: types of tube still heaters, Features of tube still heaters, ideal still, limiting factor in the designing of tube still heaters. Design of tube still heater. Wilson-Lobo-Hottel equation. Lobo-Evans method of tube still heater design. Design of radiant and convection section. Calculation of radiant absorption rates. Steps involved in Designing of tube still heaters. Analysis and evaluation of heat transfer, Stefan-Boltzmann Law, Heat transfer in the radiant and convection

section. (10hrs)

UNIT VI: Combustion: heating value, net heating value, gross heating value, excess air. Oil-burner troubles analyzed by Robert Reed, stack draft, effects of altitude on the height and diameter of a stack. Combustion reactions, combustion characteristics of gaseous fuels, combustion characteristics of liquid fuels. Use of combustion charts. Calculation of theoretical combustion air, excess air calculation, calculation of composition of flue gas, Calculation of net heating value, Use of sensible heat chart for gases, Analysis of flue gas from fuel analysis, Heat balance of furnace. (10hrs)

Recommended Books:

- Petroleum Refinery Engineering by W. L. Nelson McGraw Hill, Kogakusha, 4th Edition
- Petroleum Refinery Distillation by R. N. Watkins, Gulf Pub Co. Texas, Latest Edition
- Data Book on Hydrocarbons by J. B. Maxwell, K. E. Kroger Pub. Co. NY, Latest Edition.
- Distillation by M. Van Winkle, McGraw Hill, Latest Edition.
- Handbook of Natural Gas Engineering by D. L. Katz & Others, McGraw Hill, Latest Edition.
- Applied Hydrocarbon Thermodynamics by W. C. Edmister, Gulf Pub. Co., Latest Edition, Vol. I & II.
- Surface Operations in Petroleum Production by G. Y. Chilingar & C. M. Beeson, Elsevier, NY
- Petroleum Processing Handbook by W. F. Bland & R. L. Davidson, McGraw Hill, Latest Edition
- Chemical Engg. By J. M. Coulson & J. F. Richardson, Pergamon Press 3rd Edition, Vols. I & II, Latest Edition.
- Equipment Design Handbook for Refineries & Chemical Plants by Frank L. Evans, Jr., Gulf Pub. Co., Houston, Texas,

6FT233PC & 6FT237PC: FOOD TECHNOLOGY SP. TECH-IV

Subject Code: 6FT233PC	Title: Food Technology Sp. Tech-IV	Credits = 04		
		L	T	P
Semester: VI	Total contact hours: 5 hrs/week	03	-	02

COURSE OBJECTIVES:

Student will be well versed with unit operations in food processing industry. Process technology in milling of cereal legumes and oil processing. Knowledge about fermentation technology and process of fermented product. Knowledge about tea, coffee and chocolate processing. Standardization and processing of sugar confectionary product and traditional sweets. Student to get knowledge about extrudes food products and specialty foods.

COURSE OUTCOMES:

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

- Understand the equipment's for various operations in food processing industry.
- Understand the process requirement in cereal legumes and oilseeds and their productions.
- Understand the process requirement in baked products like bread, biscuit, cracker etc.
- Understand the process requirement in composition and processing of tea, coffee and chocolates.
- Understand the process requirement in confectionary product and processing of traditional sweets.
- Understand the processing of extruded food product and special foods.

UNIT I: **UNIT OPERATION IN FOOD PROCESSING INDUSTRY:** Equipment for various operations like clearing, sorting, Grading, size reduction and separation, mixing, filtration, extraction, centrifugation, crystallization, Evaporation-Principles of Evaporator operation etc. Application of heat in concentration, chilling and refrigeration. Thermal processing of foods. Food irradiation, Calculation of process time. Plant hygiene and water supply. (10 hrs)

UNIT II: **PROCESS TECHNOLOGY OF CEREALS, LEGUMES AND OIL SEEDS:** Process technology of milling of wheat, rice and corn. Processing of malt. By products of milling industry. Milling of cereals and legumes. Processing of oilseeds. Oil extraction, refining & hydrogenationmanufacture of margarine, shortening agents, lecithin, etc. Edible oilseed flour, Protein concentrate and Protein isolate. Mycotoxins in cereals, oilseeds and their products. (10hrs)

UNIT III: **PROCESS TECHNOLOGY OF BAKING AND BAKED PRODUCTS:** Selection and quality parameter of raw materials, Rheology of dough and dough testing methods. Changes during fermentation of dough formation, fermentation and baking, manufacture of bread, biscuits, crackers, cookies, cakes and other bakery products. (10 hrs)

UNIT IV: PROCESS TECHNOLOGY OF TEA & COFFEE: Composition and processing, flavor and aroma, methods of evaluation of quality.

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. (10 hrs)

UNIT V: PROCESS TECHNOLOGY OF SUGAR CONFECTIONARY:

Sugar crystallisation& its control. Types of confectionary products. Production of fondant, fudge, toffee, pulled confections. Standardization and processing of traditional sweets, such as Batash, pedha, Sandesh, Rasogolla, chikki and flour-based sweets. (10 hrs)

UNIT VI: **CONVINIENCE FOODS**

Manufacture of breakfast cereals, puffed cereals. Extrusion process & extruded products, Fast foods & ready mixes. Agglomeration technique & instantized foods.

SPECIALITY FOODS: Weaning & baby food, space foods, probiotic foods, nutraceuticals(10hrs)

6FT237PC: FOOD TECHNOLOGY SP. TECH-IV (LAB) Practical's Based on above syllabus

- Physico-Chemical analysis of biscuit
- Physico-Chemical analysis of wheat flour
- Physico-Chemical analysis of whey powder.
- Chemical and Instrumental analysis of tea/coffee.
- Chemical analysis of honey
- Chemical and Instrumental analysis of Jam, squash
- Analysis of sodium chloride (purity, matter in soluble in water, water soluble matter other than sodium chloride)
- Analysis of heavy metal in food stuff.
- Determination of moisture content in spices and condiments by dean - stark method.
- Determination of acidity of extracted fat in biscuit
- Determination of acidity in skim milk powder.
- Determination of germ oil content in wheat flour
- Salt content in butter and cheese.
- Sedimentation value of wheat flour
- Purity as acetone insoluble in lecithin.

Recommended Books:

- Fundamentals of Food Processing Operations by Jonslyn. M. A. and Heid, J.L.: AVI Publishing Co., Inc Westport,
- Food Processing Operations, Vols. l,2 and 3 by Jonslyn, M.A. and Heid, J .L.: AVI Publ. Co., INC, Westport, Connecticut, Latest Edition.
- Cereal technology by Matz Samuel A, AVI publishing co. Inc Westport Connecticut 1970
- Modern Cereal Chemistry by Kent Jones W.D. & Amos A.J., Food Trade Press Ltd. London 1976
- Snack food technology Matz S.A, AVI publishing Co.1976.
- Bakery technology Matz Samuel
- Sugar confectionary & chocolate manufacture by E.B Jackson & Lees R, Leonard Hill Books 24, market square Aylesbury.
- Processed plant protein food stuff edited by Aultschul A.M., Academic press London 1958
- Wheat chemistry & technology, edited by Pomeranz Y. American Association of cereal chemists, Minnesota 1978
- Bakery materials & methods by Daniel A.R., Mc Larene& sons Ltd. London 1947
- Manufacture of biscuits cakes & wafers by Fritsch J. & Grassfire, London 1932.
- Practical baking by Sultan W.J., AVI publishing Co. Inc. 1969.
- Manufacture of confectionary by an industrialist, industry publishers Ltd., 22. R.G. Kar Road, Shyam Bazaar, Calcutta.
- Preservation of fruits & vegetables by Girdharilal & Sidappa, ICAR, New Delhi, 1967

6PT233PC & 6PT237PC: PULP & PAPER TECHNOLOGY SP. TECH-IV

Subject Code: 6PT233PC	Title: Pulp & Paper Technology Sp. Tech-IV	Credits = 04		
		L	T	P
Semester: VI	Total contact hours: 5 hrs/week	03	-	02

UNIT I: 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. (10 hrs)

UNIT II: Modern bleaching processes with following agents' chlorine-dioxide, oxygen, ozone, peroxide per acids, enzyme and chelating agents. Their reactions, process variables, pulp properties, advantages disadvantages and equipment selections. Bio-bleaching, fundamentals, and economics. Bleaching of post-consumer office waste and deinked newspaper. (12 hrs)

UNIT III: Stock preparation, beating and refining, effect on fiber structure, theory of beating, factors affecting beating, stock preparation systems (8 hrs)

UNIT IV: Internal sizing of paper, rosin size and synthetic sizes, wax emulsions, asphalt emulsions, theory of internal sizing, various precipitants, alkaline sizing, fortified sizing (10 hrs)

UNIT V: Filling and loading: objectives, survey of filler properties, manufacture of fillers, preparation and addition of fillers, filler retention, adverse effects of fillers, commercial filling and loading materials, refractive index and scattering coefficient (10 hrs)

UNIT VI: Special additives for wet and dry strength, general considerations and properties, coloring, theory, terms used, dyes and pigments, fastness test, methods of coloring, coloring of special papers. (10 hrs)

6PT237PC: PULP & PAPER TECHNOLOGY SP. TECH-IV (LAB) Practical's Based on above syllabus

- Determination of ash content of given paper.
- Determination of moisture content in paper.
- Determination of acidity / alkalinity by cold water extract.
- Determination of acidity by hot water extract.
- Determination of acidity / alkalinity of paper by pH meter.
- Determination of water absorbency of paper by KELM absorbency method described the absorbency of paper by particular time interval.
- Determination of sprit absorbency of paper by KELM absorbency method.
- Determination of rosin size to given paper sample.

BOOKS RECOMMENDED:

- Pulp and Paper Science & Technology Vol. I & II by C. E. Libby
- Pulp & Paper Manufacture Vol. I, II, III by MacDonald
- Hand Book of Pulp and Paper Technology by K.W. Britt 2nd edition

6OT233PC & 6OT237PC: OIL & PAINT TECHNOLOGY SP. TECH-IV

Subject Code: 6OT233PC	Title: Oil & Paint Technology Sp. Tech-IV	Credits = 04		
		L	T	P
Semester: VI	Total contact hours: 5 hrs/week	03	-	02

COURSE OBJECTIVES: Study of soaps, detergents & toiletries from oils & fats, also study of essential oils & perfumes & glycerin and their industrial applications.

COURSE OUTCOMES: To know how about soaps, detergents & toiletries from oils & fats, also study of essential oils & perfumes & glycerin and their industrial applications. After successful completion of this course student will be able to work in oil industries.

UNIT I: **Surfactants:** Concepts of surface activity. structure of surfactant molecules, Hydrophil-Lipophil balance. Methods for measurement surface activity, mechanism of detergency. (10 hrs)

UNIT II: Type of Surfactants: Anionic, cationic, nonionic and amphoteric. Biodegradation of surfactants. Application of surfactants in household & in industries. (10 hrs)

UNIT III: **Soaps:** Raw materials for soap. classification and selection of raw materials. Properties of soap and soap solutions. Phase separation in soap boiling. Plants and process employed in soap

manufacture. Various types of soaps and cleaning preparation. Analysis of soaps. (10 hrs)

UNIT IV: Detergents: Classification & types of detergents, raw materials. plants and process employed in manufacture of detergents, analysis of detergents. I.S.I. methods of testing of detergents. (10 hrs)

UNIT V: Essential oils: Classification and chemical constituents of essential oils. Methods of extraction. Analysis of essential oils. Natural and synthetic Perfumery materials for industrial uses. (10 hrs)

UNIT VI: **Glycerin:** Manufacture of Glycerin from natural sources, sweet waters, properties spent lyes. Synthetic glycerin.: Properties. analysis and utilization of glycerin. Recent advances in the field (10 hrs)

6OT237PC: OIL & PAINT TECHNOLOGY SP. TECH-IV (LAB) Practical's Based on above syllabus

- Producing fats and fat-based products,
- Mechanical expression of Oil from Oil seeds,
- Refining and hydrogenation of Oils.
- Preparation of soaps and detergents. Preparation of various types of detergents.
- Refining of commercial waxes. Preparation and evaluation *of* wax formulations.
- Preparation of metallic soaps. preparation of boiled oil. blown oils and stand oils and their evaluation.
- Preparation of ester gum. monoglycerides. sulphated and sulphonated oils, varnishes, lime and zinc harden resin and product evaluation.
- Fat splitting and separation of fatty acids.
- Preparation of paints and its analysis, drying lime. gloss and shade matching.
- Preparation of cosmetics.
- Analysis of pigment. Oil absorption. hiding power

Recommended Books:

- Soap: Their Chemistry and Technology: J. G. Khane.
- Soap Manufacture: J. Davidson. lnerscience Publishers. New York. Latest Edition.
- Sulphated Oils and Allied Products: D. Burton and G. F. Robertshaw. Chemical Publishing Co.,New York.
- Surface active agents and' Detergents: A. M. Schwarttz. J. W. Perry and J. Berch, Interscience Publishers, New York.
- Industrial oil and fat products: A. P. Bailley, Interscience Publishers. New York. Latest Edition.
- Technology of Laundry Soap Manufacture: Small Business Publications, New Delhi
- House Hold & Industrial Surfactants: Small Business Publications, New Delhi.
- The Technology of synthetic Detergent: Small Business. Publications, New Delhi.
- Textiles Chemicals & Auxiliaries: H. C. Speed and E. W. K. Schwartz, Reinhold Publications, New York,
- The Manufacture of Glycerol: G. Martin
- The Modern Soap Detergent Industries: G. Martin
- Textile Auxiliaries: Shenoy

6PC233PC & 6PC237PC: PETROCHEMICAL TECHNOLOGY SP. TECH-IV

Subject Code: 6PC233PC	**Title: Petrochemical Technology Sp. Tech-IV**	**Credits = 04**		
		L	**T**	**P**
Semester: VI	**Total contact hours: 5 hrs/week**	**03**	**-**	**02**

COURSE OBJECTIVES: After completion of this course, the students are expected to learn about:

- Design aspects involved in the production of petrochemicals
- Oxidation and Chlorination reactions practised in petrochemical industry in petrochemical industry
- Hydrocarbon pyrolysis
- Oxo-reactions and kinetics & thermodynamics involved in ammonia formation

COURSE OUTCOMES: After successful completion of this course student will be able to:

- Learn about processes, process operations and process parameters involved in the operation of petrochemical industry
- Understand parametric sensitivity, reaction mechanism, kinetics, and thermodynamics involved in the manufacture of petrochemicals

- Learn about economic justification, kinetic models with different catalysts, control of process parameters, reaction rate, engineering problems in reactor design, process design aspects

UNIT I: Reactor design aspects for production of styrene, problems of agitation, viscosity rise, mass transfer and heat transfer, power requirement, reactor design for alkylator, cooling system, agitation and separation. (10hrs)

UNIT II: Oxidation- Oxidation of naphthalene to phthalic anhydride, parametric sensitivity, kinetics, thermodynamics, simple and complex models, and fluidized bed reactor v/s fixed bed operations. (10hrs)

UNIT III: Parallel and consecutive reactions- Chlorination of paraffins and aromatics, Acetylene Manufacture, kinetic models, thermodynamics, manufacture of glycols and amines in CSTR and plug flow reactors, their comparison, effect of reactant ratio on product distribution in different reactors. (10hrs)

UNIT IV: Pyrolysis of hydrocarbon- Pyrolysis of hydrocarbon for production of olefins, thermodynamics and kinetics, thermal cracking mechanism, role of self-inhibition, surface reactions and isomerization of radicals in mechanism product distribution in cracking processes, condition of operation of pyrolysis reactors, concept of equilibrium approach and its influence on conversion, selectivity, steam dilution and yield of products desirable condition for ethylene productions use of kinetics models in the design, kinetics of petroleum fractions for olefin production. Effect of various process design parameters like tube diameter, hydrocarbon to steam ratio, pressure drop etc. on conversion and yields. (10hrs)

UNIT V: Oxo reaction- Economic justification, kinetic models with different catalysts, control of straight chain to branched chain olefins, effect of olefin structure on reaction rate, engineering problems in reactor design, process design aspects with a flow scheme. (10 hrs)

UNIT VI: Reversible exothermic reactions- Important features, manufacture of ammonia, types of commercial reactors used for ammonia synthesis, kinetics and thermodynamics of ammonia formation, optimum temperature profiles achieved in industrial reactors. (10 hrs)

Recommended Books:

- Chemical Engineering process analysis, A.M. Mearns
- Chemistry of Catalytic processes, B.C. Gats, J.R. Katzer and G.C.A. Schuit
- Chemical reactor design and process plants, vol 1 and 2, H.A. Rase.
- Equipment Design Handbook for Refineries and Chemical Plants, F.L. Evans.
- Applied Process Design For Chemical and Petrochemical Plants Vol I, II, and III, E.E. Ludwig.

6PC237PC: PETROCHEMICAL TECHNOLOGY SP. TECH-IV (LAB) Practical's Based on above syllabus

List of Experiments:

- To determine the Bromine Number of given petroleum sample by color indicator titration method.
- To determine the Acid Value of given petroleum sample.
- To determine the Viscosity Index of given lube oil sample.
- To determine the UOP Characterization Factor of given petroleum sample.
- To determine the Correlation Index of given petroleum sample.
- To determine the Calculated Cetane Index of given petroleum sample.
- To determine the Dielectric Strength of a given transformer oil sample.
- To determine the Oxidation stability of given lube oil sample.
- To determine the Saponification Value of given petroleum sample.
- To determine the Calorific value of given petroleum sample.
- To determine the Gum Content of given gasoline sample.

6CT234PE/ 6CH239PE : Process Equipment Design & Drawing (PEC-II**)**

Subject Code	Title	Credits-03		
6CT234PE/ 6CH239PE	**Process Equipment Design & Drawing**	L	T	P
Semester: VI	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)
The course aims to:

- Understand fundamentals of process equipment design
- Apply design principles to chemical engineering equipment
- Develop skills in engineering drawing and interpretation
- Learn selection of materials and design codes
- Build capability for industrial equipment design and documentation

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

- **CO1:** Apply design principles for process equipment
- **CO2:** Perform basic design calculations for chemical equipment
- **CO3:** Prepare and interpret engineering drawings
- **CO4:** Select suitable materials and fabrication methods
- **CO5:** Understand industrial standards and safety aspects

SECTION A

UNIT I: Introduction to Process Equipment Design

Role of design in chemical engineering, Design procedure and steps, Design considerations (Mechanical, thermal, and safety aspects), Introduction to Codes and standards (ASME (conceptual understanding)), Material selection for process equipment (7)

UNIT II: Design of Pressure Vessels

Types of pressure vessels, Design of thin cylinders and spheres, Design under internal pressure, Basic Heads and closures, Introduction to thickness calculation (7)

UNIT III: Design of Heat Transfer Equipment

Design basics of heat exchangers, Introductory Shell and tube heat exchanger design, Selection of materials, Fouling considerations, Thermal and mechanical design aspects (7)

SECTION B

UNIT IV: Design of Mass Transfer Equipment

Introduction to Design of packed columns, Basics of Tray columns, Basics of Absorption and distillation equipment, Column internals and selection (7)

UNIT V: Engineering Drawing & Drafting Basics of engineering drawing

Drawing of (Pressure vessels, Heat exchangers, Storage tanks), Basic Piping and Instrumentation Diagram (P&ID), Basic Introduction to CAD tools) (7)

UNIT VI: Industrial Practices, Fabrication & Safety
Fabrication techniques (Welding, forming), Basics of Inspection and testing methods, Maintenance of equipment, Safety in design and operation, Case studies (Chemical plant equipment), Introduction to simulation/design tools (Basics of **AutoCAD** etc.) **(7)**

Text Books:
1. Process Equipment Design, M. V. Joshi, Macmillan India Ltd, 1985
2. Chemical Engineering Design (Volume 6), R. K. Sinnott, Elsevier Butterworth-Heinemann, 2005 (4th Edition)
3. Process Equipment Design**,** B. C. Bhattacharya , CBS Publishers & Distributors, New Delhi , 2011
4. Plant Design and Economics for Chemical Engineers, Max S. Peters, Klaus D. , McGraw-Hill, 2003 (5th Edition)

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**

✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks

✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks

✓ Teaching Evaluation Components : 10Marks

(Viva Voce / Assignments /Group activities/ Report Writing etc.)

✓ Class Attendance : 10Marks

- **End-Semester Examination** : **60 Marks**

6CT235PE/ 6CH235PC : Chemical Reaction Engineering-I (PEC-III)

Subject Code	Title	Credits-03		
6CT235PE/6CH235PC	Chemical Reaction Engineering-I	L	T	P
Semester: VI	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives (COs)
- Understand chemical reaction kinetics and rate laws
- Design and analyze basic reactors
- Apply material balances to reacting systems
- Interpret industrial reactor operations
- Develop problem-solving skills for real processes

Course Outcomes (COs)
After completion, students will be able to:
- CO1: Understand fundamental reaction concepts and terminology
- CO2: Derive and apply rate equations
- CO3: Understand how temperature impacts industrial reactions
- CO4: Solve basic reactor design problems
- CO5: Connect theory with real industrial practices

SECTION-A

UNIT 1: Basics of Chemical Reaction Engineering
Definition and scope of CRE, Types of reactions: homogeneous, heterogeneous, Rate of reaction and rate equations, Factors affecting reaction rates (temperature, concentration, catalyst), Elementary and non-elementary reactions. (7)

UNIT 2: Reaction Kinetics and Rate Laws
Order and molecularity of reactions, Rate laws and rate constants, Integrated rate equations for: Zero-order, First-order, Second-order reactions, Half-life method, Determination of reaction order (experimental methods – basic idea) (7)

UNIT 3: Temperature Effects on Reaction Rates
Temperature dependence of rate constant, Arrhenius equation, $k=Ae^{-Ea/RT}$, Activation energy and

frequency factor, Effect of temperature in industrial reactors, Introduction to catalysts and catalytic reactions (7)

SECTION-B

UNIT 4: Ideal Reactor Types
Batch reactor (BR), Continuous Stirred Tank Reactor (CSTR), Plug Flow Reactor (PFR), Comparison of reactor types, Conversion, yield, and selectivity (7)

UNIT 5: Design of Ideal Reactors
Material balance for: Batch reactor, CSTR, PFR, Design equations (simple derivations), $F_{A0}-FA+rAV=0$, Space time and space velocity, Performance comparison of reactors (7)

UNIT 6: Industrial Reactors, Safety & Sustainability
Overview of industrial reactors (fixed bed, fluidized bed – basic idea), Reactor safety: temperature control, runaway reactions, Introduction to reactor scale-up, Environmental considerations in reaction engineering, Green chemistry and sustainable processes (7)

Text Books:

1) Chemical Reaction Engineering: Octane Levenspiel, Wiley Eastern Ltd.
2) Chemical Engineering Kinetics: Smith J.M. McGraw Hill.

Reference Books:

1) Reaction Kinetics for Chemical Engineers, Walas McGraw Hill
2) Elements of Chemical Reaction Engineering, H. Scott Fogler, Prentice Hall.
3) Momentum Transfer Operation: S .K. Gupta, TMC, Latest edition.
4) Unit Operations of Chemical Engineering: McCabe and Smith, TMC
5) Chemical Engineering Vol. I : Coulson & Richardson, Pergamon.
6) Chemical Reaction Engineering. : Octane Levenspiel, Wiley Eastern Ltd
7) Chemical Engg. Kinetics: Smith J.M. McGraw Hill.
8) Reaction Kinetics for Chemical Engineers: Walas. McGraw Hill.
9) Elements of Chemical Reaction Engineering: H. Scott Fogler, Prentice Hall.

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment : 40 Marks**
  - ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
  - ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
  - ✓ Teaching Evaluation Components : 10Marks

  (Viva Voce / Assignments / Report Writing etc.)
  - ✓ Class Attendance : 10Marks
- **End-Semester Examination : 60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

6CT238PE/ 6CH244PC: Chemical Reaction Engineering-I Lab. (PEC-III Lab.)

Subject Code	**Title**	**Credits- 01**		
6CT238PE/ 6CH244PC	**Chemical Reaction Engineering-I Lab.**	**L**	**T**	**P**
Semester: VI	**Total Contact Hours: 2 Hrs / Week**	**0**	**0**	**2**

List of Experiments:

1. To determine the rate constant of saponification of ethyl acetate characterized byan acid like HCL.
2. To determine the activation energy of hydrolysis of an ester such as ethyl acetate.
3. To determine the kinetic of reaction between ethyl acetate and sodium hydroxide at room temperature using differential method of analysis.
4. To determine the kinetics of reaction between ethyl acetate and sodium hydroxide at room temperature by integral method.
5. Show that the decomposition of H2O2 in aqueous solution as first order reaction and determine value of rate constant.
6. To determine void volume porosity of catalyst particle.
7. To determine the RTD curve for packed bed reactor.
8. To determine the RTD curve for PFR.

9. To determine the RTD curve for mixed flow reactor.
10. Verification of performance equation of batch reactor.

Note: The students should perform minimum EIGHT experiments from the list to complete the term. All experiments in this list shall be available in the laboratory. Additional experiments relevant to the syllabus may be added to the main list. All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

Evaluation Scheme:

- **Internal Assessment : 25 Marks**
  - ✓ Teaching Evaluation Components : 20Marks
  - ✓ Class Attendance : 05Marks
  - ✓
- **External University Practical Examination : 25 Marks**

6CT239M: MULTI DISCIPLINARY MINOR-V

Subject Code: 6CT239M	**Title: Multi-Disciplinary Minor-V (MDM-V) Industrial Waste management**	**Credits = 02**		
		L	**T**	**P**
Semester: VI	**Total contact hours: 2 hrs/week**	**02**	**-**	**00**

UNIT I: Pollution, production waste, consumption waste, by product waste salvageable waste, types of pollution cause by wastes, greenhouse effect, Acid rains, Causes of acid rains, effects. Chlorofluorocarbon, application of CFCs in industry role of CFC's in depletion atmospheric ozone. Other effects of air pollution.

UNIT II: Advanced waste water treatment: Ion exchange, activated carbon adsorption, electro dialysis reverse osmosis.

Disinfection of Water: Sterilization and methods for disinfection. Sludge Disposal: Various alternatives for Sludge disposal.

UNIT-III: Waste management for industries like Food Industry, Dairy Industry, Sugar Mill, Fertilizer, Pulp and Paper, case studies, and corrective measures taken in industry to prevent environmental hazards.

6CT240VS: SIMULATION LAB

Subject Code: 6CT240VS	**Title: Simulation Lab (VSEC-V)**	**Credits = 02**		
		L	**T**	**P**
Semester: VI	**Total contact hours: 3 hrs/week**	**01**	**-**	**02**

Systems of linear equations, solution by the method of determinants, matrix inversion for the solution of linear equations, Gauss elimination method. Introduction to Python and SCILAB programming.

Regression Analysis-Least Square, error approach, approximation by Chebychev orthogonal polynomial. Recent trends in Chemical Software; Hysis, Aspin

List of Experiments:

- Write a program to design an algorithm, draw a flow chart and write program to perform
- addition, subtraction, multiplication and division of two numbers by taking two values from users.
- Write a program for solving ordinary differential equation with initial value by using Euler's method.
- Write a program to find value of unknown of simultaneous by Gauss elimination
- method.
- Write a program to design algorithm for Regula-Falsi method.

- Write a program to Find the roots of equation by Newton-Raphson method.
- Write a program to design algorithm for print the grades of students using if-else-if statement.
- Write a program to design algorithm and flow chart for Runga-Kutta method.
- Write a program to design algorithm and flow chart to find greatest and smallest element.
- Write a program to find roots of equation using Bisection method.