

SYLLABI PRESCRIBED FOR FOUR YEAR DEGREE COURSE
B. TECH (CHEMICAL TECHNOLOGY) (FOOD, PULP & PAPER, OIL & PAINT AND
PETROCHEMICAL TECH.,) SEMESTER PATTERN (NEP-2020) OLD
SEMESTER: SEVENTEETH B. TECH.
7CT1: CHEMICAL REACTION ENGINEERING-I

Subject Code: 7CT1	Title: Chemical Reaction Engineering-I (CRE-I)	Credits = 03		
		L	T	P
Semester: VII	Total contact hours: 3 hrs/week	03	-	00

Course Objectives:

- Student will learn rate equation of homogeneous reaction
- Students will understand the various methods to analyze the batch reactor data to study the kinetics of homogeneous reaction.
- Students will learn the performance equation for ideal reactors.

Course Outcomes:

After successful completion of this course student will be able to

- Understand the kinetics of homogeneous reaction
- Interpret batch reactor data to determine the kinetics of homogeneous reaction
- Design the industrial reactor using kinetic data of pilot /lab scale reactor.
- Determine the size and type of reactor.
- Compare the size of various single and multiple ideal reactor system along with recycle reactor
- Understand the kinetics and design for multiple reactions.
- Understand the effect of temperature and pressure on conversion

SECTION-A

UNIT I: Classification of chemical reactions, variables affecting the rates of reaction. Kinetics and Thermodynamics. Thermodynamics of chemical reactions. Classification of reactors. Order of reaction and rate constant. Rate of Reaction, Elementary and non-elementary homogeneous reactions, mechanism of reaction, temperature dependency from thermodynamics. (10 hrs)

UNIT II: Rates of homogeneous reactions, fundamentals of rate equation, rate equations from proposed mechanism analysis of simple and complex rate equation. Evaluation of rate equation from laboratory data. Collision and activated complex theories. (10hrs)

UNIT III: Interpretation of rate data, scale up and design. Constant volume batch reactor, variable volume batch reactor, temperature and reaction rate, theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data. Integral and differential methods for analyzing kinetic data, interpretation of constant volume reactor, reversible reaction in parallel and series, catalytic reaction, auto catalytic reaction, reversible reactions.

Interpretation of variable volume batch reactions for zero, first and second order reactions, design equation for batch, continuous stirred tank, plug flow reactors for isothermal reaction. (10hrs)

SECTION-B

UNIT IV: Single ideal reactors, ideal batch reactor. Space time and space velocity, steady state mixed flow reactors, steady state plug flow reactor, holding-time and space time for flow system. (10hrs)

UNIT V: Design for single reactions size comparison of single reactors Batch reactor, Mixed verses plug flow reactors Variation of reactant rates. General graphical comparison. Autocatalytic reactions. (10hrs)

UNIT VI: Design for multiple reactor system. Reactions in parallel and in series, series-parallel reactions. Batch recycle reactor, flow recycle reactor. Temperature & pressure effects in single and multiple reactions. Optimum temperature profile. Single and multiple reactions in ideal reactors. (10hrs)

RECOMMENDED BOOKS:

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

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SEMESTER: SEVENTEETH B. TECH.
7FT2: FOOD TECHNOLOGY SP. TECH-V

Subject Code: 7FT2	Title: Food Technology Sp. Tech-V	Credits = 03		
		L	T	P
Semester: VII	Total contact hours: 3 hrs/week	03	-	00

SECTION A

UNIT I: Process Technology of fruits and vegetables: Pre and post-harvest changes in fruits and vegetables, storage, handling, and canning of fruits and vegetables and their products. Technology of fruits and vegetables juices, purees, concentrates, jams, jellies, marmalades, preserves fruit butters, candied fruits, pickles etc. (10hrs)

UNIT II: Process Technology of meat and poultry: Livestock and poultry preparations, slaughter, cutting dressing and grading, various cuts of meat. Post-mortem changes. Preservation and packing of meat, poultry and their products. Quality control in processed meat and poultry products, Microbiological standards. By products of meat and poultry processing industries. Process technology of eggs and their products. (10hrs)

UNIT III: Process Technology of fish and other aquatic Foods: Sources, methods offishing, handling and storage processing of fish and fish products, byproducts of fish processing. Fish oils, Standards of fish and fish products, processing of other aquatic foods like crabs, frogs, etc. (10hrs)

SECTION-B

UNIT IV: Process Technology of Milk and Milk products: Composition of milk, processing, storage and distribution of milk, manufacture of cream, ice cream, butter, ghee, evaporated, condensed, and skimmed milk, whole and skimmed milk powder, and other fermented milk products. Manufacture of cheese. Preparation of Indian milk products like khoa Channa, curd and their products, Standards for milk products. Dynamic dairy technology

Process Technology of Beverages: Carbonated beverages, fruit juices and R.T.S. beverages, alcoholic beverages, quality control. (10hrs)

UNIT V: Packaging: Functions of packaging materials, rigid and flexible packages, metallic, glass and plastic containers. laminated packaging, requirement of packaging for specific products, aseptic packaging, controlled atmosphere packaging, modified atmosphere packaging. Testing of packaging materials, biodegradable packaging, label, artwork, and nutrition table. (10hrs)

UNIT VI: Quality attributes of foods and their evaluation. Analytical methods use in food analysis flavor, aroma and texture of foods, food additives, spices and condiments. Contamination in foods. Mycotoxins.

Food adulteration and Food laws: FSSAI rule and regulations, ISI and Agmark standards, food safety, food quality control & quality assurance, HACCP, ISO 22000. Recent advances in the field. (10hrs)

RECOMMENDED BOOKS:

- Preservation of Fruits and Vegetables by Girdharilal and Siddappa, G.S. Published by Indian Council and Agricultural Research (ICAR), New Delhi.
- Fruits and Vegetable Juice Processing Technology Edited by Treassler, D.K. and Jonslyn, M.A., AVI Publishing Co., Inc. Westport, Connecticut.
- Practical Canning by Lock A., Foods Trade Press Ltd., 7 Garrick Street, W.C.2, London.
- The Meat Hand book by Levie A, AVI Publishing Co., Inc. Westport, Connecticut.
- The Science of Meat and Meat Product, Edited by Price, J.F. and Schweigert, B.S: W.H. Freeman and Company, San Francisco.
- Poultry Products. Technology by Mountney, G J., AVI Publishing Co., Inc. Westport, Connecticut.
- Fishery By-products Technology by Brody, J., AVI Publishing Co., Inc. Westport, Connecticut.
- Fish and Food Vols. I,II,III & IV Edited by Brog traom. G. : Academic Press, New York and London.
- Processed Cheese Manufacture by Dr. Meyer A.: Food Trade Press, London.

- Drying of Milk and Milk Products by Hall. C. W. and Hendrick, T. I.: AVI Publishing Co., Inc. Westport, Connecticut.
- Modern Dairy Products by Lampert, I. M.: Eurasia Publishing House, (P) (Ltd.), Ram Nagar, New Delhi.
- By products from Milk by Webb, B. H. and Whittier, E.O.: A VI Publishing Co., Inc. Westport, Connecticut.
- The Chemistry and Testing of Dairy Products by New Lander, J. H. and Atherton, H. V. : Olsen Publishing Co., Milwaukee Wisconsin.
- Food Adulteration by Jacob, T.: Mc-Millan & Co. of India, Ltd.
- The Spice Handbook of Parry, J. W.: Chemical Publishing Co., New York.
- Meat Technology by Gerrard F.: Deonord Hill, London.
- Radiation Technology by Desrosier, N. W.: AVI, Publishing Co., INC, (1960)
- Symposium: Processing Agricultural and Municipal Wastes, Edited by Inglett, C.E.: AVI Publishing Co., Inc.
- Introduction of Waste Water Treatment Processes by Ramalho, R. S.: Academic Press, New York.
- Processed Plant Protein Food Stuffs, Edited by Aultschul, A. M.: Academic Press, London.
- Chemistry of Food Packaging by Swalam, C.M.: American Chemical Society, Washington D.C.
- Packaging by Newbaner, R.G.: Van Nostrand, Reinhold Co., New York.

**SYLLABI PRESCRIBED FOR FOUR YEAR DEGREE COURSE
B. TECH (CHEMICAL TECHNOLOGY) (FOOD, PULP & PAPER, OIL & PAINT AND
PETROCHEMICAL TECH.,) SEMESTER PATTERN (NEP-2020) OLD
SEMESTER: SEVENTEETH B. TECH.
7PT2: PULP & PAPER TECHNOLOGY SP. TECH-V**

Subject Code: 7PT2	Title: Pulp & Paper Technology Sp. Tech-V	Credits = 03		
		L	T	P
Semester: VII	Total contact hours: 3 hrs/week	03	-	--

COURSE OBJECTIVES:

Such a course is to prepare students for a successful career in the pulp and paper industry by providing a strong technical foundation. Mastering stock preparation, headbox design, sheet formation on Fourdrinier/twin wire machines, wet end chemistry.

COURSE OUTCOMES:

At the completion of this course, students will be able to:

- Grasp the underlying scientific and engineering principles of sheet formation.
- Pressing, water removal by force, and drying, water removal by heat.
- Evaluate and optimize the papermaking processes to improve operational efficiency,

SECTION-A

UNIT I: Paper and paper board manufacture: Introduction auxiliary equipment's, centric leaners, Sand traps, centrifugal separators, and various screens. (10hrs)

UNIT II: Paper making machines: Fourdrinier machine, history, and development of fourdrinier, modern fourdrinier machine approach flow system, head box slice, types of slices, drainage and formation on fourdrinier machine. (12hrs)

UNIT III: Advanced twin wire former, multi wire former and use of wet end chemistry in paper machine wet end. (8hrs)

SECTION-B

UNIT IV: Cylinder mold machine: Introduction, history of cylinder machine, vat, stock entries, and couch press, modern formers, cylinder machine felts. (8hrs)

UNIT V: Pick-up and press section: Suction picks-up, open draw and no draw, pressing theory, felts press section arrangements, suction rolls, crowning of press roll, swimming roll, modern press, extended nip press. (10hrs)

UNIT VI: Dryer section: Function of dryer section, theories of drying, cylinder drying, air drying, radiant drying, auxilliary equipment, operations and control, performance calculations. Cost and economics. Recent advances in the field. (12hrs)

BOOKS RECOMMENDED:

- Advances in papermaking wet end chemistry application technologies, by Martin A. Hubbe and Scott Rosencrance
- Paper and board grades, volume 18, by Hannu Paulapuro
- Pulp and Paper Manufacture, 2nd edn., Vol.II, by B.Mac. Donald, Mc Graw-Hill.
- Pulp and Paper Science & Technology Vol. I & II by C. E. Libby
- Pulp & Paper Manufacture Vol. I, II, III by Mac Donald
- Hand Book of Pulp and Paper Technology by K.W. Britt 2nd edition.

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B. TECH (CHEMICAL TECHNOLOGY) (FOOD, PULP & PAPER, OIL & PAINT AND
PETROCHEMICAL TECH.,) SEMESTER PATTERN (NEP-2020) OLD
SEMESTER: SEVENTEETH B. TECH.
7OT2: OIL & PAINT TECHNOLOGY SP. TECH-V

Subject Code: 7OT2	Title: Oil & Paint Technology Sp. Tech-V	Credits = 03		
		L	T	P
Semester: VII	Total contact hours: 3 hrs/week	03	-	00

SECTION-A

UNIT I: Convertible and non-convertible coatings: Chemical nature of coatings and their properties. Various coating technology in Auto industries like CED, TOPCOAT, 3C1B, 3C2B etc
(10hrs)

UNIT II: Natural resins. Chemistry of drying, Semi-drying and non-drying oils, Chemistry and mechanism of heat and drying.
(10hrs)

UNIT III: Manufacture of synthetic drying oils, Processes and Plants employed in refining of drying oils. Their manufacture and properties, solvents, diluents and thinners:
(10hrs)

SECTION-B

UNIT IV: Chemistry and technology of synthetic resins
(8hrs)

UNIT V: Pigment and extenders: Pigmentary properties and evaluation of pigments. General outlines of the methods of the manufacture of pigments. Properties and uses of important pigments. Organic pigments and colors.

Color measurement through spectrophotometer considering LAB value, color theory munsell color system. Brief account of primary secondary color.
(12hrs)

UNIT VI: Formulation of paints: Printing inks, lacquers, varnishes and. Methods of manufacture of paints, printing inks, and lacquers, I.S.I. Methods for evaluation of paints and printing inks. Application of paint through six axis robot and defects. Paint output parameter testing like gloss, DOI and brief about wave scan (appearance of coating) Recent advances in the field.
(10hrs)

RECOMMENDED BOOKS:

- Outline of Paint Tech: H. Hea
- Organic Coating Tech.: H. R. Payne
- Introduction to Drying Oil Tech.: A. R. Mills
- Paint and Varnish Manufacture: H. W. Chatfields
- Treatise on Coatings: Myas and Long.
- Printing Inks: C.Ellis, Rainhold Pbl., New York.
- Nitrocellulose Ester Leaquers: F. Zimmer
- Paint Film Defects: M. Hers
- Paint and Varnishes: A. S. Khanna
- O.C.C.I. Paint Technology Manual (5 Volumes)
- Tech. of Writing and Printing Inks, Small Business Publ.

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PETROCHEMICAL TECH.,) SEMESTER PATTERN (NEP-2020) OLD
SEMESTER: SEVENTEETH B. TECH.
7PC2: PETROCHEMICAL TECHNOLOGY SP. TECH-V

Subject Code: 7PC2	Title: Petrochemical Technology Sp. Tech-V	Credits = 03		
		L	T	P
Semester: VII	Total contact hours: 3 hrs/week	03	-	--

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

- Petrochemicals and petrochemical industry and raw materials.
Role of petrochemicals as building blocks for various consumer commodities.
- Synthesis of major olefins.
- Synthesis of petrochemicals and various processes involved.
- Manufacturing process of Chemicals from methane, ethylene & propylene.
- Manufacturing process of chemicals from Aromatics and Synthesis gas

Course outcomes: After successful completion of this course students will be able to:

- Know about the feeds for petrochemical manufacture, impurities & their removal techniques.
- Understand the reactions, mechanism and parameters involved in the manufacture of various petrochemicals.
- Understand the various routes for manufacture of petrochemicals, economics involved & future trends
- Understand the petrochemical processing, engineering problems encountered, causes & solutions

Section-A

Unit-I: Introduction to petrochemicals, classification, raw materials, originating source, impurities in source materials and their removal. Separation of individual constituents from hydrocarbon mixture in brief. (10hrs)

Unit-II: Synthesis of major olefins like ethylene, propylene, butene's etc. Details of steam cracking for production of olefins, aim, mechanism, technique, process conditions, reactors used, effect of various parameters like hydrocarbon to steam ratio, partial pressure of steam nature of feedstock, temperature, residence time etc. on conversion. Production of acetylene from petroleum and non-petroleum routes, limitations of acetylene as a feedstock. (10hrs)

Unit-III: Manufacturing process of Chemicals from methane and Acetylene- Manufacturing process of methanol, Acetic acid, Vinyl Acetate, Poly Vinyl Acetate. (10hrs)

Section-B

Unit-IV: Manufacturing process of chemicals from ethylene- Manufacturing process of Ethylene, Low density polyethylene, High density polyethylene, Vinyl chloride monomer, Polyvinylchloride, Ethylene oxide Ethylene glycol and Ethyl benzene. (10hrs)

Unit-V: Manufacturing process of chemicals from propylene- Manufacturing process of Propylene, polypropylene, Propylene oxide, IPA, Phenol and Acrylonitrile. (10hrs)

Unit-VI: Manufacturing process of chemicals from Aromatics and Synthesis gas- Synthesis of commercial aromatics, BTX. Production of synthesis gas, utility,

various routes. Manufacturing process of styrene, Cumene, Caprolactam, Adipic Acid, Phthalic Anhydride, Higher Alcohol. Ammonia synthesis. (10hrs)

RECOMMENDED BOOKS:

- Acetylene, vol I and II, S. A. Miller,
- Ethylene and its Industrial Derivatives, S. A. Miller.
- Propylene and its Industrial Derivatives, E. G. Hancock.
- Benzene and its Industrial Derivatives, E. G. Hancock.
- Oxidation of Hydrocarbons, S. B. Chandalia.
- Oxidation of Petrochemicals, T. Dumas and W. Bulani.
- Production of Polymers and Plastic Intermediates from Petroleum, R, Long
- A Text Book on Petrochemicals, B. K. Bhaskara Rao.
- Toluene, Xylenes and their Industrial Derivatives, E. G. Hancock.
- Handbook of Petrochemical Processes, Meyers, R., 1996

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SEMESTER: SEVENTEETH B. TECH.
7CT3: MULTIDISCIPLINARY MINOR-V (MDM-V)**

Subject Code: 7CT3	Title: Multidisciplinary Minor-V (MDM-V) Industrial wastewater Treatment	Credits = 04		
		L	T	P
Semester: VII	Total contact hours: 4 hrs/week	03	01	

SECTION-A

UNIT I: Environment, pollution, pollutant, zero 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. Agencies working on pollution control, their constitution, ageing of lakes and reservoirs, thermal stratification of lakes and reservoirs. Case study of wasteless processing. (10hrs)

UNIT II: Legislations of Environment protection, Indian standards for drinking water, effluent discharge, Indian standard codes for disposal of wastes, micro-organisms present in water, water sus-pended solids, turbidity, pH, conductivity, DO, BOD by direct method & dilution method, case sampling methods, Sampling procedures, and precaution. (10hrs)

UNIT III: General Treatment: Screening and grease removal, Neutralization, chemical coagulation, sedimentation, filtration, biological treatment: Kinetics of biological growth, various suspended and attached growth processes for the treatment of industrial effluent. 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. (10hrs)

SECTION-B

UNIT-IV: Solid waste management, land pollution, composting, land filling, incineration, types of hazardous waste, treatment of hazardous waste, sources of radioactive wastes, treatment of radioactive waste. Effects of radiations, rewashable and recyclable solid waste, recycling in chemical industries. (10hrs)

UNIT-V: Removal of particulate matter, comparative study of method employed e.g. cyclones, bag filters, precipitators, scrubbers, collectors etc., Pollutions control for fly ash, combustion, and gasification plants. Various processes for reducing SO_x, NO_x emissions.(10hrs)

UNIT-VI: 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. (10hrs)

RECOMMENDED BOOKS:

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

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PETROCHEMICAL TECH.,) SEMESTER PATTERN (NEP-2020) OLD
SEMESTER: EIGHTEH B. TECH.
8CT1: PLANT DESIGN & PROJECT ENGINEERING (PDPE)**

Subject Code: 8CT1	Title: Plant Design & Project Engineering (PDPE)	Credits = 03		
		L	T	P
Semester: VIII	Total contact hours: 3 hrs/week	03	-	--

SECTION-A

UNIT I : Project identification, Preliminary techno economic feasibility, Process design aspects selection of process, factors affecting process selection, importance of laboratory development pilot plant, scale up methods, safety factors, Types of flow diagrams. (10hrs)

UNIT II : Detection of process equipment's-standard vs special equipment, materials of construction for process equipment's, selection criteria, specification sheets. (8hrs)

UNIT III: Process auxiliaries - piping design, layout, supports for valves, process control & instrumentation control system design. Process utilities-process water, boiler feed water, water treatment, waste treatment & disposal, oils heating systems, chilling plant, compressed air & vacuum. Plant location & layout-Factors affecting both planning of layout. principles of plant layout, use of scale methods. (12hrs)

SECTION-B

UNIT IV: Cost estimation - factors involved in project cost estimation. Total capital investment, fixed capital & working capital. Methods of estimation of investment, estimation of equipment cost production factors, estimation of total product cost - factors involved in estimating. Depreciation - types of methods of depreciation, evaluation of depreciation methods. (12hrs)

UNIT V: Applied process design of fluid flow and ejectors, process planning, scheduling, flowsheet design, process safety and pressure-relieving devices. (8hrs)

UNIT VI: Economic considerations in process & equipment design, inventory control, scheduling a project using CPM/PERT methods, project management. Option design, general production rates in plant operation. Optimum conditions, optimum production rates in plant operation, optimum conditions in cyclic operation. (10hrs)

RECOMMENDED BOOKS:

- Plant Design & Economics for Chemical Engineering By M.S. Peters & K. D. Timmerhaus, McGraw Hill (Japan), 2nd Edition.
- Applied Process Design for Chemical and Petrochemical plants, Ernest E. Ludwig, Gulf Professional Publishing (Volume 1).
- Chemical Engg. Plant Design: F. C. Vibradant & C. E. Dryden, McGraw Hill (New York).

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B. TECH (CHEMICAL TECHNOLOGY) (FOOD, PULP & PAPER, OIL & PAINT AND
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SEMESTER: EIGHTEH B. TECH.
8CT2 & 8CT6: CHEMICAL REACTION ENGINEERING -II (CRE-II)

Subject Code: 8CT2	Title: Chemical Reaction Engineering-II (CRE-II)	Credits = 04		
		L	T	P
Semester: VIII	Total contact hours: 5 hrs/week	03	-	02

Course Objectives:

- Student will understand the rate equation of Homogeneous reaction
- Students will understand the reactor design of heterogeneous system

Course Outcomes:

After successful completion of this course student will be able to

- Understand the basic aspects of non-ideal flow
- Determine the conversion in a non-ideal reactor using tracer information.
- Develop the rate equation for heterogeneous reaction.
- Design the reactor for fluid-fluid reactions
- Design the reactor for fluid particle reaction
- Design reactors for solid catalyzed reactions

SECTION-A

UNIT I: Residence time distribution. Models for non-ideal flow. Residence time distribution, single parameter model; non-isothermal reactors (8hrs)

UNIT II: Mixing concept and models: Rate equation for heterogeneous reactions, fluid particle reactions. Determination of rate controlling step. Application to design, kinetics of enzyme reactions (Michaelis-Menten and Monod models), non-ideal reactors, kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis; rate and performance equations for catalyst deactivation. (12 hrs)

UNIT III: Fluid-Fluid reaction: Rate equation for different cases and application to design. Eight designs. (8 hrs)

SECTION-B

UNIT IV: Heterogeneous processes, catalysis and adsorption determination of surface area, void volume, pore volume distribution catalyst preparation, promoters and inhibition of catalyst reactivation. (12 hrs)

UNIT V: Rate equation for third solid catalytic, reactions. Internal external transport process in heterogeneous reactions. (8hrs)

UNIT VI: Design of Heterogeneous catalytic reactors, fixed broad reactors, isothermal & adiabatic fixed bed reactor, non-isothermal & non-adiabatic fixed bed rector, fluidized bed, trickle bed, slurry reactor. (12hrs)

8CT6: CHEMICAL REACTION ENGINEERING -II (CRE-II) (LAB) Based on above syllabus

BOOKS RECOMMENDED:

- Chemical Reaction Engineering: Octove Levelspiel, 3rd Edⁿ. J. Wiley Eastern Ltd.
- Chemical Engineering Kinetics: Smith J.M., Mc Graw Hill, 3rd Edⁿ. 1990.
- Elements of Chemical Reaction Engineering: H. Scott Fogler, Prentice Hall 2016.
- Chemical Reactor Analysis & Design : Gilberth F. Froment & Kenneth B. Bischoof, John Wiley & Sons.
- Chemical Reactor Design: Vol I & II: M W.Rase
- Chemical Kinetics: Keith J. Laidler, 3rd Edition, Pearson 2013.

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SEMESTER: EIGHTEH B. TECH.
8FT3 & 8FT7: FOOD TECHNOLOGY SP. TECH -VI

Subject Code: 8FT3	Title: Food Technology Sp. Tech -VI	Credits = 05		
		L	T	P
Semester: VIII	Total contact hours: 7 hrs/week	03	-	04

SECTION-A

UNIT I: Biochemical engineering and fermentation Technology: Metabolic pathways of microorganisms. Parameters for growth, energy, carbon, and nitrogen. Sources requirements and biomass, estimation, surface, submerged and solid-state cultures. Kinetics of growth and structured growth models. Measurement of dissolved oxygen, mass transfer coefficient. (10hr)

UNIT II: Effect of aeration and agitation, Kinetics of substrate utilization. Product yield and biomass production, batch, plug flow and chemostat cultures, Scale up in fermenter design. Types of fermenters. Design and operation of fermentation equipment. (10hrs)

UNIT III: Methods of aeration, agitation, and sterilization. Control of contamination in fermenters. Antifoam devices, auxiliary equipment and instrumentation, Product recovery. (8hrs)

SECTION-B

UNIT IV: Fermentation technology of alcohol, alcoholic beverages, vitamins, antibiotics, vinegar, organic acids such as citric acid, lactic acid, solvents. Single cell protein, enzymes, and other miscellaneous products. Cultivation of algae, mushrooms, and the starter culture. (12 hrs)

UNIT V: Immobilized enzymes, methods of immobilization, properties an application of immobilized enzymes. Reactor design for immobilized enzyme Systems. (10hrs)

UNIT VI: Waste water treatment & water recycling, new special in fermentation technology. (8hrs)

8FT7: FOOD TECHNOLOGY SP. TECH -VI (LAB): More than six experiments expected

- Preparation of fruit juices, squash, concentrate.
- Preparation of jam, jellies, pickles etc.
- Canning of fruits and vegetables and their evaluation.
- Processing of meat, fish.
- Preparation dairy products such as butter, cheese, ice cream.
- Dehydration of fruits and vegetables and their evaluation.
- Preparation of bakery products like bread, biscuits, cakes, crackers etc.
- Preparation and evaluation of confectionery products like hard- and soft-boiled candies.
- Preparation of fruit candies and chikkies
- Preparation of beverages.
- Evaluation of Michaelis-Menten constant.
- Determination of BOD, COD and dissolved oxygen by chemical and instrumental methods.
- Production, recovery, and control tests of the fermentation products like alcohols.
- Production, recovery and control tests organic acids, enzymes.

BOOKS RECOMMENDED:

- Biochemical Engineering Fundamentals by Bailey, lame, E.: McGraw Hill Book Co.
- Advances in Biochemical Engineering. Vols. 1 to 6 Edited by Bhose, T.K. and Ficchter, A : Springer Vorlag, Berlin, L Lcidelberg New York.
- Biochemical and Biochemical Engineering, Science Vols. 1 to 2 Edited by Blakebrough : Academic Press, London and New York.
- Industrial Fermentation, Vols. 1 & 2 By Under Kofler, L.A.: Chemical Publishing Co., INC, 212, Fifth Avenue, New York.
- Immobilized Enzymes, Antigens, Antibodies and Peptides, Vols. 1& 2, 3 & 4 Edited by Weetal, H.H.: Marcel Decker, INC New York.
- Industrial Microbiology by Presscot and Dunn: McGraw Hill Book Co., INC, New York.
- Industrial Microbiology by Casida, L.E.: John Wiley and Sons, INC, New York.

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PETROCHEMICAL TECH.,) SEMESTER PATTERN (NEP-2020) OLD
SEMESTER: EIGHTEH B. TECH.
8PT3 & 8PT7: PULP & PAPER TECHNOLOGY SP. TECH -VI

Subject Code: 8PT3	Title: Pulp & Paper Technology Sp. Tech -VI	Credits = 05		
		L	T	P
Semester: VIII	Total contact hours: 7 hrs/week	03	-	04

COURSE OBJECTIVES: This course will help the students to understand the concepts of Pulp and Paper making processes and finishing of paper. To address the environmental issues that arise from different processes and the conservation and efficient utilization of resources like steam, power, and water in the industry.

COURSE OUTCOMES:

At the completion of this course, students will be able to:

- Design the operation, maintenance and safety aspects for paper making.
- Identify the factors that drive industry trends.
- Grade paper and boards based on different testing methods

SECTION-A

UNIT I: Finishing of paper and board: Operation and benefits of calendaring, reeling and wrapping, winders, super calendaring, embossing, cutting of paper, packing of paper in ream and sheet form, dispatch of paper. (10hrs)

UNIT II: Surface treatment of paper and board: Definitions, objectives, general approaches, typical surface treatment processes- coating and surface sizing, factors controlling surface sizing, different types of sizing chemicals used, equipment used for application of surface sizing and coating on paper, preparation of coating color, adhesives used for coating. (12hrs)

UNIT III: Manufacturing of insulating boards, hard boards, and particle board, raw material used, processing of different pulps, forming machines, and finishing of boards. (8hrs)

SECTION-B

UNIT IV: Energy conservation: Strategies to follow for conserving energy in digester, bleach plant, chemical recovery, boiler, stock preparation and in paper machine. (10hrs)

UNIT V: Analysis and testing: Introduction, test facilities, equipment, BIS, TAPPI and ISO standards used in analysis and testing, testing of pulp, wood, paper and converted products. (10hrs)

UNIT VI: Rag processing, manufacturing of handmade papers, and manufacturing and properties of speciality papers. (10hrs)

8PT7: PULP & PAPER TECHNOLOGY SP. TECH -VI (LAB) : More than six experiments expected

- To find out basis weight of paper(gm/m²)
- To determine caliper of paper (Thickness)
- To determine bulk of paper (Cobb value)
- To determine folding endurance of paper.
- To determine brightness and opacity of paper.
- To determine tearing resistance of paper.
- To determine bursting strength of paper.
- Manufacturing of handmade paper.
- Preparation of various GSM paper from semi-automatic sheet former.

RECOMMENDED BOOKS:

- Pulp and Paper Manufacture, 2nd Ed. Vol-II. by B. MacDonald, McGraw Hill
- Winding machine mechanics and measurements by Dr. David Roisum and Dr. James K. Good
- Pulp and Paper Science & Technology Vol. I & II by C. E. Libby
- Hand Book of Pulp and Paper Technology by K.W. Britt 2nd edition.

SYLLABI PRESCRIBED FOR FOUR YEAR DEGREE COURSE
B. TECH (CHEMICAL TECHNOLOGY) (FOOD, PULP & PAPER, OIL & PAINT AND
PETROCHEMICAL TECH.,) SEMESTER PATTERN (NEP-2020) OLD
SEMESTER: EIGHTEH B. TECH.
8OT3 & 8OT7: OIL & PAINT TECHNOLOGY SP. TECH -VI

Subject Code: 8OT3	Title: Oil & Paint Technology Sp. Tech -VI	Credits = 05		
		L	T	P
Semester: VIII	Total contact hours: 7 hrs/week	03	-	04

SECTION-A

UNIT I: Waxes: Natural sources classification, chemical composition, extraction refining and processing of waxes, their modification and formulation, synthetic waxes, properties. (10hrs)

UNIT II: Cosmetics: Classification, manufacture, and evaluation of cosmetic, preparation such as shampoos, shaving creams, lotions, toiletries and perfumery materials. (10hrs)

UNIT III: Other fat-based products: Manufacture and utilization of nitrogen, phosphorous and Sulphur containing compounds (10hrs)

SECTION-B

UNIT IV: Fatty acids: Theory and practice of fat splitting and purification of products, separation of fats and fatty acids and their applications in foods, pharmaceuticals, textile, plastics, leather and other industries. Recent development in the field. (12hrs)

UNIT V: Utilization, testing and evaluation of waxes, testing of cosmetic products, plasticizers and products obtained by inter esterification hydrogenation, oxidation and pyrolysis (10hrs)

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

8OT7: OIL & PAINT TECHNOLOGY SP. TECH -VI (LAB):

- Analysis of butter, ghee, margarine, vanaspati, soap stock, sulphonated and oil spent lyes
- Commercial fatty acids and glycerin. Evaluations of detergents
- Analysis of Cosmetics products.
- Analysis of mixture of oils and fats.
- Analysis of bye products and wastes obtained from oil & allied industries.
- Preparation and, analysis of some industrially important fatty acids.
- Analysis of natural & Synthetic Pigments
- Analysis of raw materials for Paints & Paint products.

RECOMMENDED BOOKS:

- The Chemistry and Technology of Waxes: A.H. Warth
- Industrial Waxes: H.Benet (2 Volumes)
- Fatty Acids and their Industrial Applications: E. S. Pattison
- Industrial Oil and Fat Products: A. E. Bailey
- Industrial Chemistry of Fats and Waxes: T. P. Hilditch.
- Cosmetics Science and Tech.: W. Saggari
- Perfumes, Cosmetics and Soaps: W. A. Poucher (Vol.-I, II, III)
- Chemistry and Biochemistry of Natural Waxes: P. E. Kolattukudy.
- Basics of Paint Technology, Part-I, V. C. Malshe, Meenal Sikchi, ICT, Mumbai.

**SYLLABI PRESCRIBED FOR FOUR YEAR DEGREE COURSE
B. TECH (CHEMICAL TECHNOLOGY) (FOOD, PULP & PAPER, OIL & PAINT AND
PETROCHEMICAL TECH.,) SEMESTER PATTERN (NEP-2020) OLD
SEMESTER: EIGHTEH B. TECH.
8PC3 & 8PC7: PETROCHEMICAL TECHNOLOGY SP. TECH -VI**

Subject Code: 8PC3	Title: Petrochemical Technology Sp. Tech -VI	Credits = 05		
		L	T	P
Semester: VIII	Total contact hours: 7 hrs/week	03	-	04

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

- Metal working fluids, Turbine Oils, Gear Oils, Hydraulic Fluids, Electrical Insulating Oils & White Mineral Oils, their types.
- Formulations, tests & functions of these specialty products.
- Natural gas & its occurrence, composition, chemical properties, and characteristics
- Phase behavior of natural gas.
- Natural gas treatment & processing.

Course outcomes: After successful completion of this course students will be able to:

- Understand the processing of petroleum specialty products.
- Understand the test & test methods of petroleum specialty products.
- Natural gas industry, natural gas processing.
- Phase behavior of natural gas, treatment, gas flow measurement etc.

Section-A

Unit-I: Metal Working Fluids- Types & Functions of MWF's, Cutting Oil Formulation, Maintenance & Disposal. Quenchants: Heat Treating Processes, Quenching, Types of Quenchants, three stages of Heat Removal, Quench System Design, Other Heat-treating Processes. (10hrs)

Unit-II: Turbine Oils, Gear Oils & Hydraulic Fluids- Base oils, formulation, life, Test methods. SAE Gear oil Classification, Automotive lubricant Test Methods, Cold Crank Simulator (ASTM D 5293) and Four Ball Wear Test (ASTM D 4172). Physical Properties of Hydraulic Fluids, Biodegradability, base oils for Hydraulic Fluids, Brake Fluids. (10hrs)

Unit-III: Electrical Insulating Oils & White Mineral Oils- Properties, Specifications, Transformer Oil Manufacture. Properties, Uses, Manufacturing of White Oils, Process description, Intermediate Product Nomenclature and Storage, Sulfonate Blending, petroleum Sulfonates. (10hrs)

Section-B

Unit-IV: Introduction Brief history of natural gas industry, characteristics of various utility and industrial gases, sources of natural gas, occurrence, composition, chemical properties and characteristics of natural gas.

Properties of natural gases and volatile hydrocarbon liquids, diffusion coefficient, compressibility factors, density of gases and liquids, surface tension, thermodynamic properties, heating value, flammability limits, critical properties, viscosity and thermal conductivity. (10hrs)

Unit-V: Phase behavior of natural gas, pressure-volume-temperature diagram for pure hydrocarbons. Phase rule, solubility of gases in liquids, binary mixtures.

Water-hydrocarbon system, general phase relations for water-hydrocarbon system, measurement of water contents of natural gas, gas hydrates, conditions of formation, prediction of hydrate formation condition, prevention of hydrate formation.

Unit-VI: Gas flow measurement, flow and compressor calculations, flow equation, pipeline flow calculations, calculations of work required to compress natural gas.

Low temperatures processing of natural gas, natural gas liquefaction, dehydration and sweetening of natural gas, methods of dehydration and sweetening. (10hrs)

8PC7: PETROCHEMICAL TECHNOLOGY-VI SP. TECH.-VI (LAB)

- 1) Ash from Petroleum
- 2) Molecular Weight determination by Steam Distillation
- 3) Carbon Residue by Ramsbottom
- 4) Water content by Dean and Stark method
- 5) Water content by Karl fisher method
- 6) Refractive Index by Abe / Digital Method
- 7) Reid Vapour
- 8) Viscosity gravity constant
- 9) UV spectrophotometer
- 10) Centrifuge
- 11) TBP distillation of Kerosene
- 12) Analysis of TBP fractions
- 13) Preparation of Distillate Blend
- 14) Preparation of residue blends
- 15) Plotting of Distillate & Residue yield curves and mid percent curve of distillate
- 16) Determination of Demulsibility Characteristics of Lubricating Oil

RECOMMENDED BOOKS:

1. Petroleum Fuels Manufacturing Handbook, Surinder Prakash, Mc Graw Hill.
2. Modern Petroleum Technology, G. D. Hobson & Pohl., Applied Science Publications.
3. Asphalts and Road Materials, Modern Technology, J. E. Parson, Noyes Data Corporation.
4. Lubricant Additives, M. W. Ranney, Noyes Data Corporation.
5. Natural Gas Engineering, Donald L. Katz and Robert L. Lee McGraw – Hill Publishing Company, NY.
6. Fuel Science and Technology Handbook, Speight, J.G Marcel Decker Inc.
7. The Natural Gas Industry – A review of World Resources and Industrial Applications, Dring, M.M – Butterworth, London.
8. Substitute Natural Gas, Lom. W.L and A.F. Williams, Kalstod Willey, New York.
9. Liquefied Natural Gas Technology, Dermott, M.C. Neysos Park Ridge, N.J.
10. Petroleum Production Systems, M.J. Economides A. Daniel, Prentice Hall Petroleum Engineering series.
11. Economides, Petroleum Production Systems, Michael J. Economides, A. Daniel Hill and Christine Ehlig PTR Prantice Hall, NJ
12. Guide to Natural Gas Utilization Technologies, Fairmount Press Inc.

SYLLABI PRESCRIBED FOR FOUR YEAR DEGREE COURSE
B. TECH (CHEMICAL TECHNOLOGY) (FOOD, PULP & PAPER, OIL & PAINT AND
PETROCHEMICAL TECH.,) SEMESTER PATTERN (NEP-2020) OLD
SEMESTER: EIGHTEH B. TECH.
8CT4: RESEARCH METHODOLOGY (RM)

Subject Code: 8CT4	Title: Research Methodology (RM)	Credits = 04		
		L	T	P
Semester: VIII	Total contact hours: 4 hrs/week	04	-	00

Course objectives:

- To understand the role of research methodology in Engineering/Science/Pharmacy
- To understand literature review process and formulation of a research problem
- To understand data collection methods and basic instrumentation
- To learn various statistical tools for data analysis
- To learn technical writing and communication skills required for research
- To create awareness about intellectual property rights and patents

Unit I: Introduction to Research

Definition of research, Characteristics of research, Types of research- Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, Overview of research methodology in various areas, Introduction to problem solving, basic research terminology, Role of Information and Communication Technology (ICT) in research. (12 hrs)

Unit II: Research Problem Formulation and Methods

Literature review, sources of literature, various referencing procedures, Identifying the research areas from the literature review and research database, Problem Formulation, Identifying variables to be studied, determining the scope, objectives, limitations and or assumptions of the identified research problem, Justify basis for assumption, Formulate time plan for achieving targeted problem solution. Important steps in research methods: Observation and Facts, Laws and Theories, Development of Models, Developing a research plan: Exploration, Description, Diagnosis and Experimentation. (12 hrs)

Unit III: Data collection

Static and dynamic characteristics of instruments, calibration of various instruments, sampling methods, methods of data collection, Basic Concepts concerning testing of hypotheses, procedures of hypothesis testing, generalization and interpretation Applied statistics: Regression analysis, Parameter estimation, Multivariate statistics, Principal component analysis Software tools for modeling, Simulation and analysis. (12 hrs)

Unit IV: Research reports and Thesis writing

Introduction: Structure and components of scientific reports, types of report, developing research proposal. Thesis writing: different steps and software tools in the design and preparation of thesis, layout, structure and language of typical reports, Illustrations and tables, bibliography, referencing and footnotes, Oral presentation: planning, software tools, creating and making effective presentation, use of visual aids, importance of effective communication. (12 hrs)

Unit V: Research Ethics, IPR and Publishing

Ethics: Ethical issues. IPR: intellectual property rights and patent law, techniques of writing a Patent, filing procedure, technology transfer, copy right, royalty, trade related aspects of

intellectual property rights Publishing: design of research paper, citation and acknowledgement, plagiarism tools, reproducibility and accountability. (12 hrs)

Reference Books:

1. Ranjit Kumar, "Research Methodology: A Step-by-Step Guide for Beginners", SAGE Publications Ltd., 2011.
2. Wayne Goddard, Stuart Melville, "Research Methodology: An Introduction" JUTA and Company Ltd, 2004.
3. C.R. Kothari, "Research Methodology: Methods and Trends", New Age International, 2004
4. S.D. Sharma, "Operational Research", Kedar Nath Ram Nath & Co., 1972
5. B.L. Wadehra, "Law Relating to Patents, Trademarks, Copyright Designs and Geographical Indications", Universal Law Publishing, 2014.
6. Donald Cooper, Pamela Schindler, "Business Research Methods", McGraw-Hill publication, 2005.

SYLLABI PRESCRIBED FOR FOUR YEAR DEGREE COURSE
B. TECH (CHEMICAL TECHNOLOGY)
(FOOD, PULP & PAPER, OIL & PAINT AND PETROCHEMICAL TECH.,)
SEMESTER PATTERN (NEP-2020) OLD
SEMESTER: EIGHTEH B. TECH.
8CT5: MULTIDISCIPLINARY MINOR-VI (MDM-VI)

Subject Code: 8CT5	Title: Multidisciplinary Minor-VI (MDM-VI) Corrosion Control	Credits = 02		
		L	T	P
Semester: VIII	Total contact hours: 2 hrs/week	02	-	00

Course Outcomes:

- At the end of the Course, the Student will be able to
- Recognize the factors that play a role in selection of engineering materials.
- Differentiate types of corrosion.
- Identify different corrosion types and the remedial measures.
- Identify the methods for preventing corrosion.
- Select materials of construction for chemical engineering processes and operations to minimize corrosion rates.

UNIT - I

Definitions-explanation with suitable examples Factors affecting the choice of Engineering Material-Factors affecting Corrosion Resistance-Dry Corrosion, Wet Corrosion- Corrosive media or environments-acidic, basic, neutral marine-Corrosion Rate Expressions-Effect of aeration, flow rate of the medium, corrosive concentration, temperature, pH on the rates of Corrosion. (10 hrs)

UNIT - II

Corrosion Cell–its components with examples–types of corrosion cells generally encountered concentration cells, galvanic or dissimilar metal cells, temperature differentiation cells, Differential aeration cells. Forms of Corrosion-Uniform, Pitting, crevice corrosion, Cavitation erosion, impingement attack. (10 hrs)

UNIT - III

Intergranular Corrosion, mechanism and remedial measures, Stress Corrosion Cracking, Caustic embrittlement, Biological corrosion due to bacterial habitat, Combination of two dissimilar metal electrodes and relevant current-potential diagrams to evaluate corrosion rates-galvanic Corrosion. (10 hrs)

Text Books:

- Fontana. M.G, and Grene., “Corrosion Engineering”, 3rd edition, Tata Mc Graw Hill, New York, 2005.
- Uhlig. H.H., “Corrosion and Corrosion Control”, 4th edition, John Wiley and Sons, New York, 2008.
- S S. Dara, A Text book of Engineering Chemistry, S.Chand & Co New Delhi. Eleventh Edition.
- P.C. Jain and Monica Jain, Engineering Chemistry, Dhanpat Rai & sons New Delhi, Sixteenth Edition.