

**Course Curriculum Structure and Syllabi**  
*for*  
**Minor Degree**  
*in*  
**Chemical Engineering**



**Department of Chemical Engineering**

**National Institute of Technology Hamirpur**

**Hamirpur – 177 005 (India)**

5 <sup>th</sup> Semester						
SN	Code	Subject	L	T	P	C
1	CH-310	Chemical Process Principles and Reaction Kinetics	3	0	0	3
6 <sup>th</sup> Semester						
SN	Code	Subject	L	T	P	C
1	CH-320	Unit Operations	3	0	0	3
7 <sup>th</sup> Semester						
SN	Code	Subject	L	T	P	C
1	CH-410	Petroleum Refining and Petrochemicals	3	0	0	3
8 <sup>th</sup> Semester						
SN	Code	Subject	L	T	P	C
1	CH-420	Chemical Technology	3	0	0	3
		Total =				12

Course Name: <b>Chemical Process Principles and Reaction Kinetics</b>		
Course Code: <b>CH-310</b>		
Course Type: <b>Discipline Core</b>		
Contact Hours/Week: <b>3L</b>		Course Credits: <b>03</b>
<b>Course Objectives</b>		
<ul style="list-style-type: none"> <li>To understand the basic units of different parameters and their conversions.</li> <li>To formulate and solve material and energy balances for chemical processes.</li> <li>To understand principles of chemical reactions with respect to kinetics and reactor design.</li> <li>To analyse the kinetic data, and to estimate the kinetic parameters.</li> </ul>		
<b>Unit Number</b>	<b>Course Content</b>	<b>Lectures</b>
UNIT-01	<b>Stoichiometry &amp; material balance:</b> Units and dimensions, stoichiometric principles, composition relations, density and specific gravity, material balances for systems with and without chemical reactions, species and elemental balance, analysis of systems with by-pass, recycle and purge	<b>12 L</b>
UNIT-02	<b>Energy Balance:</b> Law of conservation of energy, heat capacity, enthalpy change for non-reacting systems, heats of fusion, vaporization, reaction, formation, and combustion, Hess' law.	<b>08 L</b>
UNIT-03	<b>Reaction kinetics &amp; Data Analysis:</b> Homogeneous and heterogenous reactions, elementary and non-elementary reactions, order and molecularity of reactions, reactions kinetics, concentration and temperature dependent term of rate equation, integral and differential method of analysis of data, series and parallel reactions, reversible reactions	<b>10 L</b>
UNIT-04	<b>Reactor Design:</b> Ideal batch reactor, CSTR, plug flow reactor, holding and space time, design for single reactions	<b>06 L</b>
<b>Course Outcomes</b>		
Upon successful completion of the course, the student will be able to		
CO1: Perform unit conversion and check dimensional homogeneity.		
CO2: Solve material and energy balances of a chemical process.		
CO3: Determine the kinetics of chemical reaction from the data using integral, differential method of analysis.		
CO5: Design of reactors for conducting the homogeneous reactions under isothermal conditions.		
<b>Textbooks and References</b>		
1. Basic Principles and Calculations in Chemical Engineering by D.M. Himmelblau, and J.B. Riggs, 8th edition, Prentice Hall India, 2014.		
2. Stoichiometry by B.I. Bhatt, and S.B. Thakore, 5th edition, McGraw Hill, 2017.		
3. Elements of Chemical Reaction Engineering by H.S. Fogler, PHI, 2010.		
4. Chemical Reaction Engineering by O. Levenspiel, Wiley, 2007.		

Course Name: <b>Unit Operations</b> Course Code: <b>CH-320</b> Course Type:		
Contact Hours/Week: <b>3L</b>		Course Credits: <b>03</b>
<b>Course Objectives</b>		
<ul style="list-style-type: none"> <li>Develop basic knowledge on the fundamentals of fluid mechanics, heat and mass transfer, and particles characteristics.</li> <li>Exposure to various unit operations involved in chemical industries.</li> </ul>		
<b>Unit No.</b>	<b>Course Content</b>	<b>Lectures</b>
<b>UNIT-01</b>	<b>Heat Transfer:</b> Concept of conduction, convection and radiation. Conduction: Fourier's law, 1D heat conduction through plane walls, cylindrical and spherical surfaces. Convection: heat transfer coefficient, hydrodynamic and thermal boundary layers, laminar and turbulent heat transfer inside and outside of tubes, individual and overall heat transfer coefficients. Radiation: Stefan-Boltzmann Law, Black and Grey Body	<b>09 L</b>
<b>UNIT-02</b>	<b>Fluid Mechanics:</b> Fluids Statics: Hydrostatics law, Pascal's law, manometers and pressure measurement. Fluid Kinematics: Laminar and turbulent flow. Continuity equation, Navier-Stokes equation, Bernoulli's equation and its application. Pitot tube, orificemeter, venturimeter and rotameter	<b>09 L</b>
<b>UNIT-03</b>	<b>Mass Transfer:</b> Molecular and eddy diffusion, molar flux, Fick's law, diffusivity: solid, liquid and gas; steady state diffusion, mass transfer coefficient: local and overall mass transfer coefficient; distillation, McCabe-Thiele method, feed plate and feed line, reflux.	<b>09 L</b>
<b>UNIT-04</b>	<b>Mechanical Operations:</b> Determination of mean particle size, Particle shape and size Distribution; Screening: Types of screens, Industrial screening, Screen effectiveness, Particle size analysis using screens; Size Reduction: Principles of crushing and grinding, Laws of size reduction, Industrial size reduction equipment, Closed and open circuit grinding; Size distribution equations	<b>09 L</b>
<b>Course Outcomes</b>		
Upon successful completion of the course, the students will be able to CO1: Understand the basics modes of heat transfer mechanisms. CO2: Understand the fluid flow characteristics and flow equipment's. CO3: Understand the the mass transfer operations and equilibria CO4: Understand the processes like screening, sizing, handling and various mechanical operations.		
<b>Textbooks and References</b>		
<ol style="list-style-type: none"> <li>W. McCabe, J. Smith, and P. Harriott, Unit Operations of Chemical Engineering, McGraw Hill, 2017.</li> <li>J. M. Cimbala, Y. A. Cengel, Fluid Mechanics: Fundamentals and Applications, McGraw Hill, 2019</li> <li>Y.A. Cengel and Afshin J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications, 6<sup>th</sup> ed., 2020.</li> <li>J.P. Holman, Heat Transfer, McGraw Hill, 10<sup>th</sup> ed. 2017.</li> <li>B. K. Dutta, Heat Transfer: Principles and Applications, PHI Learning Private Limited, 2001.</li> <li>R.E. Treybal, Mass Transfer Operations, McGraw Hill, 1980.</li> <li>B.K. Dutta, Principles of Mass Transfer and Separation Processes, Prentice Hall of India, 2006.</li> <li>B.C. Bhattacharya, and C.M. Narayanan, Mechanical Operation for Chemical Engineers, Khanna Publishers, 1990.</li> <li>J.M. Coulson, J.F. Richardson, and R.K. Sinnott, Chemical Engineering, Butterworth-Heinemann, Vol.-2, 2003.</li> </ol>		

Course Name: <b>Petroleum Refining and Petrochemical Technology</b>		
Course Code: <b>CH-410</b>		
Course Type:		
Contact Hours/Week: <b>3L</b>		Course Credits: <b>03</b>
<b>Course Objectives</b>		
<ul style="list-style-type: none"> <li>To impart knowledge about petroleum refineries and various operations carried out in it.</li> <li>To introduce the fundamental of various aspects of petrochemical engineering and petroleum products.</li> </ul>		
<b>Unit Number</b>	<b>Course Content</b>	<b>Lectures</b>
UNIT-01	<b>Introduction to Petroleum Industry:</b> Scope and purpose of refining; global and Indian refining scenario, practice and prospect. An overview of the entire spectrum of the refinery products, physiochemical characteristics of petroleum and petroleum products, refinery configuration development.	<b>07L</b>
UNIT-02	<b>Refinery Distillation Processes:</b> Classification of crude oil, desalting and stabilization of crude, fractional distillation of crude oil, ASTM, TBP and EFV distillation, atmospheric distillation unit, vacuum distillation unit, degree of separation (5-95 gap) and degree of difficulty of separation ( $\Delta t$ 50), Packie charts.	<b>08L</b>
UNIT-03	<b>Fuel Refining:</b> Cracking, coking, reforming, alkylation, isomerisation, polymerization, sweetening, visbreaking, hydroprocessing: hydro cracking, hydro treating, hydro finishing.	<b>09L</b>
UNIT-04	<b>Petrochemicals:</b> Refinery feed stock; nature and effect of different types of refinery feedstock and impurities on refinery configuration and operation, natural gas, production of petrochemical precursors - synthesis gas, hydrogen, acetylene, ethylene, propylene, and butylene.	<b>06L</b>
UNIT-05	<b>Polymer Based Industries and Their Characteristics:</b> Plastic; production of thermoplastic and thermosetting resins such as polyethylene, polypropylene, phenolic resins and epoxy resins. Polymers and their applications in engineering practice. Polyamides, polyesters and acrylics from monomers. Production of natural and synthetic rubbers.	<b>06L</b>
<b>Course Outcomes</b>		
Upon successful completion of the course, the student will be able to		
CO1: Identify the key problems associated with smooth operation of petroleum refinery		
CO2: Describe various types of solution to problems normally encountered in refineries		
CO3: Apply principles of distillation, product up gradation, catalysis and polymer science in industries		
CO4: Understand the production of chemicals made from petroleum products		
<b>Books and References</b>		
<ul style="list-style-type: none"> <li>Petroleum Refinery Engineering by W. L. Nelson, McGraw-Hill, 1961.</li> <li>Petroleum Refinery Distillation by R.N. Watkins, Gulf Publishing, 1979.</li> <li>Modern Petroleum Refining Processes by B.K.B. Rao, Oxford and IBH Publishing, New Delhi, 1990.</li> <li>Fundamentals of Petroleum and Petrochemical Engineering by U. Ray Chaudhuri, CRC Press, 2010.</li> </ul>		

Course Name: <b>Chemical Technology</b>		
Course Code: <b>CH-420</b>		
Course Type:		
Contact Hours/Week: <b>3L</b> <b>03</b>		Course Credits:
<b>Course Objectives</b>		
<ul style="list-style-type: none"> <li>To provide a broader perspective of manufacturing of various organic and inorganic chemical.</li> <li>To study process technologies of various chemical process industries.</li> <li>To familiarize with the processes, flow diagram, various process parameters and equipment.</li> </ul>		
<b>Unit Number</b>	<b>Course Content</b>	<b>Lectures</b>
UNIT-01	<b>Natural Products Processing:</b> Gasification of coal and chemicals from coal, Fermentation process, Sugar Industries: Manufacture of raw and refined sugar, by products of sugar industry. Oils and Fats: Types of oil, different fatty acids, extraction of oil from seeds, oil purification, hydrogenation of oil. Manufacture of paints and varnishes, pigments.	<b>10 L</b>
UNIT-02	<b>Soaps and Detergents:</b> Types of soaps, soap manufacture, recovery and purification, manufacturing of detergents. <b>Pulp and Paper industry:</b> various pulping methods, recovery of chemicals from black liquor, manufacture of paper, quality improvement of paper.	<b>07 L</b>
UNIT-03	<b>Chlor-alkali Industries:</b> Manufacture of Soda ash, brine electrolysis, manufacture of caustic soda and chlorine in mercury cells, diaphragm cells, membrane cells, Bleaching powder.	<b>03 L</b>
UNIT-04	<b>Fertilizer Industries:</b> Ammonia, nitric acid, ammonium sulphate, ammonium chloride, urea Phosphorus, phosphoric acid, phosphatic fertilizers, calcium phosphate, ammonium phosphates, nitrophosphates, sodium phosphate, potassium chloride and potassium sulphate.	<b>07 L</b>
UNIT-05	<b>Acids:</b> Mining of sulphur and manufacture of sulphuric acid, hydrochloric acid, nitric acid. <b>Ceramic Industries:</b> Types and manufacture of cement, lime, gypsum, manufacture of glasses and special glasses, refractories.	<b>09 L</b>
<b>Course Outcomes</b>		
Upon successful completion of the course, the students will be able to		
CO1: Understand the processes involved in manufacturing of various inorganic and organic chemicals.		
CO2: Prepare the process flow diagrams.		
CO3: Analyze important process parameters and engineering problems during production.		
<b>Books and References</b>		
<ol style="list-style-type: none"> <li>Shreve's Chemicals Process Industries by G.T. Austine, McGraw Hill.</li> <li>Dryden's Outlines of Chemical Technology, G.M. Rao, and M. Sittig, East West Press, New Delhi.</li> <li>Chemical Technology by G.N. Pandey, Vol - 1, Lion Press, Kanpur.</li> <li>Industrial Chemicals by W.L. Faith, D.B. Keyes, and R.L. Clark, Wiley.</li> <li>Encyclopedia of Chemical Technology by Kirk, and Othmer, Wiley.</li> </ol>		

