IPS Academy, Institute of Engineering & Science

(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)

Department of Chemical Engineering

Minor in Chemical Engineering

(To be offered to the students of other departments excluding CM)

List of subjects for minor degree from Semester V to VIII

S. No.	Semester	Subject Code	Subject Name	Contact Hours per week			Total Credits
				L	T	P	
1	V		Chemical Process Calculations	4	-	-	4
2	VI		Mass Transfer Operation	3	-	2	4
3	VII		Chemical Technology	4	-	-	4
4	VIII		Chemical Reaction Engineering	4	-	2	3
			Total	14		04	15

1 Hr Lecture	1 Hr Tutorial	2 Hr Practical
1 Credit	1 Credit	1 Credit

Note: VII semester subject (Chemical Technology or any other course equivalent to Chemical Technogy) can also be done from MOOC courses (NPTEL SWAYAM, EDx etc.) with minimum credit 3.

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Course Code	Semester	Course Title	Load	Credit
	V	Chemical Process Calculation	04L:0T: (04 hrs)	Credits:04

Objective

The objective of this course to understand and apply the basics of calculations related to material and energy flow in the processes. In addition to make practical approach to solve industrial related material energy balance problems.

Module-I **08 hrs**

Units and Dimensions, Conversion of Units and conversion factors, Dimensional consistency and Mole unit, Density, specific gravity, mole Fraction and mass fraction, Concentration, Basic problems on above topics

Module-II **08 hrs**

Ideal gas law, Gas constant, Composition of gaseous mixtures, Dalton's & Amaget's law, partial pressure, Vapor pressure, saturation, partial saturation and humidity, Basic problems on above topics

Module-III **10 hrs**

Fundamental of material balance; Basis, General Material Balance, Material Balance without chemical reaction, Problems based on tie material, Inert material balance & simultaneous equation involving various unit operations, Concepts of recycle, purge and bypass, Basic problem of material balance

Module-IV **07 hrs**

Material Balance with chemical reaction Simple steady state material balance problems with chemical reaction.. Combustion Types of fuels, calorific value, Basic problems to find out the air requirement & composition of exit gases etc.

Module-V **08 hrs**

Fundamental of energy balance, Heat capacity, the general energy balance, Calculations of enthalpy changes, calculation of standard heat of reaction, heats of formation, combustion, solution, mixing, Enenrgy balances that account for chemical reactions. Basic problem of energy balance.

Course outcome-At the end of the course, the students will be able to acquire the knowledge of….

CO1: Unit conversion, concept of stoichiometry, mole and composition.
CO2: Behavior of liquids as well as gases and concept of humidity.
CO3: Material balance across equipment's used in process industries.
CO4: Material balance for chemical reactions involves in chemical process industries.
CO5: Energy balance including and excluding chemical reaction.

Text/Reference Book:

1. O.A. Hougen, K.M. Watson, R.A. Ragatz; Chemical Process Principles Part I –CBS pub.
2. David M. Himmelblau-Basic Principles and calculations in chemical Engineering –PHI
3. B. I. Bhatt, S.M. Vora; Stoichiometry; TMH.
4. K.V. Narayanan, B. Lakshmikutty; Stoichiometry and Process Calculations, PHI

Department of Chemical Engineering

Course Code	Semester	Course Title	Load	Credit
	VI	Mass Transfer Operation	3L:0T::2P (05 hrs)	Credits:04

Course Objective: The objective of this subject is to introduce the undergraduate students with the most important separation equipments in the process industry, and provide proper understanding of unit operations.

Module-I **08 hrs**

Introduction Importance of mass transfer operations, classification of mass-transfer operations, methods of conducting mass transfer operations. Molecular Diffusion of Fluids, Concept of molecular and eddy diffusion, Fick's law for diffusion, general equation for steady-state molecular diffusion in fluid..

Module-II **08 hrs**

Interphase Mass Transfer Concept of equilibrium, local and average overall mass transfer coefficient, film theory, and penetration theory, analogy between mass and momentum transfer, column internals: types of trays/ plates and packing, and concept of stage, stage efficiency, etc.

Module-III **08 hrs**

Gas Absorption Definition and application of absorption, equilibrium solubility of gases in liquids, choice of solvents, and material balance for the component transfer in counter current and concurrent flow.

Crystallization: Theory of crystallization, saturation, supersaturation, nucleation and crystal growth, various types of equipment for crystallization.

Module-IV **08 hrs**

Distillation: Vapor liquid equilibrium, boiling point diagram, relative volatility, flash and differential distillation for two component mixture, steam distillation, Rectification, reflux ratio, calculation, optimum reflux ratio, McCabe Thiele method for number of stage calculation, Fensky and Underwood equation for minimum numbers of plate calculation.

Module-V **08 hrs**

Humidification: General Theory, psychometric chart, fundamental concept humidification & dehumidification, construction & working of different types of cooling tower.

Drying:, Equilibrium mechanism of drying, various types of moisture in drying, drying rate curve, time of drying, drying equipments such as tray dryers, rotary dryers, drum and spray dryers.

Course Outcomes:

After completion of this course, the students are able to:

CO1: Knowledge about Importance of mass transfer operations.

CO2: Knowledge about interphase mass transfer concept of equilibrium.

CO3: To understands about basic mass transfer operation including gas absorption & crystallization.

CO4: Knowledge about concept of distillation. Evaluate the number of stages by Mc-Cabe-Thiele method.

CO5: Describe the concept of humidification and dehumidification. Discuss the different type of dryer used in process industries.

List of Experiments

1. To determine diffusion coefficient, or diffusivity, of given liquid (CCl4) in air.
2. To determine the mass transfer coefficient in gas liquid system by evaporation.
3. To study different types of plates and packing.
4. To prepare a calibration curve for methanol water by plotting refractive index as function of mole fraction at the ambient temperature
5. To analyze the performance of a Laboratory Scale Bubble Cap Column, to obtain a desired separation of an alcohol waste feed product
6. To study absorption of CO_2 in aqueous NaOH solution in a Packed bed column and gas phase mass transfer coefficient, KG a.
7. To study the yield of crystals of Sodium Sulfate (Na_2SO4) from its saturated solution using open tank type agitated batch crystallizer.
8. To study the performance of forced draft water-cooling tower.
9. To find the rate of drying for given porous / nonporous material
10. To study the yield of crystals of potassium nitrate (KNO3) from its saturated solution using Swenson walker crystallizer.

Text/Reference Book:

1. McCabe W.L., Smith J.C. and Harriott P. (2017) Unit Operations of Chemical Engineering", 7th Ed., McGraw Hill.
2. Coulson J. Richardson M., (2013) Chemical Engineering (5^{th} Edition) Vol 2; Oxford:Butterworth Heinmann.
3. Treybal R.E., (1981) Mass Transfer Operation (3^{rd} Edition), New York: Mc. Graw Hill
4. Dutta. B.K., (2007) Principles of Mass Transfer and Separation Processes (1^{st} Edition), Delhi:PHI Learning.

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Course Code	Semester	Course Title	Load	Credit
	VII	Chemical Technology	3L:0T::2P (05 hrs)	Credits:04

Course Objective: To Study the organic and inorganic process industries, involving process technology, raw material availability, production pattern.

Module-I **08 hrs**

Introduction: General Survey of Chemical Industries, Importance contribution to human life & classification of chemical industries. Carbohydrate Industries Manufacture of sugar and starches. Ethanol from molasses by fermentation.

Module-II **08 hrs**

Chlor-alkali Industries: caustic soda, chlorine, hydrochloric acid and potassium salts.
Phosphorus Industries: Phosphorus, Phosphoric acid, Phosphate fertilizers.
Mixed Fertilizers: SSP, TSP, and DAP.

Module-III **08 hrs**

Industrial gases: Nitrogen, Oxygen, Hydrogen, Helium and Argon,
Sulphur Industries: Sulphur dioxide, Sulphuric acid, Oleum.
Nitrogen Industries: Ammonia, Nitric acid, Urea.

Module-IV **08 hrs**

Oil & Fats Industries: Classification of oil & fats, Extraction of vegetable oil, Hydrogenation of oil, manufacture of soap and detergent, engineering problems of all such industries.

Module-V **08 hrs**

Pulp and Paper Industries Methods of pulp production, manufacture of pulp by Kraft process.
Cement Industries: Types of cement, classification of cement, manufacturing of cement & engineering problems related to cement industries.

Course Outcome

CO1: Ability to understand about various chemical industries
CO2: Ablity to understand general overview about chlor-alkali Industries
CO3: Ablity to understand general overview about Industrial gases.
CO4: Ability to describe the processing of Oil & Fats Industries.
CO5: Ablity to understand general overview about pulp and paper.

Text/Reference Book:

1. Dryden's Outline of Chemical Technology for the 21st Century, Third Edition.
2. Shreve's Chemical Process Industry, Fifth Edition.

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Course Code	Semester	Course Title	Load	Credit
	VIII	Chemical Reaction Engineering	4L:0T: (04 hrs)	Credits:03

Course Objective: To provide the comprehensive knowledge of reaction engineering and chemical Reactors.

Module I **8 hrs**

Introduction: Definition of reaction rates, variables affecting reaction rates, classification of reactions, order, molecularity. The Reaction Rate Constant, concept of kinetics, Concentration dependent term of a rate equation, temperature dependent term of a rate equation.

Module II **9 hrs**

Introduction to Reactor Design: Ideal reactors for single reaction: Ideal batch reactor, steady state Mixed Flow Reactor, steady state PFR, Holding time and space time for flow systems. Design for single reactions: Size comparison,

Module III **6 hrs**

Interpretation of Batch Reactor Data: Differential Method of Rate Analysis, Integral Method**.** Heterogeneous processes: Classification of catalysts, Preparation of catalysts, Promoters and Inhibitors, poisoning,

Module IV **07 hrs**

Design for Multiple Reactions: Parallel and series reactions, selectivity and yield factors, reactor choice for multiple reactions.

Module V **10 hrs**

Non-ideal Flow: Residence time distribution of fluids, General characteristics, Measurement of RTD, RTD in ideal reactor,

Course Outcomes:

After completion of this course, the students are able to:

CO1: Ability to define the classification of reaction, reaction rate and order of reaction.

CO2: Ability to know classification of reactors and to design isothermal and non-isothermal batch, CSTR, PFR reactors.

CO3: Ability to interpret integral and differential method of kinetic analysis.
CO4: Ability to describe multiple reactions in batch, CSTR, PFR reactors.
CO5: Ability to evaluate RTD characteristics, dispersion model, tank and series model.

List of Experiments:

1. To determine experimentally the reaction rate constant k or variation of concentration of NaOH with time in the isothermal semi batch reactor.
2. To determine the reaction rate constant for Saponification of ethyl acetate with NaOH at ambient conditions.
3. To plot the RTD curve for a packed bed reactor, using a pulse input as a tracer. To determine the Dispersion Number (D/uL).
4. To determine the reaction rate constant of a cascade of three equal volumes CSTR's in series for the Saponification of ethyl acetate with NaOH.
5. To study of a catalytic homogeneous reaction in a batch reactor under adiabatic condition.
6. RTD studies on a CSTR.
7. To study of a Non-catalytic homogeneous reaction in a coil type plug flow reactor under ambient Conditions & To determine the reaction rate constant for Saponification of ethyl acetate with NaOH at ambient temperature.
8. To study of Fluidized-Bed Reactors.

Text/Reference Book:

1. Levenspiel, O.,"Chemical Reaction Engineering" ,3rd ed.,Wiley & Sons, Singapore, 1999.
2. Fogler, H. S., "Elements of Chemical Reaction Engineering," 3rd ed., Prentice Hall of India, 2003.
3. Smith, J. M., "Chemical Engineering Kinetics", 3rd ed. McGraw Hill, 1981.
4. Richardson, J.F., and Peacock D.G., "Coulson and Richardson's Chemical
5. Engineering," vol. 3, 3rd ed., Asian Books Pvt. Ltd., New Delhi, 1998.