

INTRODUCTION TO CHEMICAL ENGINEERING

Course Title :	Introduction to Chemical Engineering	Course Code	CH-106
YEAR/Semester	I YEAR	Course Group	Core
Teaching Scheme in periods(L:T:P)	105:45:0	Credits	3
Methodology	Lecture + Tutorial	Total Contact Periods:	150 Pds
CIE	60 Marks	SEE	40 Marks

Prerequisites: This subject requires the knowledge of Physics, Chemistry and mathematics.

Course objectives:

To familiarize with the knowledge of importance of Chemical Engineering, Physico-chemical calculations and Material and energy balances, unit operations and processes, equipment for flow of fluids, chemical kinetics, measuring devices, natural resources and their utilization

COURSE OUTCOMES:

Upon completion of the course the student shall be able to

CO1	Explain the importance, scope, and applications of chemical engineering in various industries and describe the principles of unit operations and unit processes.
CO2	Apply principles of material and energy balances, gas laws, and stoichiometry to solve basic chemical engineering calculations.
CO3	Analyze the properties and behavior of fluids, fluid flow principles, pumps, valves, and flow measurement devices used in chemical industries.
CO4	Explain the mechanisms of heat transfer, laws of heat transfer, heat exchangers, and evaporation processes used in industrial applications.
CO5	Describe mass transfer operations such as distillation, drying, absorption, along with their industrial equipment.
CO6	Explain the principles of chemical kinetics, types of reactors, catalytic processes, natural resources, energy resources, furnaces, refractories, and nuclear energy systems.

Course Content and Blue Print of Marks for SEE

Unit No	Unit Name	Periods	Questions to be set for SEE				
			R		U	A	
1	Introduction	25	Q4	Q1		Q9(a)	Q13(a)
2	Material and Energy Balances	25					
3	Fluid Mechanics	25		Q2		Q10(a)	Q14(a)
4	Heat Transfer	25					
5	Mass Transfer	25		Q3	Q5,Q6	Q9(b), Q11(a), Q11(b)	Q14(b), Q15(a), Q15(b)
6	Chemical Kinetics & Natural Resources and their utilization	25					
Total		150	8		8	8	

COURSE CONTENTS:

UNIT-1 : Introduction:

Duration: 25 Periods (L:18-T:7)

Importance of Chemical Engineering- Chemical Engineering in everyday life, List of Industries of various fields of Chemical Engineering and their applications- Lab scale to plant scale, Versatility of a Chemical/Petrochemical Engineer, Role of Chemical Engineers in Petroleum refinery, Chemical, Petro chemical, Nanotechnology, Energy and environment. Batch Processing, Transition from batch to continuous processing, Case study: Any chemical industry, Role of basic sciences in Chemical Engineering (Introduction)

Definition of unit operation, types, Principles of Unit Operations like Filtration, Evaporation, Drying, Mixing, Crystallization, Distillation, Extraction,

Leaching, Adsorption, Absorption, Stripping-Discuss only the principle of unit operation -Definition of Unit Processes, types of unit processes, Principle of unit processes like Nitration, sulphonation, halogenation, oxidation, hydrogenation, hydrolysis and polymerization- Basic Laws of Chemical Engineering, their statements, mathematical expressions- Laws- Law of conservation of mass and energy, Steady state and unsteady state balance for mass and energy.

UNIT -II Material and Energy Balances: Duration: 25 Periods (L:15-T:10)

Units and dimensions - Dimensional formula of basic quantities, - Ideal gas laws, Dalton's law and Amagat's law. Differences between ideal gas and real gas - Gas laws and Ideal gas equation- Ideal gas constant in (lit atm/gmol K)- STP/NTP conditions. Material balance concepts, Material balance equations for some unit operations- Stoichiometry - application of stoichiometry equations , stoichiometric coefficients- Stoichiometric proportions.

Internal energy and enthalpy- Partial and Complete Combustion- Calorific value definition and its classification- example for values of calorific values of few fuels.

UNIT - III Fluid Mechanics Duration: 25 Periods (L:18-T:7)

State the importance of flow of fluids - Define a fluid and types of fluids- Newtonian fluids - Non-Newtonian Fluids with examples- Important physical properties of fluid and their units- Viscosity, density, Surface tension, Vapor pressure- List out different types of fluids based on physical properties- Fluid statics and principles of fluid statics- - Newton's law of Viscosity -Variation of pressure with depth of a fluid- Pascal's principle- Archimedes principle- Measurement of gauge pressure, absolute pressure - Fluid dynamics- Distinguish Laminar and turbulent flow- Importance of Reynold's number Continuity equation- Bernoulli's equation- Energies associated with a flowing

fluid - - Different types of valves and their functioning -. Working principles of Flow meters, Pumps. Classification of pumps

UNIT - IV Heat Transfer:

Duration: 25 Periods (L:18-T:7)

Introduction to heat transfer with examples-Steady state and unsteady state heat flow - Nature of heat flow-Mechanisms of heat flow - Conduction, convection and Radiation -Fourier's law of heat flow by conduction derivation -Thermal conductivity, its definition and units in SI system- - Natural convection and forced convection- dimensionless numbers- Heat Transfer to fluids without and with phase Change - Emission of Radiation and emissive power-Black body-Laws of radiation-Kirchoff's law, Stefan Boltzmann law, Plank's law, Wein's displacement law- Classification of heat exchangers based on flow path (parallel, counter and cross current flow) and fluid transfer (cooling tower and double pipe heat exchanger) - Evaporation-Different types of evaporators like natural circulation(Standard vertical tube evaporator}, and forced circulation evaporators with classification and examples.

UNIT - V Mass Transfer:

Duration:25 Periods (L:18-T:7)

Mass transfer operation-Process of diffusion-Process of molecular diffusion with example- Molar flux-Eddy diffusion-Fick's law of molecular diffusion-Chemical Equilibrium- Batch, continuous contact operations- Distillation and its block diagram with example -Drying operation and its block diagram with example -Absorption with examples-Stripping operation with examples- Extraction and leaching operations with example - Adsorption with examples-Types of adsorption- Crystallization operation and its block diagram with examples-Principles of crystallization. Distillation column- Absorbtion column- Equipment for mass transfer (Brief descrption)

UNIT VI : Chemical Kinetics & Natural Resources and their Utilization:

Duration: 25 periods (L-20 :T-5)

Chemical Kinetics:

Progress of a chemical reaction-Definition of rate of a reaction-Expression for rate of a reaction- factors effecting the rate of a reaction- rate constant dependent equation- Molecularity of a chemical reaction-Order of a chemical reaction – Differences between order and molecularity of a reaction- Collision theory- explain and differences between batch, semi-batch and continuous reactors, Catalysts- Role of a catalyst-List of catalysts-List of catalytic reactions -Characteristics of a catalyst-activity and selectivity.

Natural Resources and their Utilization: Renewable sources-Sources and applications of Renewable sources-Non-Renewable sources- Renewable Energy Resources -Solar Energy, Hydro power, Geothermal Energy, Wind Power, Tidal Energy, Biomass-Non- Renewable Energy Resources-classification of fuels basing on source (fossil, by- product, chemical and nuclear fuels)-classification of fuels based on state (liquid gas and solid), fuels classification based on primary and secondary fuels.

Furnaces-classification of furnace based on mode of operation (batch, continuous, direct and indirect heating furnaces with examples), Refractories –classification of refractories basing on their chemical nature, refractoriness and method of manufacture and Nuclear Energy.

Text books:

1. Introduction to Chemical Engg by Badger & Banchero
2. Introduction to Chemical Engg by S.K.Ghavane

Reference books:

1. Introduction to Chemical Engineering by Sanyal, Ghoshal and Dutta.
2. Unit operations in Chemical Engineering by Mc-Cabe, Smith and Harriot
3. Basics of Chemical Engg by K.A. Ghavane

Suggested Learning Outcomes

CO 1: Explain the importance, scope, and applications of chemical engineering in various industries and describe the principles of unit operations and unit processes.

1. Know the importance of Chemical Engineering.
2. Enlist industries of various fields of Chemical Engineering.
3. List industrial applications of various fields of Chemical Engineering.
4. Illustrate principle, types of Unit Operations with examples.
5. Illustrate the principle, types of Unit Processes with examples.
6. Understand the basic laws, statement of the laws, mathematical forms of the laws related to Chemical Engineering.
7. Transition from batch to continuous processing, Case study: Any chemical industry
8. List the useful mathematical methods of Chemical Engineering
9. Apprise the Scope of chemical engineering
10. State Laws of conservation of mass and energy

CO 2 : Apply principles of material and energy balances, gas laws, and stoichiometry to solve basic chemical engineering calculations

1. Know the list of Fundamental and Derived quantities.
2. Define atom, molecule, mole, gram-atom, gram-molecule, gram molar volume.
3. Define density and specific gravity, variation of density and specific gravity with temperature.
4. Know the kinetic theory of gases.
5. Know about gas laws
6. Know about ideal gas equation and ideal gas constant
7. Know about Stoichiometry, application of stoichiometry, Stoichiometric equations, Stoichiometric coefficients, and Stoichiometry proportions. Give suitable examples.
8. Explain the terms internal energy and enthalpy.
9. Know the terms sensible heat and latent heat.
10. Define a) Heat capacity and b) Specific heat.
11. Know different methods of expression concentration.
12. Know about partial and complete combustion.

CO 3: Analyze the properties and behavior of fluids, fluid flow principles, pumps, valves, and flow measurement devices used in chemical industries.

1. State the importance of flow of fluids.
2. Define a fluid and know about the types of fluids.
3. State the important physical properties of fluid and give their units.
4. List out different types of fluids based on physical properties.
5. Explain fluid statics and principles of fluid statics.
6. Explain Fluid dynamics and its significance.
7. State Newton's law of viscosity with mathematical expression.
8. Distinguish Laminar and Turbulent flow.
9. State the continuity equation.
10. Know the energies associated with a flowing fluid.
11. Apply Bernoulli's equation.
12. State the importance of Reynolds number.
13. List different types of valves and their applications with line diagrams.
14. Classify the pumps.
15. Discuss Functioning of pumps, Fan, Blower and compress, or with line diagrams and their uses.
16. Discuss measurement of flow rate and list devices to m
measure flow rate with line diagram.

CO4: Explain the mechanisms of heat transfer, laws of heat transfer, heat exchangers, and evaporation processes used in industrial applications.

1. Illustrate various mechanisms of heat flow such as conduction, convection and Radiation.
2. Define conduction, convection and Radiation.
3. Define steady state and unsteady state heat flow
4. Explain the Fourier's law of heat flow by conduction with mathematical expression.
5. Define natural convection and forced convection
6. Explain emission of radiation and emissive power.
7. Define black body and state laws of black body radiation.

8. Explain operation, classification of heat exchangers with line diagrams.
9. Explain about the operation of different types of evaporators with line diagrams.
10. Select a suitable heat exchanger and evaporator.

CO 5: Describe mass transfer operations such as distillation, drying, absorption, along with their industrial equipment

1. Define mass transfer operation and mention the applications.
2. Explain the process of molecular diffusion with examples.
3. State Fick's law of molecular diffusion, its equation.
4. Explain Eddy diffusion with examples.
5. Differentiate the batch, continuous contact operations.
6. Differentiate the co-current, counter-current contact and crosscurrent operations.
7. Illustrate about operation of distillation with examples and line diagrams.
8. Explain about operation of absorption and stripping with examples and line diagrams.
9. Explain extraction and leaching with examples and line diagrams.
10. Describe about the types and operation of adsorption with examples and line diagrams.
11. Describe the operation of drying with examples and line diagrams.
12. Illustrate the principles of crystallization, operation of crystallization with examples and line diagrams.

CO 6: Explain the principles of chemical kinetics, types of reactors, catalytic processes, natural resources, energy resources, furnaces, refractories, and nuclear energy systems.

1. Define the order of a chemical reaction/rate of reaction
2. Apprise the terms involved in the rate expression.
3. Define molecularity of a chemical reaction.
4. Define order of a chemical reaction.

5. Explain about collision theory.
6. Differentiate between batch, semi batch and continuous reactors
7. Enlist the catalysts and catalytic reactions.
8. Describe Characteristics of a catalyst-activity and selectivity

Natural Resources and their Utilization:

1. Define Renewable sources.
2. Enlist the Sources and applications of Renewable sources.
3. Define Non-Renewable sources
4. Enlist the Sources and applications of Non-Renewable sources.
5. Explain about different types of Renewable Energy Resources
6. Explain about different types of Non-Renewable Energy Resources.
7. Classify fuels and give examples
8. Classify furnaces
9. Classify Refractories based on nature
10. Apprise the importance of nuclear energy

CO- PO MAPPING matrix:

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11
CO1	3	2	1	1	2	1	2	1	1	1	1
CO2	3	3	2	2	1	1	2	-	-	1	1
CO3	3	3	2	2	2	1	1	-	1	1	1
CO4	2	3	2	2	2	1	2	-	-	1	1
CO5	3	2	2	2	2	1	2	-	1	1	1
CO6	3	2	2	1	3	2	3	1	1	1	2
Avg	3	2.5	1.83	1,67	2.0	1.17	2	0.33	0.67	1.0	1.17

MappingStrength:3=Strong|2=Moderate|1=Slight| Blank=No

Correlation

QUESTION PAPER PATTERN FOR MID SEMESTER EXAMS

MID-I Examination

S.No	Unit	Questions to be set for MID Exam			
		R	U	A	Remarks
1	UNIT-1	1, 2	5(a) 5(b)	7(a) 7(b)	
2	UNIT-2	3, 4	6(a) 6(b)	8(a) 8(b)	
Total Questions		4	4	4	

MID-II Examination

S.No	Unit	Questions to be set for MID Exam			Remarks
		R	U	A	
1	UNIT-3	1, 2	5(a) 5(b)	7(a) 7(b)	
2	UNIT-4	3, 4	6(a) 6(b)	8(a) 8(b)	
Total Questions		4	4	4	

Year End Examination (SEE)

S.N O	Unit No	Unit	Questions to be set for SEE				Remarks
			R		U	A	
1	1	UNIT-1	Q4	Q1	Q9(a)	Q13(a)	
2	2	UNIT-2					
3	3	UNIT-3		Q2	Q10(a)	Q14(a)	
4	4	UNIT-4					
5	5	UNIT-5	Q3	Q5,Q6	Q9(b),Q11(a), Q11(b)	Q13(b),Q15(a), Q15(b)	
6	6	UNIT-6		Q7,Q8	Q10(b),Q12(a) , Q12(b)	Q14(b),Q16(a), Q16(b)	
Total Questions			8		8	8	