GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3140411
Semester – IV
Subject Name: Chemical Engineering Fundamentals - I

Type of course: professional core course

Prerequisite: Fundamentals of mathematics and physics

Rationale: in chemical and allied industrial sector like biotechnology and biochemical an engineer must be well aware with basic chemical engineering calculations and fundamentals of momentum and heat transfer. Understanding of these concepts will help an engineer to design and troubleshoot process engineering equipments.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
	PART-A STOICHIOMETRY	
1.	**Dimensions and units:** Dimensions and system of units, fundamental and derived units, dimensional homogeneity in equations, dimensionless numbers and their significance, methods of dimensional analysis.	**04**
2.	**Basic chemical calculations:** Calculations for mole, molecular weight, equivalent weight, Composition of gaseous mixtures, liquid mixtures, solid mixtures, Dalton's law, Raoult's law, Henry's law.	**03**
3.	**Material balance** • *without chemical reactions:* Law of conservation of mass, setting up a process flowsheet, material balances with recycle, by-pass and purge streams, material balance around equipments related to unit operations like absorber and stripper, distillation towers, extractors, dryers, evaporators. • *Material balance involving chemical reactions:* Concept of limiting and excess reactants, percentage conversion yield, selectivity, Material balance with chemical reactions - single and multiple reactions.	**08**
4.	**Energy balances:** Heat capacity of gases and gaseous mixtures, liquids & solids, sensible heat change in liquids & gases, enthalpy changes without and with chemical reactions, heat of solution, mixing and adiabatic reactions.	**05**
	PART-B Fluid Flow Operation	
5.	**Fluid Statics and basic Concepts of fluid dynamics** Principle of hydrostatic equilibrium, decanters, manometers, Newton's law of viscosity and concept of viscosity, rheological classification of fluids, boundary layer theory, Reynolds number.	**05**
6.	**Flow of Incompressible fluids:** Equations of continuity, Bernoulli's equation and correction factors, Skin friction, Friction factor, kinetic and momentum correction factors, Hagen-Poiseulle's	**07**

	equation and pressure loss.	
7.	**Flow Past Solid Bodies:** Drag Force, drag co-efficient, Fluidization.	**02**
8.	**Transportation and Metering of Fluids:** Pipe fittings, Pumps and Pumping Problems, Venturimeter, Orifice meter, pitot tube, viscometers	**06**
PART-C Process Heat Transfer		
9.	**Modes of Heat Transfer:** Introduction to three modes of heat transfer: Conduction, Convection & Radiation, General laws of heat transfer.	**03**
10.	**Conduction** Fourier's law of conduction, Application of Fourier's law for plane wall, composite wall, cylinder, sphere. Heat transfer in case of simultaneous conduction & convection for plane wall & cylinder, unsteady state heat conduction, Concept of critical thickness of insulation.	**06**
11.	**Convection:** Natural convection & forced convection, Empirical equation for individual coefficients, significance of Prandtl No, Grashoff no, Nusselt no, peclet no.	**04**
12.	**Radiation:** Wave and Quantum theory of radiation heat transfer, Black body, Gray body, Transmissivity, Absorrtivity, Reflectivity, Emissivity, Stefan Boltzmann law, Wien's law, Kirchhoff's law.	**03**
13.	**Heat Exchangers :** Types of heat exchangers, Double pipe heat exchanger, shell and tube heat exchanger and plat type heat exchanger, LMTD, Heat transfer area requirement, Overall heat transfer coefficient.	**04**

R Level	U Level	A Level	N Level	E Level	C Level
13	**24**	**21**	**12**	**0**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Unit Operations of Chemical Engineering, McCabe W L, Smith J C, Harriott P, 7th Ed. McGraw Hill,
2. Bioprocess Engineering Principles', Doran P. M , 2nd Edition, Elsevier science and technology publication.
3. Heat Transfer, Kern D. Q., McGraw Hill
4. Stoichiometry, Bhatt B. I., Vora S. M., 4th Edition McGraw Hill Publishing Company Limited.
1. Basic Principles & Calculations in Chemical Engineering, Himmelblau D. M., Riggs J.. B., 7th Edition PHI Learing Pvt. Ltd.

Course Outcomes: At the end of the course, the students will be able to:

Sr. No.	CO Statement	Marks % weightage
1.	Understand fundamental concepts of chemical engineering calculations and unit operations.	25

2.	Solve material and energy balance for process engineering equipments`	10
3.	Understand the principles of continuity, momentum, and energy as applied to incompressible flow.	15
4.	Analyze the fluid flow in situations like presence of solid objects, machineries like pumps, compressors and metering devices.	20
5.	Understand the basic laws and modes of heat transfer and heat exchange equipments.	30

List of Experiments:

1. To verify Bernoulli's Theorem
2. To calibrate Venturi meter, Orifice meter and Rota meter and obtain it's coefficient of discharge
3. Study of Pressure measurement devices
4. To study Reynolds's Experiment Apparatus
5. Study of Shell & Tube heat exchangers
6. To study finned tube heat exchanger
7. To study Plate type heat exchanger
8. To study Thermal conductivity metal rod
9. To study Emissivity measurement.

Assignments can also be given based on numerical of stoiciometry`

List of Open Source Software/learning website:

- NPTEL lecture series
- Literature available on momentum, heat and mass transfer
- MIT Open course lecture on Transport Processes