GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3133606
Semester – III
Subject Name: Fundamentals of Material & Energy Balance Calculations

Type of course: Professional Core Course

Prerequisite: Basics of Mathematics and Chemistry

Rationale: The main objective of course is to make a clear conceptualized knowledge regarding various unit operations carried out in Chemical Engineering. This will provide a background for applying these principles to industrial problems

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	1	0	5	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs
1	**Units & Dimensions:** Dimensions & system of units, Fundamental and derived units, Unit conversion and its significance.	03
2	**Basic Chemical Calculations** Concepts of atomic weight, equivalent weight and mole. Composition of solids, liquids and solutions (weight percent, mole percent, molarity, normality etc.), other expressions for concentration, Average molecular weight and density, Gaseous mixtures, Ideal gas laws, Real gas laws and their applications, Raoult's law, Henry's law, Amagat's Law & Dalton's law	08
3	**Material Balance without Chemical Reactions:** Process flow sheet, Material balance with and without recycle; Bypass, Purge streams, Material around equipments related unit operations like absorber and stripper, Distillation towers. Extractors. Dryers, Evaporators, Crystallizers, Humidification and dehumidification towers. Material balance of unsteady state operations.	08
4	**Material balances with Chemical reaction:** Concept of limiting and excess reactants, percentage conversion and yield. Material balance involving reactions with special reference to fertilizers, petrochemicals, dyestuffs, electrochemical industries. Complex material balances	10
5	**Energy balances:** Heat capacity of gases and gaseous mixtures, liquids & solids, Sensible heat change in liquid & gases, enthalpy changes during phase transformation, enthalpy changes accompanied by chemical reactions, standard heat of reaction, Hess's law, Adiabatic	08

	reactions, Theoretical Flame temperature	
6	**Fuel & Combustion** Types of fuels, calorific value of fuels, liquid fuels, gaseous fuel etc. Proximate and ultimate analysis, combustion calculations, Air requirement and flue gases.	**08**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**10**	**20**	**20**	**20**	**20**

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. Basic Principles & Calculations in Chemical Engineering, D.M.Himmelblau. 6th Ed., 2004
2. Stoichiometry, B.I.Bhatt&Thakore, Tata McGraw Hill Book Company, 5th Ed, 2010
3. Chemical Process Principles, Vol.1, O.A.Hougen, K.M.Watson, R.A.Ragatz., Indian print, CBS Publishers, 2nd Ed., 1995
4. Stoichiometry & Process Calculations, Narayanan K.V., &Lakshmikutti B., Prentice Hall, 2006
5. Process Calculations, V Venkataramani and N Anantharaman, PHI Learning, 2004
6. Chemical Process Calculations Manual, David Carr Igbinoghene, McGraw Hill Professional, 2004
7. Optimization of Chemical Processes, T F Edgar, D M Himmelblau and L S Lasden, Tata McGraw Hill, 2001

Course Outcomes:

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	To identify different system of units and dimensions with conversion	7
CO-2	To distinguish concepts for expressing compositions and behaviour of different gases and solutions.	18

CO-3	To demonstrate material balance in steady and unsteady state unit operations with and out recycle.	18
CO-4	To analyze Material balance involving Chemical reactions in fertilizer, petrochemicals, dyestuff and electrochemical industries.	21
CO-5	To describe energy changes in liquid and gases accompanying various chemical reactions with terms used to associate energy changes in different phases.	18
CO-6	To evaluate fuel quality and to device requirement of gases in combustion.	18

List of Open Source Software/learning website:

- Reference to NPTEL lectures can be made for a better understanding regarding various unit operations.