GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Subject Code: BE03044031

Branch: Chemical Engineering (Green Technology and Sustainability Engineering)

Course/Subject Name: Engineering Principles of Material & Energy Balances

w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	Professional Core

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

Course Outcome:

After Completion of the Course, Student will able to:

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 recycles.	21
CO-4	To analyze Material balance involving Chemical reactions in fertilizer, petrochemicals, dyestuff and electrochemical industries.	18
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

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
60	15	0	45	120	04	70	30	0	30	0	130

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

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Course Content:

Sr. No.	Content	Total Hrs
1	**Units & Dimensions:** Dimensions & system of units, Fundamental and derived units, Unit conversion and its significance, Dimensional consistency, Dimensional Equations	04
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 and its applications, Raoult's law, Henry's law, Amagat's Law & Dalton's law, Humidity and Saturation	12
3	**Material Balance without Chemical Reactions:** Introduction, Process flow sheet, solving material balance problems without chemical reactions of unit operations like Absorption and Stripping, Distillation, Extractions and Leaching, Drying, Evaporation, crystallization, Mixing/Blending, etc., Material balance of unsteady state operations, Material balance with and without recycle; Bypass and Purge streams.	14
4	**Material balances with Chemical reaction:** Concept of limiting and excess reactants, percentage conversion, selectivity 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, dissolutions of solids, Adiabatic reactions, heat of solution by partial molar quantities	10
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.	10

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	**20**	**30**	**10**	**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. 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

List of Open Source Software/learning website:

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

- **List of suggested activities for Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
5.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
6.	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
7.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
8.	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
9.	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.

Note:

- All the suggested activity should be related to the subject.

- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request. •
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective recordkeeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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