GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Chemical Engineering
Subject Code : BE03005031
Subject Name : Material and Energy Balance Computation

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

Prerequisite:	Basics of Mathematics and Chemistry
Rationale:	This subject's main objective is to teach the basic calculations required for the chemical processes that take place in the fertilizer, dye, petrochemical, speciality chemical industries. The subject imparts knowledge about the basic concepts required to prepare chemical process flow sheets.

Course Outcome:

After completion of the course, students will be able to:

No	Course Outcomes
01	Interpret different system of units with conversion and to develop fundamental concepts and basic chemical engineering principles
02	Apply the principles of material balance for chemical plant having different unit operations and unit processes
03	Evaluate the fundamentals of energy balance including thermal properties estimation for unit operations and unit processes of chemical industries.
04	Analyze quality of different types of fuel (Solid, Liquid and Gas)

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	20	30	00	150

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.**

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Units & Dimensions:** Dimensions & system of units, Fundamental and derived units, Unit conversion and its significance, Dimensional consistency, Dimensional Equations	4	5
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	10	10
3.	**Material Balance without Chemical Reactions:** Introduction, Process flow sheet such as process flow diagram, process block diagram, P&ID diagram, solving material balance problems without chemical reactions of unit operations, Material balance of unsteady state operations, Material balance with and without recycle; Bypass and Purge streams.	10	20
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	15
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	20
6.	**Stoichiometry and Unit Operations:** Distillation, Absorption & Stripping, Extraction & Leaching, Crystallization, Psychrometric operations, Psychrometric chart for air–water system, Drying, Evaporation etc.	8	15
7.	**Fuel & Combustion** Types of fuels, calorific value of fuels, Problems on combustion of coal (NCV, GCV etc,) Dulong Formula, Calderwood Equation examples, liquid fuels, gaseous fuel etc. Proximate and ultimate analysis, combustion calculations, theoretical flame temperature, Air requirement and flue gases, Boiler material and energy balance calculations.	8	15
	Total	60	100

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**15**	**25**	**15**	**25**	**---**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per 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 the above table.

References/Suggested Learning Resources:

(a) Books:

1. Stoichiometry, B.I.Bhatt, Suchen Thakore & Dr Satish R Shah ,McGraw Hill Book Company, 6th Ed, 2021
2. Basic Principles & Calculations in Chemical Engineering, D.M.Himmelblau. 6th Ed., 2004
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

(b) Open source software and website:

1. Students can refer to video lectures available on the websites including NPTEL.

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

Activity	No. of hours	Total hours claimed	Evaluation Criteria
Technical video demonstration based on subject content and learning related to the content	Duration of video 5h Report preparation 5h	10	Report /presentation based on the video learning outcomes.
Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each.	10	Based on the assignment submitted.

Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding-based assignments of 2 h each.	10	Based on the coding solution submitted.
Self-learning on-line course related to the subject	Minimum duration of the course should be 10h.	10	Examination based assessment at the end of course. Based on the certificate produced.
Complex problem solving of real industrial problem	Maximum 1problems. Study of the problem and solution finding, Problem related to industrial mass and energy balance of the plant.	10	Based on the depth of the solution submitted.
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 (5 h)	20	Based on evaluation of critical problems and solutions
Poster/Chart/PowerPoint preparation on technical topics	Poster/Chart/Power point preparation and presentation	10	Based on poster/chart preparation and presentation skills
Real world case studies-based learning	Duration of data collection/study 5h Report preparation 5h	10	Based on in-depth study, technical depth, data collected, fact finding, etc.
Technical Video Preparation related to subject	Preparation of content 5 h Video Preparation and upload at department/college website 5h	10	Based on the quality of the video prepared by student

- Above activities are suggestive, faculty can choose any of these activities and cover up the rest of the Self Learning Hour.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, the total number of hours is fixed.
- 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 record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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