B. Tech. Semester III

Subject Name: Basic Calculation in Chemical Engineering **Subject Code:** BTCH13302

Type of course: PCC

Prerequisite (if any): 12th Standard Mathematics, Chemistry, Physics, Applied Mathematics – I, Organic Chemistry – I, Applied Physics – I, Analytical Chemistry.

Rationale: This is a basic Chemical Engineering Course later on concept of it will be necessary for all the subject of chemical engineering.

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	
3	0	2	4	60	25	15	30	20	150

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	**Introduction to Chemical Engineering:** Chemical Process Industries, Chemistry to Chemical Engineering. **Introduction to process calculation:** Concept of Unit: Fundamental & Derived Dimensional Consistency, Different ways of expressing units of quantities & physical constant Unit conversion & its significance. Introduction to block diagram, PFD and P&ID.	6	13%
2.	**Basic Chemical Calculations:** Mole concept, Calculation of mole, molecular weight, equivalent weight etc. Composition relationship and Stoichiometry, Behaviour of gases and vapors, Composition of gaseous mixture, liquid mixture, solid mixture.	7	15%
3.	**Material Balance without chemical reaction:** Material balance around equipment: Evaporator, Extractors, Distillation, Absorber, dryer, Mixing. Humidification, Use of Psychrometric charts and determination of humidity.	8	18%
4	**Material Balance with chemical reaction & Recycle Operations** Concept of limiting and excess reactant, Yield, Conversion, Selectivity etc. Material balance involving reactions with special reference to fertilizers, petrochemicals, combustion. Importance of Purge, Bypass and Recycle streams, Calculation based on purge, bypass & recycle stream in process.	8	18%
5	**Introduction to Energy Balances:**	8	18%

	Energy Balances in systems with and without reactions. First law of thermodynamics and its application. Heat capacity of gases & gaseous mixtures, Heat capacity of liquids and solids Equation of state, Enthalpy changes accompanying chemical reaction: Heat of reaction, Heat of formation, Heat of combustion, Heat of mixing, Dissolution of solids etc. Various examples to calculate heat change with or without phase change.		
6.	Types of fuels, calorific value of fuels, liquid fuels, gaseous fuel etc. Proximate and ultimate analysis.	4	9%
7.	Material and Energy Balances for multistage processes and complete plants	4	9%

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**20**	**25**	**25**	**10**	-

Legends: R: Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **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 Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1	Stoichiometry	Bhatt B.I, S B. Thakore, S.R.Shah	McGraw Hill Company	2021	6th Edition
2	"Stoichiometry and Process Calculations"	K.V. Narayanan, B. Lakshmikutty	Prentice-Hall of India Pvt. Ltd.,	2006	4th Edition
3	Process Calculations	V Venkataramani and N Anantharaman	PHI Learning,	2011	2nd Edition

Course Outcome:

Sr. No.	CO Statement After learning this subject, students will be able to	Marks % weightage
CO-1	Interpret a fundamentals of the basic principles related to basic chemical unit operation and calculations.	10
CO-2	Comprehend the mole concept and perform calculations involving concentration expressed as mass and molar concentration	18
CO-3	Apply the gas laws to solve problems related to ideal gases and mixtures and perform calculations on vapor gas systems.	18
CO-4	Establish mathematical methodologies for the computation of material balances without chemical reaction and recycle.	18
CO-5	Establish mathematical methodologies for the computation of material balances with chemical reaction, recycle and bypassing.	18

CO-6	Establish mathematical methodologies for the computation of energy balance.	18

Mapping with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO-1	3	3	3	1	1	2	2	3	3	3	2	2	2	2	2
CO-2	3	3	3	3	3	2	3	3	2	2	2	2	2	2	2
CO-3	3	3	3	3	3	2	3	3	2	2	2	2	2	2	2
CO-4	3	3	3	3	3	2	3	3	2	2	2	2	3	3	3
CO-5	3	3	3	3	3	2	3	3	2	2	2	2	3	3	3
CO-6	3	3	3	3	3	2	3	3	2	2	2	2	3	3	3
Rationale *	**18**	**18**	**18**	**16**	**16**	**12**	**17**	**18**	**13**	**13**	**12**	**12**	**15**	**15**	**15**

Rationale*: Explaining why it is matching this particular program outcome

LIST OF PRACTICALS: (Minimum 10 performed.)

1. Convert the unit form from SI to FPS unit system.
2. Convert the Empirical equation from FPS to SI unit system.
3. Evaluation of molecular weight, equivalent weight.
4. Find molar and mass composition of the given solid mixture.
5. Find molar and mass composition of the given Liquid mixture.
6. Find molar and mass composition of the given gaseous mixture.
7. Calculate the average molar mass and density of gaseous mixture at NTP and STP and given Temperature.
8. Material balance across the different unit operation used in chemical industries.
9. Material balance across the Chemical Reactor.
10. Energy balance across the different unit operation used in chemical industries.
11. Material balance across the Chemical Reactor.
12. Material balance of Total Flow sheet.
13. Energy balance of Total Flow sheet.
14. Use of software's (Such as Excel, Sci Lab, Aspen plus etc.) to carryout Material and Energy Balance.

Reference Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1	Basic Principles and Calculations in Chemical Engineering,	Himmelblau	Pretice Hall	2004	6th Edition
2	Chemical Process Principles,	Hougen O.A., Watson K. M.	Indian print, CBS Publishers,	1995	2nd Edition
3	Industrial Stoichiometry	W. K. Lewis, A. H. Radaxh & H. C. Lewis	McGraw Hill Kogakusha Co.		2nd Edition
4	Elementary Principles of Chemical Processes	Richard M. Felder, Ronald W. Rousseau.	Wiley	2005	4th edition,
5	Optimization of Chemical Processes	T F Edgar, D M Himmelblau and L S Lasden	Tata McGraw Hill	2001	3rd

List of Open Source/learning website:

- https://nptel.ac.in/courses/103/103/103103165/
  - Detail of coverage as per syllabus
- https://www.digimat.in/nptel/courses/video/103103165/L01.html
  - Detail of coverage as per syllabus
- https://onlinecourses.nptel.ac.in/noc20
  - Detail of coverage as per syllabus