Syllabus for Bachelor of Technology
Chemical Engineering

Subject Code: 01CH1302

Subject Name: Chemical Process Calculations

B.Tech. Year: 2 (Semester III)

Objective: To make student aware about material and energy balance which can be used to solve the real chemical engineering problem.

Credits Earned: 4 Credits

Course Outcomes: After completion of this course, student will be able to:

1. Understand the concepts of dimensional consistency and effective application of units and dimensions.
2. Apply the energy balance concept to calculate the heat of reaction.
3. Find out quantity of material input and outputs of various unit operations.
4. Carry out combustion calculations, proximate analysis and ultimate analysis

Pre-requisite of course: None.

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	IA (I)	CSE (C)	Viva (V)	Term work (TW)	
3	1	0	4	50	30	20	25	25	150

Contents:

Unit	Topics	Contact Hours
1.	**Introduction to Basic Chemical Calculations** Units and dimensions, concept of mole, atomic mass & molar mass, density and specific gravity, Equivalent Mass, Mole Fraction, Composition of mixtures, methods of expressing compositions of mixtures and solutions: concentration, Molarity, Normality, Molality, Gases: Vapour Pressure, Dalton's law of partial pressures, Ideal Gas law, Equation of state, Introduction to psychometric charts.	10
2.	**Material Balances with and without Chemical Reactions** Fundamentals of Material Balance calculation, Material Balance without chemical reaction: drying, mixing, crystallization, membrane separation, and extraction & distillation. Fundamentals of recycle bypass and purge streams.	10

	Fundamentals of Limiting Reactant, Excess Reactant, Conversion, Selectivity, Yield. Material balances for systems involving chemical reactions. Recycling, Parallel & Bypass operations.	
3.	**Energy Balance** Heat capacity, Heat and Latent Heats, Standard Heat of Combustion, Temperature Dependence of ΔH^{o}, Empirical equations for heat capacities; Mean heat capacities of gases, Sensible, Enthalpy calculations, Heat of Formation, Hess's Law, calculation of the standard heat of reaction from heats of formation.	8
4.	**Fuels and Combustion** Fuel types, Calorific value of fuels, Calculations based on coal combustion, liquid fuels, gaseous fuels, etc., Proximate and ultimate analysis, Combustion as a case of material balance with reactions, Combustion products analysis, Excess air calculation.	10
	Total Hours	38

List of Tutorials:

1. Numerical based on empirical equations of Molarity, Molality, Normality.
2. Numerical based on mass fraction, mole fraction, unit conversion, volume composition.
3. Numerical based on Psychometric charts.
4. Numerical based on material balance of chemical processes such as drying, mixing, separation processes.
5. Numerical based on material balance of chemical reactions, conversion, limiting reactant, excess reactant, yield.
6. Numerical based on chemical processes with reaction such as bypass operation, parallel operation.
7. Numerical based on heat of reaction, formation, combustion etc.
8. Numerical based on Heat capacity, Enthalpy, Heat of Formation and Hess's Law.
9. Numerical based on coal combustion and Proximate and ultimate analysis of Coal.

References:

1. "Basic Principles & Calculations in Chemical Engineering", David M. Himmelblau, James B. Riggs, PHI Learning Pvt. Ltd, 7th edition, 2006.
2. "Stoichiometry", B.I. Bhatt, S.M. Vora, McGraw Hill Publishing Company Limited, 4th edition, 2004.
3. "Chemical Process Principles Part-I: Material and Energy Balances", O. A. Hougen, K. M. Watson, R. A. Ragatz, CBS Publishers New Delhi, 2nd edition, 2004.

4. "Stoichiometry and Process Calculations", K.V. Narayanan, B. Lakshmikutty, Prentice-Hall of India Pvt. Ltd., 2006.

Suggested Theory distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember	Understand	Apply	Analyze	Evaluate	Create
20%	30%	20%	20%	10%	-

Instructional Method:

a. The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
b. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.
c. Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
d. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory

Design Based Problems (DP)/ Open Ended project (OEP) :

In the beginning of the session, subject faculty will allot an OEP / DP to the students. Students will be free to choose a topic of their choice which will be relevant to the syllabus and they will either prepare a working model/ report / presentation / poster on their topic.

Web Resources:

a. https://nptel.ac.in/courses/103103165
b. https://nptel.ac.in/courses/103105209
c. https://www.coursera.org/lecture/intro-chemistry/intro-stoichiometry-part-i-chemical-formulas-FcCWs