GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

INDUSTRIAL STOICHIOMETRY

(Code: 3330504)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	3rd Semester

1. RATIONALE

Industrial Stoichiometry provides the fundamental information to determine the material and energy balances for all types of unit operations and unit processes across the equipment and overall chemical plant. Material and energy balance calculations are of prime importance for design and also for conservation of mass and energy to reduce the losses and cost that enhances overall economy of plant. The unit conversions, material and energy balance are the essential part in the practice of other courses such as mechanical operations, fluid flow, heat Transfer, mass transfer etc. Thus this course is a core course for chemical engineers and should be learned sincerely by students.

2. COMPETENCY (Programme Outcome according to NBA Terminology):

The course should be taught and implemented with the aim to develop different types of skill so that students are able to acquire following competency:

- **Determine material and energy balance for different unit operations and processes.**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	100
3	2	0	5	70	30	00	00	

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

4. COURSE DETAILS

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – I Unit Systems	1a. Explain importance of process calculation	1.1 Introduction to process calculation
	1b. Define different unit systems	1.2 Dimensions and systems of units 1.3 Fundamental quantities of units, Derived quantities
	1c. Explain the importance of physical quantities of Units.	1.4 Definition and units of force, volume, pressure, work, energy, power, heat
	1d. Convert units among different systems	1.5 Unit conversions in FPS, MKS and SI systems
Unit– II Basic Chemical Calculations	2a. Calculate important physical quantities	2.1 Definition and calculations of mole, atomic weight, molecular weight, equivalent weight, specific gravity and API gravity
	2b. Calculate composition of mixtures and solutions	2.2 Composition of solid, liquid by weight % and mole % 2.3 Morality, normality, morality, gm/lit and related simple numericals
Unit– III Ideal Gas Law	3a. Derive ideal gas law. 3b. State reference conditions	3.1 Concept of ideal gas 3.2 Derivation of ideal gas law 3.3 Definition of STP and NTP 3.4 Dalton's law and Amagat's law
	3b. Calculate important quantities for ideal gas mixture	3.5 Derive relation between mole%, volume% and pressure% of ideal gases 3.6 Calculation of average molecular weight, density, mole%, weight% in gas mixture in SI/MKS systems
Unit– IV Material Balance In Processes Without Chemical Reactions	4a. Explain law of conservation of mass	4.1 Law of conversation of mass
	4b. Calculate mass balance of important unit operations at steady state condition	4.2 Brief description and simple material balance calculation of drying, distillation, absorption, mixing, crystallization, evaporation 4.3 Single stage material balance calculation of leaching and extraction
	4c. Describe recycling and by passing operations	4.4 Brief idea regarding recycling and by passing operation
Unit– V Material Balance In Processes	5a. Explain basic concepts of material balance with chemical reaction	5.1 Definition: Limiting reactant, Excess reactant, conversion, yield and selectivity

Unit	**Major Learning Outcomes (**Course Outcomes in Cognitive Domain according to NBA terminology)	**Topics and Sub-topics**
Involving Chemical Reactions	5b. Calculate mass balance with chemical reaction	5.2 Simple numerical for finding yield, conversion and composition 5.3 Simple calculation of material Balance based on reaction.
Unit– VI Energy Balance	6a. Calculate heat capacity, specific heat, heat capacity of gas mixture and liquid mixture	6.1 Heat capacity and specific heat 6.2 Mean heat capacity of gases 6.3 Heat capacity of gas mixture and liquid mixture 6.4 Calculations of heat capacity by integral equation up to three terms
	6b. Explain concepts of sensible heat and latent heat	6.5 Brief explanation of sensible Heat and latent heat of fusion, sublimation, vaporization
	6c. Calculate standard heat of formation and heat of reaction	6.6 Calculations of standard heat of formation from heat of combustion data 6.7 Calculations for heat of reaction from heat of formation and heat of combustion data
Unit– VII Combustion	7a. Describe combustion	7.1 Introduction of combustion
	7b. Describe calorific values	7.2 Types of fuels 7.3 Calorific values of fuels 7.4 Proximate and ultimate analysis of solid fuel
	7c. Calculate calorific value and air requirement for combustion	7.5 Numericals related to calorific values of fuel from composition 7.6 Numericals related to air Requirement and composition of flue gases.

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Unit Systems	3	2	2	2	06
II	Basic Chemical Calculations	5	2	2	4	08
III	Ideal Gas Law	5	2	2	4	08
IV	Material Balance in Process without Chemical Reactions	8	0	6	7	13
V	Material Balance in Process Involving Chemical Reactions	7	2	3	7	12
VI	Energy Balance	8	2	4	8	14
VII	Combustion	6	2	2	5	09
Total		**42**	**12**	**21**	**37**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised 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.

6. SUGGESTED LIST OF PRACTICAL/EXERCISES

Not Applicable

7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities: Tutorials, group assignments based on mass and energy balance of equipments like heat exchanger, boilers, distillation column, evaporator, dryer, reactors, absorption column, Use of MS-Excel in solving numerical.

8. SPECIAL INSTRUCTIONAL STRATEGY (If Any)

i. More numerical examples should be discussed in the class to make concepts clear. Home Assignment should given to students on similar type of numerical for more practice.
ii. Video lecture from NPTEL websites may be shown to class for better understanding of the concepts.
iii. Video/animation films may be shown for explaining abstract concepts.
iv. Quizzes may be organised in the class by dividing it into groups to create an environment of competition.
v. Tutorial sessions may be organised as given in following table

Sr. No.	Unit No.	Topics/Sub Topics on which Numerical may be given during Tutorial Sessions	Approx. Hrs. Required
1	I	Systems of Units and Conversions	02
2	II	Numericals based on composition of mixtures and solutions	03
3	III	Numericals based on Ideal gas law and calculation of composition of gas mixture	03
4	IV	Numericals based on mass balance for important unit operations	06
5	V	Numericals based on mass balance involving chemical reactions	04
6	VI	(a) Numericals based on heat capacity and heat change (b) Numericals based on heat of formation and heat of reaction	06
7	VII	Numericals on calorific values of fuel, theoretical air requirement and composition of flue gases	04
		Total	**28**

9. SUGGESTED LEARNING RESOURCES

A. List of Books:

S. No.	Title of Books	Author	Publication
1	Stoichiometry	Bhatt B. I. and Vora S. M.	Tata-McGraw Hill, New Delhi, Year-2007
2	Process Calculation	Gavhane K. A.	Nirali Prakashan, Pune, Year-2012
3	Basic Principles and Calculations in Chemical Engineering	Himmelablau David M.	PHI Learning, New Dehli, Year-2003

B. List of Major Equipment/Materials

Nil.

C. List of Software/Learning Websites

i.Basic Principles & Calculations in Chemical Engg (CD Rom)
ii.www.ocw.mit.edu

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. Harsh B. Shukla**, Lecturer in Chemical Engineering, Shri K.J. Polytechnic, Bharuch
- **Prof. Rakesh R. Vasava**, Lecturer in Chemical Engineering, Shri K.J. Polytechnic, Bharuch
- **Prof. Mukesh B. Dhangar**, Lecturer in Chemical Engineering, Shri N. G. Patel Polytechnic, Isroli-Afwa

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof Bashir Shaikh**, Assistant Professor, Department of Applied Sciences.
- **Prof Shashi Kant Gupta,** Professor and Coordinator for State of Gujarat