

# GUJARAT TECHNOLOGICAL UNIVERSITY

## ENVIRONMENTAL SCIENCE AND TECHNOLOGY (35)

Fundamentals of Stoichiometry

**SUBJECT CODE:** 2143507

B.E. 4<sup>th</sup> SEMESTER

**Type of course:** Environmental Science and Technology

**Prerequisite:** Linear Algebra, Chemistry

**Rationale:** After learning the course the students should be able:

- To deal with the basic calculations used in the industries e.g. the unit conversions of temperature, pressure, concentrations etc.
- To understand the stoichiometry and its basic terms like conversion, yield and selectivity.
- To apply material and energy balance in unit operation and unit process of environmental science and technology.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		PA (V)		PA (I)		
PA	ALA	ESE		OEP						
3	1	0	4	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

**Content:**

Sr. No.	Topic	Teaching Hours	Module Weightage (%)
1	<b>Units and conversions</b> <ul style="list-style-type: none"><li>• Dimensions and Systems of units,</li><li>• conversions</li></ul>	2	10
2	<b>Basic Definition and terminologies</b> <ul style="list-style-type: none"><li>• Mole, Atomic mass, Molar mass, Equivalent mass, solids, liquids, solution (Normality, morality etc.),</li><li>• Temperature, Pressure, Basis,</li><li>• The chemical equations and Stoichiometry</li><li>• Vapour pressure and liquids, saturation, Vapour-liquid equilibria</li><li>• Calculations based on ideal gas laws and other equations of state</li></ul>	9	10

3	<b>Material Balances without reaction</b> <ul style="list-style-type: none"> <li>• Simple Material balances, recycling, bypassing and purging operations without reaction,</li> <li>• Material balance involving Condensation and vaporization, partial saturations and humidity</li> <li>• Material balance calculations for unit operations such as distillation, crystallizations, evaporations, gas absorption, adsorptions etc.</li> <li>• Material balances of Unsteady state operation</li> </ul>	10	20
4	<b>Material balances involving reactions</b> <ul style="list-style-type: none"> <li>• Material balances involving reactions such as water softening reactions,</li> <li>• Electrochemical reactions,</li> <li>• Recycling, bypassing and purging calculations (with reaction)</li> </ul>	9	20
5	<b>Energy Balance without Reaction</b> <ul style="list-style-type: none"> <li>• Energy balance for open and closed system</li> <li>• Enthalpy changes</li> <li>• Heat of mixing</li> <li>• Humidity charts and their use</li> </ul>	9	20
6	<b>Energy balance with reaction</b> <ul style="list-style-type: none"> <li>• The standard heat of reaction, The standard heat of formation, Energy balance with reaction</li> <li>• Hess's law of constant heat summation</li> <li>• Effect of temperature on standard heat of reaction</li> <li>• Adiabatic reaction temperature (flame temperature)</li> </ul>	9	20

#### Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
17	41	24	10	8

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate 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:

- Basic Principles & Calculations in Chemical Engineering ,D.M.Himmelblau.,6th Ed., 2004
- Stoichiometry, B.I.Bhatt & Thakore ,Tata McGraw Hill Book Company, 5th Ed ,2010
- Chemical Process Principles, Vol.1, O.A.Hougen, K.M.Watson, R.A.Ragatz., Indian print, CBS Publishers,2nd Ed., 1995
- Stoichiometry & Process Calculations, Narayanan K.V., & Lakshmikutti B., Prentice Hall, 2006
- Process Calculations, V Venkataramani and N Anantharaman, PHI Learning, 2004
- Chemical Process Calculations Manual, David Carr Igbino ghene, Mc Graw Hill Professional,2004

- Optimization of Chemical Processes, T F Edgar, D M Himmelblau and L S Lasden, Tata Mc Graw Hill, 2001

### **Course Outcome:**

After learning the course the students should be able to:

- To express concentration of pure component & mixture of gases and liquids.
- To carry out material and energy balance calculations of relevance processes taking place in the industry.
- Present an overview of industrial processes.
- Develop a fundamental understanding of the basic principles of environmental processes and calculations.
- Examine and select pertinent data, and solve material and energy balance problems.
- Give examples of important application of material balances in Environment science and technology.
- Evaluate their own solutions and those of others to find and correct errors.

### **Design based Problems (DP)/Open Ended Problem:**

Students are free to select any area of science and technology based on environment science and technology applications to define Projects.

Some suggested projects are listed below:

- Carry out material balance and energy balance of any one of the existing lab equipment.
- Use Microsoft Excel (or similar spreadsheet tool) to carry out material and energy balance for a given problem by teacher. Students should prepare a flowsheet using an open source flow-sheeting tool for example Microsoft visio.

### **List of Open Source Software/learning website:**

- 1) NPTEL
- 2) MIT Open course lecture available on Internet etc...
- 3) Delnet

### **ACTIVE LEARNING ASSIGNMENTS:**

Preparation of power-point slides, which include videos, animations, Pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus is covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three Works should be sent to achievements@gtu.edu.in.