



# GUJARAT TECHNOLOGICAL UNIVERSITY

**Bachelor of Engineering**

**Subject Code: 3150506**

**Semester – V**

**Subject Name: Chemical Process Plant Design & Economics**

**Type of course:** Humanities and social science

**Prerequisite:** Basic Concepts of material and energy balance, fluid flow operations and unit process and chemical technology.

## **Rationale:**

This course brings together the concepts of engineering and economics with special reference to chemical process and plant design along with the hierarchy of decisions in synthesis and analysis of a chemical process and its alternatives. This course is intended to challenge chemical engineer to combine basic technical principles learned in other courses in the general curriculum with practical elements of economics, business practices and organization along with principles of safety, environmental and sociological issues to design an integrated chemical process plant.

## **Teaching and Examination Scheme:**

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
3	0	0	3	70	30	0	0	100

## **Content:**

Sr. No.	Content	Total Hrs
1	<b>Introduction and Process design aspects:</b> Basic design, optimization, selection of process-factors affecting process selection. Types of project design, Importance of Laboratory development pilot plant, safety factors, types of flow diagrams.	6
2	<b>Selection of process equipments:</b> Standard versus special equipment-material of construction for process equipments, selection criteria, and specification sheets.	4
3	<b>Process auxiliaries and Process utilities:</b> Piping design, layout, and supports for piping insulations. Pipe fittings, types of valves, selection of valves, process control and instrumentation control system design. Process water, boiler feed water, water treatment, waste treatment and disposal, disposal, steam, oil heating system, chilling plant, compressed air and vacuum	6
4	<b>Plant location and layout:</b> Factors affecting plant location, factors in planning layouts, principles of plant layout, Unit plot plan, vertical and horizontal lay out	4
5	<b>Cost estimation:</b> Cash flow and cumulative factors affecting estimation of investment and production cost, breakeven point and its significance, total capital investment, fixed and working capital investment & their estimations, type of estimates, cost indexes, method for	5



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	estimating capital investment. Simple and compound interest.	
6	<b>Estimation of total product cost:</b> manufacturing cost, general expenses, Manufacturing cost: direct production cost, fixed charges, plant overhead cost.	5
7	<b>Depreciation:</b> Types of depreciation, Method for determining depreciation: straight line method, decline balance method, sum of the year digit method, shrinking fund method etc, single unit and group depreciation, adjustment of depreciation account, evaluation of depreciation methods	5
8	<b>Profitability, alternative investments and replacement:</b> Methods for profitability evaluation, Evaluation of Break Even Point, % rate of return, Practical factors in alternative investment and replacement Studies.	5
9	<b>Project management:</b> Planning of project schedule by BAR CHART, Inventory control scheduling a project using CPM/PERT methods.	5

### Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	26	23	7		

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

1. Peters, Max S., K.D. Timmerhaus and R.E. West, Plant Design and Economics for Chemical Engineers (5th Ed), McGraw-Hill International Editions (Chemical Engineering Series), New York, USA (2003).
2. Douglas, James M., Conceptual Design of Chemical Processes, McGraw-Hill International Editions (Chemical Engineering Series), New York, USA (1988).
3. Biegler, L.T., I.E. Grossmann and A.W. Westerberg, Systematic Methods of Chemical Process Design, Prentice Hall (Pearson Education), New Jersey, USA (1997).
4. Mahajani, V.V., Chemical Project Economics, Macmillan Indian Ltd., New Delhi, India (2005).
5. Smith, R., Chemical Process: Design and Integration, John Wiley and Sons, West Sussex, UK (2005).



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6. Coulson and Richardson's Chemical Engineering, Vol. 6: Chemical Engineering Design. By R.K. Sinnott, Butterworth-Heinemann, Oxford, 3rd, Ed., 1999, 1994

**Course Outcomes:** At the end of the course, the students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	State the basic concepts of economics, selection of equipment, process plant design and project management.	25
CO-2	Discuss Plant auxiliaries, process utilities, plant location and layout	20
CO-3	Calculate capital investment, total product costs, break even analysis and depreciation.	30
CO-4	Explain alternative investment, replacements and profitability analysis.	25

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

NPTEL lecture series Literature available on Plant design and project Economics

Suggested activities/mini-project on plant design and cost estimation:

The plant design project involves a small group of students working as a team to design a nominated chemical manufacturing plant. The tasks include the study of the available processes, process selection, calculation of material and energy balances, preparation of flow sheets, design of selected plant items, an assessment of factors affecting plant safety, sustainability and environmental impact, estimation of plant cost and process economics, preparation of a design report and drawing of the plant layout.