



# GUJARAT TECHNOLOGICAL UNIVERSITY

**Bachelor of Engineering**

**Subject Code: 3170516**

**Semester – VII**

**Subject Name: Process Auxiliaries and utilities**

**Type of course:** Open Elective

## **Rationale:**

Process auxiliaries and utilities involve the understanding of designing the process plants or creating design layouts of plant. It also includes the fundamentals of chemical engineering viz. development of flow diagrams, importance of various design consideration, various utility systems, and key selection considerations during the development and design of any process. This subject is intended to familiarize students with the basics as well as advanced understanding of various process auxiliaries and utilities used in chemical plant and how they integrate with the process facilities and overall operation.

## **Teaching and Examination Scheme:**

Teaching Scheme			Credits C	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.	Contents	Total Hrs
1	Process Auxiliaries: Basic considerations and flow diagrams in chemical engineering plant design. Piping design: Selection of material, pipe sizes, working pressure, basic principles of piping design, piping drawings, pipe installations, overhead installations, Process steam piping, selection and determination of steam – pipe size, Piping insulation, application of piping insulation, weather proof and fire resisting pipe insulation jackets, piping fittings, pipe joints	07
2	Valves: Types of valves, selection criteria of valves for various systems. Pumps: Types of pumps, NPSH requirement, pump location, pump piping, pump piping support.	07
3	Process Utilities: Process Water: Sources of water, hard and soft water, Requisites of industrial water and its uses, Methods of water treatment, Chemical softening, Demineralization, Resins used for water softening, Water for boiler use, cooling purposes, cooling towers, drinking and process water treatment, reuse and conservation of water, waste water treatment and disposal.	06
4	Process heating systems using steam, hot oil, glycol and water, Steam generation and its application in chemical process plants, distribution and utilization, boilers, design of efficient steam heating systems, steam economy, condensate utilization, steam traps, their characteristics, selection and application, waste heat utilization. Process cooling systems, process drains-open and closed. Non-steam heating system: Thermic fluid heater, Down	06



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	therm heater, Temperature range, Principle, construction & working.	
5	Air: Air compressors, Vacuum pumps, Air receivers, Distribution systems, Different types of ejectors, Air dryers	06
6	Compressors and Vacuum Pumps: Types of compressors and vacuum pumps and their performance characteristics, Methods of vacuum development and their limitations, materials handling under vacuum, lubrication and oil removal in compressors and pumps, instrument air.	07
7	Refrigeration and Chilling systems. Oil heating systems, Nitrogen systems, utilities energy consideration and utilities management issues.	06

### 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
07	21	21	07	14	--

**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. Steam generators and waste heat boilers for process and plant engineers, V Ganapathy, CRC Press, Taylor & Francis Group.
2. Process Utility Systems: Introduction to Design, Operation, and Maintenance, Jack Broughton, IChemE, UK
3. Plant design and Economics for Chemical Engineers, Max S Peters, Klaus D Timmerhaus, Ronald E West. Mc Graw Hill 5<sup>th</sup> Edition.
4. Process plant layout and piping design, Ed Bausbacher & Roger Hunt, PTR Prentice Hall, UK
5. Efficient Use of Steam, Oilver Lyle Prentice Hall 1963

**Course Outcomes:** After learning the course the students should be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	To understand the importance of process auxiliaries and utilities in a	20



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	chemical industry.	
CO-2	To acquire an overview of key selection considerations of plant utilities	35
CO-3	To understand how the utilities could be integrated with the process facilities and overall operation.	20
CO-4	To understand basic calculation involved in the steam generation, psychometric operation and refrigeration	25

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

- Students can refer to the video lectures available on the websites including NPTEL lecture series.
- Students can refer to the CDs available with some reference books for the solution of problems using software/spreadsheets. Students can develop their own programs/spreadsheets for the solution of problems.
- MIT Open course lecture on Equipment design.
- Literature available for Process design of equipment in plant / industry.