GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Chemical Engineering

Course / Subject Code: DI01005011

Course / Subject Name: Plant Utilities

w. e. f. Academic Year:	2024-25
Semester:	1st
Category of the Course:	PCC

Prerequisite:	NA
Rationale:	Diploma chemical engineer has to ensure smooth and proper operation of utilities and auxiliaries' plants such as steam, compressed air, instrumental air, inert gases, DM water and chilled water. These utilities are essential for manufacturing different chemical products. Use of concept of energy efficiency and green chemistry are necessary for energy conservation in chemical plant for producing materials of desired quality and to maintain plant safety. Hence the course has been design to develop these competencies And its associated cognitive and effective domain learning outcomes.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Select Various Methods For Water Softening And Purification.	R
02	Explain Different Types of Steam Generators and Compressors along with their components.	U
03	Explain different methods of Refrigeration for Various Applications.	U
04	Apply concepts of energy efficiency and green chemistry for conservation of utilities.	A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
4	0	0	4	70	30	0	0	100

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
Unit-1 Water as Basic Utility	1.1 List and use of various utilities in chemical plant 1.2 Sources of water 1.3 Impurities in water 1.4 Hard & Soft water 1.4.1 Causes of hardness 1.4.2 Disadvantages of hard water 1.4.3 Measurement of hardness 1.5 Boiler Feed water and demineralized water 1.6 Methods of water softening processes 1.6.1 Lime soda process (Hot &Cold) 1.6.2 Zeolite process 1.6.3 Ion exchange process 1.6.4 Phosphate process 1.7 Characteristics of drinking water 1.8 Purification of water 1.8.1 Screening 1.8.2 Sedimentation 1.8.3 Coagulation 1.8.4 Filtration 1.8.5 Sterilization 1.9 Conventional techniques 1.9.1 Sterilization by chlorine 1.9.2 Sterilization using bleaching powder 1.9.3 Sterilization by chloramines solution 1.10 Green techniques 1.10.1 Sterilization using UV rays 1.10.2 Sterilization using Ozone 1.11 Treatment to boiler feed water for prevention of 1.11.1 Formation of scale 1.11.2 Corrosion 1.11.3 Priming and foaming 1.11.4 Caustic embrittlement	20	35%
Unit – II Steam, Air	2.1 Use of Steam, Air & Inert Gasses utilities 2.2 Properties of steam	20	42%

&Inert Gases	2.2.1 Enthalpy 2.2.2 Wet steam 2.2.3 Saturated Steam 2.2.4 Superheated steam 2.2.5 Specific volume of steam 2.3 Steam Generator : Classification, comparison 2.4 Factors affecting selection of Boiler 2.5 Explain boiler Accessories and mountings 2.5.1 Air Pre heater 2.5.2 Water level indicator 2.5.3 Fusible plug 2.5.4 Super heater 2.5.5 Economizer 2.5.6 Steam trap 2.6 Explain construction and working of 2.6.1 Lancashire boiler 2.6.2 Locomotive boiler 2.7 Utility air 2.7.1 Compressed Air 2.7.2 Blower Air 2.7.3 Fan Air 2.7.4 Instrumental air 2.8 Types of Air compressors 2.8.1 Reciprocating Air compressors 2.8.2 Rotary compressors 2.9 Energy efficient air compressor 2.9.1 Multistage compressors 2.9.2 Advantages of multistage compressor 2.10 Comparison of Reciprocating, Rotary vane, Rotary screw and Centrifugal type of Air compressor 2.11 Inert gas - Nitrogen, Argon		
Unit – III Refrigeration	3.1 Concept of refrigeration 3.2 Methods of Refrigeration 3.2.1 Ice refrigeration 3.2.2 Evaporative refrigeration 3.2.3 Vapor compression refrigeration 3.2.4 Vapor absorption refrigeration 3.2.5 Steam-jet refrigeration system 3.3 Explain COP and TOR	20	23%

	3.4 Classification of refrigerants 3.4.1 Primary 3.4.2 Secondary 3.5 Types of Primary Refrigerants 3.5.1 Halo Carbons (Freon of Different type) 3.5.2 Azeotropes 3.5.3 Hydrocarbons 3.5.4 Inorganic compounds 3.5.5 Unsaturated organic compounds 3.6 Types of secondary Refrigerants 3.6.1 Water 3.6.2 Brine 3.7 Explain various properties desirable in an ideal refrigerant 3.7.1 Thermodynamic properties 3.7.2 Safe working properties 3.7.3 Physical properties 3.7.4 Selection of Refrigerants		
	Total	**60**	**100**

Suggested Specification Table with Marks (Theory):

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Water as Basic Utility	20	10	10	5	25
II	Steam, Air & Inert Gases	20	10	10	9	29
III	Refrigeration	20	5	6	5	16
Total		**60**	**25**	**26**	**19**	**70**

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
36%	37%	27%	-	-	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Chemical Plant Utilities	Sathiyamoorthy-Manickkam	Lambert Academic Publishing; India, 2016, ISBN: 978-3-659-97828-9
2	Unit operation of Chemical Engineering	McCabe, Warren L., Julian C. Smith	McGraw Hill Publication; New York,7th Edition, 2004
3	Plant utilities	D. B. Dhone	Nirali Prakashan; Pune, 2ndEdition, 2012
4	Power Plant Engineering	P.K. Nag	McGraw Hill Education; India,4th edition, 2017, ISBN: 978-9339204044
5	Thermal Engineering	R.S. Khurmi, J. K. Gupta	S. Chand Publishing; India, 2008, ISBN: 9788121925730
6	Thermal Engineering	R.K. Rajput	Laxmi Publications; India, 11thedition,

(b) Open source software and website:

1. https://nptel.ac.in/courses/112/107/112107291/
2. https://www.thermodyneboilers.com/economisers/
3. https://www.steamtrapefficiency.com/wp-content/uploads/BITHERM-STEAM-MANUAL.pdf
4. http://www.silbert.org/MSA_WT_Manual.pdf
5. http://ppuchem.blogspot.in/2013/02/unit-1-notes.html
6. https://booksite.elsevier.com/samplechapters/9780080966595/Chapter_3.pdf

Suggested Project List:

A suggestive list of Projects is given here. This has to match the competency and the COs. Similar micro- projects could be added by the concerned course teacher:

PROJECT 1: Identify sources of water at your college premises and measure the following physical properties.

- Measure temperature of water.
- Measure TDS of water.
- Measure pH of water.
- Measure turbidity of water.

PROJECT 2: Perform basic treatment techniques for purification of water.

PROJECT 3: Prepare 15-20 slides presentation showing classification of refrigeration & refrigerants.

Suggested Activities for Students:

Other than the classroom and laboratory learning, following are the suggested student- related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

- Undertake micro-projects in team/individually.
- Encourage Students for creating and designing water treatment processes using waste materials.
- Students are encouraged to register themselves in various **MOOCs** such as: **Swayam, edx, Coursera, Udemy** etc. to further enhance their learning.

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