GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Plant Utilities
(Course Code: 4330505)

Diploma programmer in which this course is offered	Semester in which offered
Plant Utilities	Third

1. 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.

2. COMPETENCY

The course should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following competency:

- **Use different utilities in chemical process plants for various applications.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Select Various Methods For Water Softening And Purification.
b) Explain Different Types of Steam Generators and Compressors along with their components.
c) Select Refrigeration For Various Applications.
d) Apply concepts of energy efficiency and green chemistry for conservation of utilities.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	0	2	30	70	0	0	100

(*): For this practical only course, 50 marks under the practical CA have two components i.e. the assessment of micro-project, which will be done out of 10 marks and the remaining 15

marks are for the assessment of practical. This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	Not applicable		

Note

i. More ***Practical Exercises*** *can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. Care must be taken in assigning and assessing study report as it is a first year study report. Study report, data collection and analysis report must be assigned in a group. Teacher has to discuss about type of data (which and why) before group start their market survey.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipments with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical's in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	**Not applicable**	

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Follow ethical practices.
b) Practice good housekeeping.
c) Demonstrate working as a leader/a team member during brain storming.

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.

iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major Underpinning Theory is formulated as given below and only higher level UOs of *Revised Bloom's taxonomy* are mentioned for development of the COs and competency in the students by the teachers. (Higher level UOs automatically include lower level UOs in them). If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application level)	Topics and Sub-topics
Unit – I Water as Basic Utility	1.a Explain role of Utilities in Chemical Plant 1.a.1 List various utilities in chemical plant & uses 1.b List sources of Water 1.c Differentiate types of Water 1.d Compare Softening processes of water 1.e Explain the process of Purification of water. 1.f Classify conventional and green techniques for sterilization of water.	1.1 List and use of various utilities in chemical plant 1.2 Sources of water 1.3 Hard & Soft water 1.4 Boiler Feed water and demineralized water 1.5 Methods of water softening processes 1.5.1 Lime soda process (Hot & Cold) 1.5.2 Zeolite process 1.5.3 Ion exchange process 1.5.4 Phosphate process 1.6 Purification of water 1.6.1 Screening 1.6.2 Sedimentation 1.6.3 Coagulation 1.6.4 Filtration 1.6.5 Sterilization 1.7 Conventional techniques 1.7.1 Sterilization by chlorine 1.7.2 Sterilization using bleaching powder 1.7.3 Sterilization by chloramines solution 1.8 Green techniques 1.8.1 Sterilization using UV rays 1.8.2 Sterilization using Ozon

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application level)	Topics and Sub-topics
Unit – II Steam, Air & Inert Gases	2.a Explain uses of utilities like Steam, Air & Inert Gases 2.b Define properties of steam 2.c Label the different part of steam generator 2.d Classify steam generator 2.e Compare steam generators 2.f List the Factors affecting selection of Boiler 2.g Describe boiler accessories and mountings for improving efficiency and conservation of energy. 2.h Discuss utility air 2.i Describe the working principle, application of Air compressors – 2.i.1 Explain energy efficient alternative 2.j Describe properties of Inert gases	2.1 Use of Steam, Air & Inert Gases as utilities 2.2 Properties of steam 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 , components, steam handling, condensate removal 2.4 Factors affecting selection of Boiler 2.5 Boiler Accessories and mountings 2.5.1 Air Pre heater 2.5.2 Super heater 2.5.3 Economizer 2.5.4 Steam trap 2.6 Utility air 2.6.1 Compressed Air 2.6.2 Blower Air 2.6.3 Fan Air 2.6.4 Instrumental air 2.7 Types of Air compressors 2.7.1 Reciprocating Air compressors 2.7.2 Rotary compressors 2.8 Energy efficient air compressor 2.8.1 Multistage compressors 2.9 Inert gas - Nitrogen, Argon
Unit – III Refrigeration	3.a Explain the working principle of Refrigeration 3.b Distinguish methods of Refrigeration 3.c Describe and TOR of refrigeration 3.d Use primary and secondary Refrigerants and list out green refrigerants 3.d.1 Explain advantages of green refrigerants over conventional refrigerants	3.1 Concept of refrigeration 3.2 Methods of Refrigeration 3.2.1 Ice Refrigeration 3.2.2 Evaporative Refrigeration 3.2.3 Vapor Refrigeration System 3.3 TOR of refrigeration 3.4 Types of Primary Refrigerants 3.4.1 Ammonia 3.4.2 Halo Carbons (Freon of Different type) 3.4.3 HFC (Hydro Fluorocarbon) 3.5 Types of secondary Refrigerants 3.5.1 Water 3.5.2 Brine 3.6 Selection of Refrigerants

***Note**: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Water as Basic Utility	10	10	10	6	26
II	Steam, Air & Inert Gases	12	10	10	9	29
III	Refrigeration	6	4	6	5	15
Total		**28**	**24**	**26**	**20**	**70**

10. SUGGESTED STUDENT ACTIVITIES

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:

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

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Guide student(s) in undertaking micro-projects.
b) Diagnosing Essential Missed Learning concepts that will help for students to improve their performance.
c) Guide Students to do Personalized learning so that students can understand the course material at his or her pace.
d) Encourage students to do Group learning by sharing so that learning can be enhanced.
e) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods. Guide students on addressing the issues on environment and sustainability using the knowledge of this course.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project is group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop- based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the microproject should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

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

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

1. Measure temperature of water.
2. Measure TDS of water.
3. Measure pH of water.
4. Measure turbidity of water.

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

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

13. SUGGESTED LEARNING RESOURCES

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; NewYork, 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,

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
			2020, ISBN: 978-8131808047

14. SOFTWARE/LEARNING WEBSITES

a. https://nptel.ac.in/courses/112/107/112107291/
b. https://www.thermodyneboilers.com/economisers/
c. https://www.steamtrapefficiency.com/wp-content/uploads/BITHERM-STEAM-MANUAL.pdf
d. http://www.silbert.org/MSA_WT_Manual.pdf
e. http://ppuchem.blogspot.in/2013/02/unit-1-notes.html
f. https://booksite.elsevier.com/samplechapters/9780080966595/Chapter_3.pdf

15. PO-COMPETENCY-CO MAPPING

Semester-III	Plant Utilities (Course Code: 4330505)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ develop-ment of solutions	PO 4 Engineering Tools, Experimen-tation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Manage-ment	PO 7 Life-long learning
Competency	***Use different utilities in chemical process plants for various applications.***						
Course Outcomes CO a) Select Various Methods For Water Softening And Purification.	3	2	2	1	2	1	2
CO b) Explain Different Types of Steam Generators and Compressors along with their Components.	2	1	-	-	1	1	1
CO c) Select Refrigeration For Various Applications.	3	1	2	-	2	2	3
CO d) Apply concepts of energy efficiency and green chemistry	3	2	2	1	3	2	3

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
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