Program Name : **Diploma in Chemical Engineering**

Program Code : **CH**

Semester : **Third**

Course Title : **Plant Utility**

Course Code : **22311**

1. RATIONALE

Diploma Chemical Engineers have to use various plant utilities like water, air, steam, refrigerant and thermic fluid in different industrial processes. The important utilities required for process plant are water, steam, air and refrigerants. Steam and non steam heating media are important for conversion of raw materials to required product in reactor and to increase or elevate the temperature in chemical processes. Refrigeration is important to maintain the required temperature in process plant. Compressed air, process air are used in processes and instrument air is used in Pneumatic devices and controls. This course is designed to provide basic understanding about the various plant utilities and their applications for process industries.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

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

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Use different water treatment methods for boiler feed water.
b. Use steam generators and non steam heating systems in chemical process industries.
c. Use industrial air in chemical process industry.
d. Apply refrigeration in various chemical engineering processes.
e. Use Humidification and dehumidification processes for air in chemical industries.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	2	--	6	3	70	28	30*	00	100	40	--	--	--	--	--	--

(*): Under the theory PA, out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs;.

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

5. COURSE MAP(with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

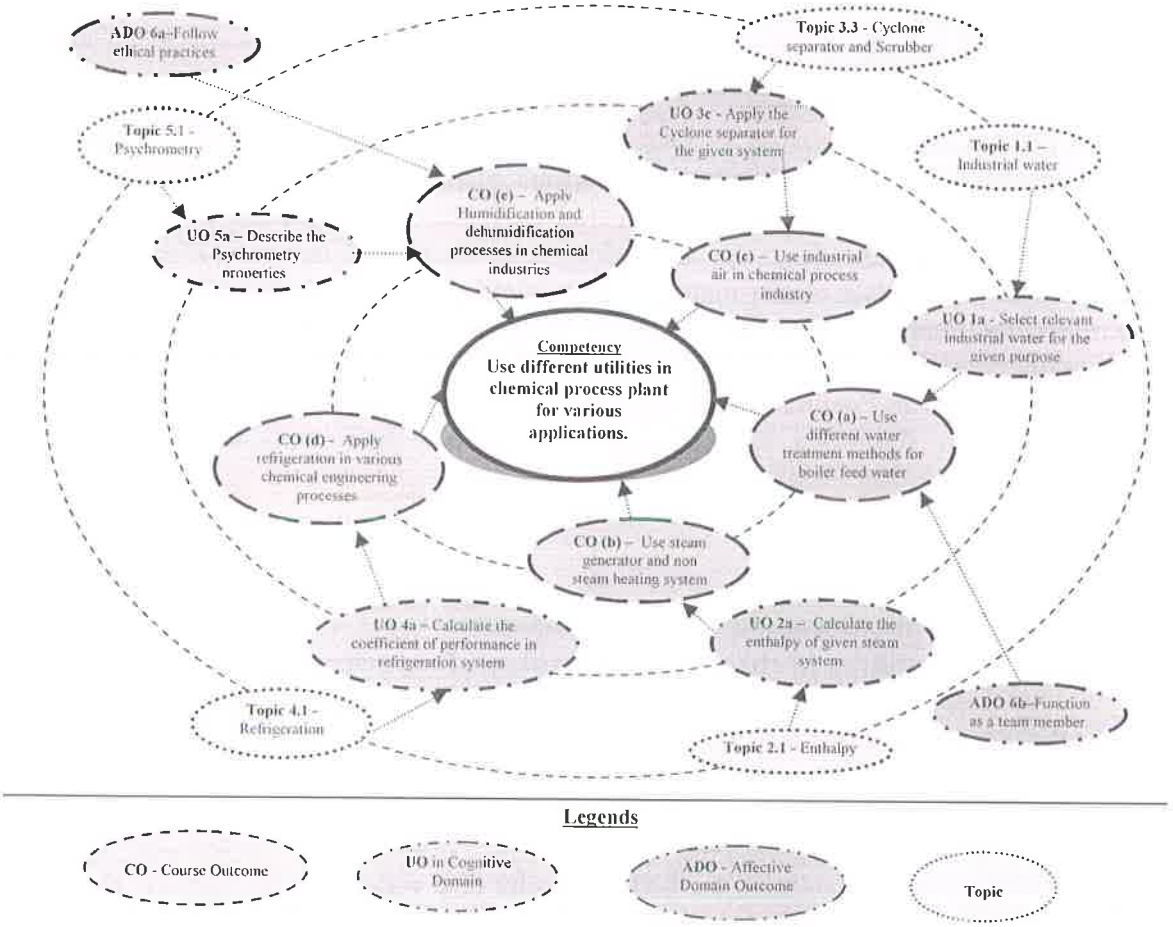

Figure 1 - Course Map

6. SUGGESTED TUTORIALS

S. No.	Tutorial	Unit No.	Approx. Hrs. Required
1	List different sources and characteristics of water.	I	2
2	Determine Temporary hardness of water.	I	2
3	Determine Permanent hardness of water.	I	2
4	To read/interpret different properties of steam using steam table.	II	2
5	Determine enthalpy of wet and dry steam using steam table	II	2
6	Classify boilers based on different parameters.	II	2
7	Differentiate steam heating and non steam heating system.	II	2
8	List different types of boiler mountings with their applications.	II	2
9	List different types of boiler accessories with their applications.	II	2
10	Differentiate single and multistage compressor.	III	2
11	Draw vapour compression refrigeration cycle.	IV	2
12	Draw vapour absorption refrigeration cycle.	IV	2

S. No.	Tutorial	Unit No.	Approx. Hrs. Required
13	Numerical on Calculation of refrigeration effect.	IV	2
14	Numerical on Calculation of coefficient of performance	IV	2
15	Determine humidity by using Psychrometric chart	V	2
16	Calculate dry bulb and wet bulb temperature using psychrometric chart.	V	2
			32

Note: The above tutorial sessions are for guideline only. The remaining tutorial hours are for revision and practice

The above tutorials also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
e. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED:

- Not applicable –

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Industrial Water	1a. Select relevant industrial water for the given purpose. 1b. Calculate the hardness of the given water sample. 1c. Identify various boiler problems due to the given boiler feed water. 1d. Apply the lime soda method of water softening for the given hard water.	1.1 Industrial water: definition, properties and uses 1.2 Hard water, Hardness, Total hardness, permanent hardness, temporary hardness, Numericals. 1.3 Boiler feed water, Scale and sludge formation , Corrosion, Priming and Foaming , Caustic Embrittlement 1.4 Water treatment: Lime Soda Process. Ion Exchange Process, Zeolite Method.
Unit– II Steam, Steam Generators and Non Steam Heating System	2a. Calculate the enthalpy of the given steam system. 2b. Apply the relevant steam for the given system. 2c. Implement boiler act in the given industries.	2.1 Enthalpy: definition, formula, numerical. 2.2 Steam Types: Wet, Dry, Superheated, Saturated and Unsaturated Steam. 2.3 Steam boilers: Classification, construction and working of Bab-Cock and Wilcox, Lancashire, Waste heat and Fluidized bed boilers. 2.4 Boiler mountings and accessories: Water level indicator, Pressure gauge, Steam trap, Pressure reducing valve, Economizer, Preheater, Super heater. 2.5 Boiler Act: Indian boiler act and duties of boiler inspector
	2d. Select relevant thermic fluid for the given temperature range. 2e. Apply the Thermic fluid heater for the given system.	2.6 Thermic fluid: Definition, properties. 2.7 Types of thermic fluid and temperature range. 2.8 Thermic fluid heater: Construction and working difference with steam boiler.
Unit– III Industrial Air	3a. Identify relevant type of industrial air for the given system. 3b. Identify relevant air compressors for the given process. 3c. Apply the Cyclone separator for the given system. 3d. Apply relevant air purifier for the given system.	3.1 Industrial Air: Definition, types and application, compressed air, process air and instrumental air. 3.2 Compressor: definition, types, uses, Single and multistage compressor. 3.3 Cyclone separator and Scrubber: construction, working and uses. 3.4 Air dust collectors, electrostatic precipitator

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-IV Refrigeration	4a. Calculate the coefficient of performance in the given refrigeration system. 4b. Apply the reverse Carnot cycles for the given system. 4c. Describe with sketches the refrigerant cycle for the given application. 4d. Identify relevant refrigerant for the given system with justification.	4.1 Refrigeration: Definition, unit of refrigeration, coefficient of performance. 4.2 Refrigeration cycles: Reversed Carnot cycle, representation on PV and TS diagram. 4.3 Air refrigeration cycle: Bell Coleman air refrigeration cycle. 4.4 Vapor compression and absorption cycle: Li-Br absorption system 4.5 Refrigerants: Classification, selection criteria and applications.
Unit –V Psychrometry	5a. Identify the Psychrometry properties in the given system with justification. 5b. Apply relevant air condition equipments for the given system. 5c. Solve numerical using the given psychrometric chart. 5d. Select the relevant cooling tower for the given situation with justification.	5.1 Psychrometry: definition, dry bulb temperature, wet bulb temperature, numerical, psychrometric chart, humidity. 5.2 Air condition equipments: Principle, construction and working of humidifier, dehumidifier. 5.3 Cooling Towers: Principle, construction and working of induced draft and forced draft.

***Note**: To attain the COs and competency, above listed Unit Outcomes (UOs) need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Industrial Water	14	04	04	08	16
II	Steam, Steam Generators and Non steam heating system.	20	04	06	10	20
III	Industrial Air	08	02	04	04	10
IV	Refrigeration	12	02	04	06	12
V	Psychrometry	10	02	04	06	12
	Total	**64**	**14**	**22**	**34**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

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 conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Identify related engineering problems with the use of free tutorials available on the internet.
b. Use Steam table and Psychrometric chart.
c. Visit nearby industry to study steam generation by boiler.
d. Participate in seminar on relevant topic.

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. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the LOs/COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.

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 are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, 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 total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. **Industrial water softening Report:** Prepare report on water softening methods used by different industries.
b. **Model preparation:** Prepare model displaying the Mountings on various types of the boiler.
c. **Chart preparation:** Prepare charts displaying the accessories used by various industries for boiler.

d. **Identification of refrigerants**: Prepare the list of different refrigerants with specific use in process industry.
e. **Listing of non steam heating systems:** Collect information regarding different Non-steam heating fluids used in industry.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Thermal Engineering	Balleney, P.L	Khanna Publication, New Delhi 1975 ISBN 9788174090317
2	Industrial Water Treatment.	Powel, S.T	Mc Graw Hill, New York. 2009, ISBN 9781118843727
3	Engineering Chemistry	Jain and Jain	Dhanpatrai Publications, New Delhi, 2008, ISBN-9788121903455
4	Refrigeration: Theory and Applications	James K. Carson	McGraw Hills Edition, New York 2011, ISBN: 978-87-403-0363-6
5	A Textbook of Refrigeration & Air Conditioning	Rajput, R.K.	S K Kataria & Sons, New Delhi, 2003 ISBN13: 9789350142554

14. SOFTWARE/LEARNING WEBSITES

a. https://www.swtc.edu/ag_power/air_conditioning/lecture/basic
b. www.boiler.guide
c. www.aquascience.net
d. www.idc-online.com/technical_references/pdfs
e. www.sciencedirect.com
f. www.scopeus.com