Program Name : **Diploma in Chemical Engineering**

Program Code : **CH**

Semester : **Sixth**

Course Title : **Piping in Chemical Engineering (Elective-II)**

Course Code : **22612**

1. RATIONALE

Piping in chemical industries focuses on piping materials, color coding, piping insulation, installation, leak testing and others. This course also helps student to become conversant with related manufacturing codes and standards of process piping e.g. ASME, API, BS, IS and others. This course has been so designed that the chemical engineering technologists will be able to maintain piping systems for various chemical engineering processes.

2. COMPETENCY

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

- **Maintain piping system for trouble free functioning in chemical plants.**

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) Select the relevant pipes for various chemical processes as per standards.
b) Identify significant material of pipe for various chemical processes.
c) Choose relevant insulation material and accessory for piping system.
d) Identify relevant leak testing and heat tracing methods for various chemical processes.
e) Interpret piping drawings for maintenance.

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
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA is for micro-project assessment to facilitate attainment of COs and the remaining 20 marks is for tests and assignments given by the teacher.

***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, Learning Outcomes i.e. LOs 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.

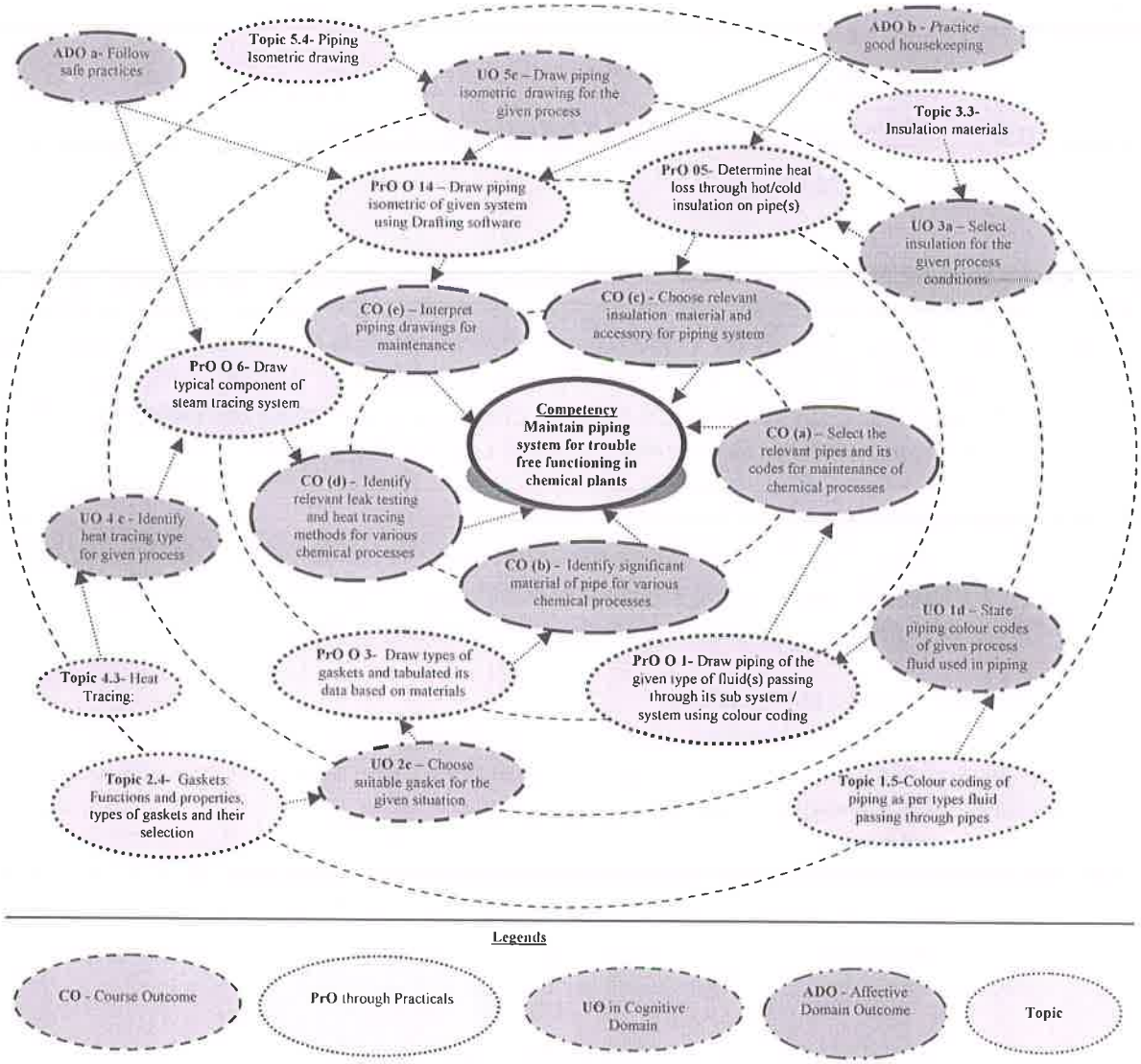

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify the different types of pipes, joints, washers and related accessories used in chemical engineering plants.	I	02*
2	Describe the condition of the given type of pipes and joints	I	02
3	Determine fluid velocity for given pipe size for different flowrates.	I	02*
4	Describe with sketches the condition of the given gaskets.	II	02*
5	Use the drafting software to draw sectional view of the given pipes with insulation	III	02
6	Determine heat loss through hot/cold insulation on pipe(s)	III	02*
7	Describe with sketches the condition of the given steam tracing system.	IV	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8	Describe with sketches the condition of the given self-regulating parallel resistance heat tracer.	IV	02
9	Perform pneumatic leak test for joints/connections to check the leakage by soap bubble method.	IV	02*
10	Perform leak test by determination of pressure drop in straight pipe.	IV	02
11	Use the drafting software to draw the given piping line symbols.	V	02*
12	Use the drafting software to draw pipe rack column spacing.	V	02
13	Use the drafting software to draw the components of the given pump suction and discharge piping system	V	02*
14	Use the drafting software to draw the piping isometric symbols	V	02*
15	Use the drafting software to draw the piping isometric of given system	V	02*
16	Use the drafting software to draw the plant layout of given system	V	02*
17	Use the drafting software to draw the Piping General Arrangement of the given system.	V	02
18	Use the drafting software to draw the single line drawing for given system	V	02
19	Use the drafting software to draw the double line drawing for given system.	V	02*
	Total		**38**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	10
2	Setting and operation	20
3	Safety measures	20
4	Observations and recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

The above PrOs 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) Practice energy conservation.

d) Work as a leader/a team member.
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
- 'Organisation Level' in 2nd year
- 'Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	Exp. No.
1	Drawing Table	1, 3, 6, 7, 16, 18
2	Computers – Processor: Intel i5 / i7, Memory 32 GB, Graphics card :NVIDIA Quadro, Hard disk – 1 TB, Operating system: Windows 8 64- bit	4, 10, 11, 12, 13, 14, 15, 17
3	Freeware / Open source Drafting software	4, 10, 11, 12, 13, 14, 15, 17
4	Laser Printer (Black) – Print/Copy/Scan/Fax multitasking, memory 256MB	4, 10, 11, 12, 13, 14, 15, 17
5	Experimental setup of different pipe size with flowmeter and pump	2
6	Experimental setup of pipe with hot/cold insulation, thermocouples with digital indicators, tank with heat arrangement, flowmeter, pump	5

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Piping Fundamentals	1a. Choose relevant piping for the given process of chemical industries. 1b. Select pipe size for the given process system with justification 1c. Identify the piping Standards as per given application with justification 1d. State piping colour codes	1.1 Introduction to Piping: Pipe, classification of pipe 1.2 Pipe Size, Pipe wall thickness, Schedule number 1.3 Standards referred by piping engineer: API, ASME, BS, IS 1.4 Fundamentals of Design Codes and selection criteria for piping. 1.5 Colour coding of piping as per types of fluid passing through pipes (IS 2379:1990)

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	of the given process fluid used in piping	
Unit-II Piping Material, Properties and Gasket	2a. Describe material properties of the given piping in chemical industries 2b. Select relevant metallic material for the given process application with justification 2c. Choose relevant gasket for the given situation with justification.	2.1 Selection of material for piping 2.2 Material properties of piping: - Chemical Properties - Mechanical Properties: Modulus of elasticity, yield strength, elongation and reduction of area, hardness, toughness - Physical Properties: density, thermal conductivity, thermal expansion, specific heat 2.3 Metallic Material: Ferrous metals, Cast Iron, Steel, Copper and alloys, Aluminum and alloys 2.4 Gaskets: Functions and properties, types of gaskets and their selection
Unit– III Piping Insulation	3a. Select insulation for the given process conditions with justification. 3b. Calculate insulation thickness for the given pipe size and situation 3c. Identify Accessory materials for insulation with justification 3d. Calculate heat loss through insulation for given condition	3.1 Design parameters of insulation system design for piping, Service types for insulation design. 3.2 Critical thickness of insulation, estimating thickness of insulation, optimum thickness of insulation 3.3 Insulation materials: Calcium silicate, Cellular glass, Fiberglass and Mineral wool, Phenolic foam, Polyurethane foam 3.4 Accessory materials for Insulation: Acrylic latex mastic, Aluminum banding, Aluminum jacketing, FRP jacketing, Stainless steel jacketing, Mesh fabric 3.5 Heat loss through insulation
Unit– IV Piping Installation, Leak Testing and Heat Tracing	4a. Describe the given piping installation for chemical industries 4b. Describe the use of relevant leak testing method in the given system 4c. Identify relevant heat tracing type for the given process with justification	4.1 Piping Installation: Installation Drawings, Erection Planning, Cold spring, Joint alignment 4.2 Leak testing: Methods of leak testing, Hydrostatic, Pneumatic, vacuum and static head testing 4.3 Heat Tracing: Types of heat tracing system, Steam tracing, Self-regulating heater, Skin effect, Impendance heat tracing and Induction heating. Selection criteria for tracing systems

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit –V Piping Drawings	5a. Suggest the sources for piping drawing and layout with justification 5b. Describe the given pipe rack spacing and rack drawing for the given process. 5c. Draw piping isometric drawing for the given process.	5.1 Information sources for piping arrangement drawings, layout procedure 5.2 Pipe rack spacing and rack drawing organization 5.3 Drawing formats - Single line drawings - Double line drawings 5.4 Piping Isometric drawing: - Isometric piping symbols - Isometric dimension and text callouts - Isometric offset

***Note**: To attain the COs and competency, above listed Learning Outcomes (LOs) 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	Piping Fundamentals	08	04	04	04	12
II	Piping Material, Properties and Gasket	08	04	04	04	12
III	Piping insulation	08	02	06	04	12
IV	Piping Installation, Leak Testing and Heat Tracing	10	02	02	10	14
V	Piping Drawings	14	04	06	10	20
Total		**48**	**16**	**22**	**32**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of LOs. 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) Prepare journals based on practical performed.
b) Follow the safety precautions.
c) Use software for understanding piping systems.
d) Library / Internet survey of piping used for various parameters
e) Prepare power point presentation or animation for understanding different piping systems

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) Use Flash/Animations to explain various instruments for measurement
f) 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) Prepare report on different insulation used for piping in nearby industries.
b) Prepare model of pipe rack.
c) Prepare charts for displaying Pipe supports.
d) Prepare the list of piping size and its material used in chemical industries.
e) Collect different gasket samples from market and prepare report.
f) Visit nearby fabrication unit to collect information of piping joints and fittings.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Piping Handbook	Mohinder L. Nayyar	McGraw Hill; Seventh Edition 2000, ISBN-10: 0070471061
2	Process Plant Layout and Piping Design	Ed Bausbacher; Roger Hunt	PTR Prentice Hall Inc,1993 ISBN: 0131386298
3	Pipe Drafting and Design	Roy A. Parisher, Robert A. Rhea	Gulf Professional Publishing, ISBN: 0-7506-7439-3
4	Indian Standard 2379:1990	Indian Standard	Bureau of Indian Standards , 1991

S. No.	Title of Book	Author	Publication
5	ASME code for Power Piping, B31.1	ASME	ASME B31.1, 2004
6	ASME code for Process Piping, B31.3	ASME	ASME B31.3, 2004

14. SOFTWARE/LEARNING WEBSITES

a) Codes and Standards, https://www.scribd.com/document/235892891/TN-Gopinath
b) Thermal Insulation Handbook, https://www.aaamsa.co.za/images/Technical%20Publications/TIASA/Handbook%20Chapter1.pdf
c) Piping and Equipment Insulation, http://www.standard.no/pagefiles/1094/r-004.pdf
d) Single line and Double line diagram, https://www.standards.doe.gov/standards-documents/1000/1016-bhdbk-1993-v1/@@images/file