GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Process Piping Fabrication
(Course Code: 4355502)

Diploma programme in which this course is offered	Semester in which offered
Fabrication Technology	5th Semester

1. RATIONALE

Today industrial process piping is a vast field for career development. Role of piping engineer is very much important in chemical plants, fertilizer plants, pharmaceutical plants, petrochemical refineries etc., Many multinational companies are working in process piping fabrication field. This course develops knowledge and skills in student to work in process piping fabrication field. This course focuses on different types of process piping fabrication work. This course gives information about process piping drawing, piping isometric, process flow diagram and P&ID used for chemical plants. Student identify different components and elements of industrial piping system. This course helps to practice use of different tools, equipments and machineries applicable in piping fabrication. This includes hands on practice to student for deciding fundamental technical requirements in piping fabrications. This course also helps student to become conversant with related manufacturing codes and standards of process piping fabrication e.g., ASME, API, ASTM, AWS etc. This course imparts fundamental technical knowledge of fluid mechanics applicable in process piping. Student can understand duties and responsibilities of piping fabrication engineer. Hence this course explores one of the key areas of fabrication technology and provide employment opportunity.

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:

- **Fabricate process piping as per drawing by using concept of fluid mechanics, tools & equipments, qualifying to the applicable codes & standards.**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to required learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes

i. Describe importance of process plant piping& piping codes/standards used in fabrication field.
ii. Describe the functions and features of various piping components/elements.
iii. Interpret piping isometric/spool drawing in a given situation.
iv. Describe concept of fluid mechanics applicable in process piping.
v. Fabricate process piping by appropriate tools, equipments & piping elements.

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	
4	0	2	5	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment 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, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *These PrOs need to be attained to achieve COs.*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Draw different pipe fittings with its function.	2	02
2	Demonstrate pipe sizing (ID, OD, schedule number etc.)	1	02
3	Draw simple process flow diagram (PFD)& P & ID diagram.	3	02
4	Draw& interpret given simple spool/Isometric piping drawings.	3	02
5	Calculate/Interpret 1) end point co-ordinates 2) No of joints, 3) List all given piping fitting/elements with size 4) inch-meter erection & inch dia. Welding from the given piping isometric drawing.	3	02
6	Prepare typical piping spool from the given piping isometric drawing with the help of mild steel wire/PVC pipe & fittings.	2,3,5	02
7	Prepare a job of T type piping joint.	3,5	06
8	Prepare a job of L or Angle type piping joint.	3,5	06
9	Demonstrate use of Reynold's number.	4	02
10	Demonstrate purging operation for given piping joint.	5	02
		TOTAL HRS.	**28**

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. *Practical Sr.no. 6 to 10 are to be performed in a group of one batch.*
iii. *Boiler suit, safety shoes and necessary hand tools & instruments are compulsory while attending laboratory and has to be bought by students. (Annexure-1)*

The following are some sample 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed Practical Exercises of this course required which are embedded in the COs and ultimately the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For PrOs no: 6,7,8		
1	Knowledge of experiment	20
2	Performance	30
3	Procedure followed	30
4	Quality of report	10
5	Punctuality	10
Total		**100**

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For PrOs no: 2,5,9,10		
1	Knowledge of experiment	30
2	Quality of report	30
3	Participation	20
4	Punctuality	10
5	Originality	10
Total		**100**

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For PrOs no: 1,3,4		
1	Knowledge.	20
2	Drawing Layout, Planning & Scale	20
3	Neatness & completeness	30
4	Dimensions (accuracy)	20
5	Punctuality	10
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Drawing instruments	1,3,4
2.	Mild steel pipes, Bench vice, Hacksaw blade, marking & measuring instruments, white chalks, various types of files, welding equipments, various piping components (e.g., bend, reducer, valves, cap etc.,)	6,7,8
3.	Reynold's apparatus	9
4.	Pipe to pipe joints, tapes, hose pipe, nipples, purging gas, regulator, pressure gauge, adhesive tape etc.,	10

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 safety practices in laboratory.
b) Practice good housekeeping.
c) Work as a leader/a team member.
d) Maintain tools/equipment
e) Follow ethical practices

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& 4th year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Basics of piping	1a. List types of pipes based on material 1b. Compare pipe vs tube 1c. Describe industrial process piping. 1d. Calculate volume of liquid storage tank. 1e. Describe importance of ASME code for piping. 1f. Describe the responsibilities of piping field engineer.	1.1 Introduction of piping 1.2 Duties & responsibilities of piping field engineer 1.3 Piping classification 1.4 Pipe (types, material, method of joining pipe) 1.5 Pipe vs tube 1.6 General definitions related to piping. 1.7 Length areas, surfaces& volumes related to piping. 1.8 Acronyms and abbreviation used in piping. 1.9 Vent & drain in piping. 1.10 Volume calculation of liquid storage tank. 1.11 Industrial process piping 1.12 Pipe color code& labelling 1.13 Pipe sizes & specification 1.14 Introduction of ASME, ASTM, AWS, API ASME B31.1, ASME B31.2 1.15 Basic information about ASME B31.3 (process piping)

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – II Piping components	2a. Describe functions and features of butt welded piping components. 2b. Describe functions and features of socket welded piping components. 2c. Describe functions and features of screwed piping components. 2d. Describe function of flanges, gaskets, valves & special components for piping. 2e. Describe types of supports used for piping.	2.1 Components for butt welded piping system. 2.2 Components for socket welded piping system. 2.3 Components for screwed piping system. 2.4 Flanges, gaskets, valves 2.5 Fasteners. 2.6 Expansion joint & flexible piping. 2.7 Separator, strainer, screens, driplegs, traps, gaskets. 2.8 Procedure for application of bolt torque on flanged joints. 2.9 Pipe supports.
Unit – III Piping Drawing	3a. Classify the various types of piping drawing. 3b. Interpret piping isometric/spool drawing. 3c. Calculate relevant information from piping isometric drawing.	3.1. Introduction of piping drawing. 3.2. Types of piping drawing. 3.3. Piping drawing symbols and abbreviations 3.4. Introduction of G.A drawing, process flow diagram (P.F.D), Piping and instrumentation diagram(P&ID), plot plan) 3.5. Piping Isometric drawing / spool drawing. 3.6. Calculate dimension of pipe fittings from piping isometric drawing. 3.7. Pipe to pipe joint development (L-joint, T-joint etc.)
Unit– IV Fluid Mechanics and pipe sizing	4a. Describe various fluid properties. 4b. Describe various types of fluid flow. 4c. Apply fundamentals of fluid mechanics in process piping fabrication. 4d. Explain methods of measuring pressure in pipes. 4e. Explain precautions to be taken in piping fabrication to minimize loss in head due to flow of fluid through piping.	4.1. Introduction to Fluid mechanics 4.2. Definition of hydraulics, fluid mechanics 4.3. Definition of total pressure and center of pressure 4.4. Properties of fluid 4.4.1. Liquid and their properties 4.4.2. Density, specific gravity, viscosity, Surface tension &capillarity action, Compressibility 4.4.3. Vapor Pressure 4.4.4. Fluid characteristics 4.5. Pressure measurement 4.5.1. Pressure of fluid 4.5.2. pressure head of a liquid 4.5.3. Pascal laws 4.5.4. Relation between positive and

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		negative gauge pressure (Vacuum) and absolute pressure 4.6. Fluid kinematics 4.6.1. Type of fluid flow 4.7. Fluid dynamics 4.7.1. Introduction 4.7.2. Different types of head 4.7.3. Bernoulli's equation 4.8. Laminar flow & Turbulent flow in pipe 4.9. Flow through Pipes 4.9.1. Loss of energy / head in pipes Loss of head due to frication 4.9.2. Minor energy losses 4.10. Water hammer in pipes
Unit – V Piping Fabrication & coating	5a. Describe various types of pipe fabrication, welding and joints 5b. Describe the process of pipe shaping, bending and forming. 5c. Describe the features and functions of equipment / Tools / Accessories used in piping fabrication 5d. Describe the properties of various types of coating. 5e. Describe function, ingredients & application of paint for piping. 5f. Describe the process of surface preparation for painting and coating.	5.1. Orbital pipe welding 5.2. Up-hill / down-hill welding. 5.3. Spiral pipe welding 5.4. Various pipe welding position groove, fillet. 5.5. General fabrication procedure for piping spool. 5.6. Shop weld plan for piping. 5.7. Fit-up & set-up for welding of pipe 5.8. Purging/trailing gas concept in pipe fabrication 5.9. FPW- full penetration welding of pipe. 5.10. Different types of purging. 5.11. Equipment/tools / accessories used in piping fabrication (e.g., pulling and lifting) 5.12. Hot taping process 5.13. TKY joints 5.14. Pipe Shaping/bending/forming of pipe. 5.15. Coating: definition, introduction, function & types/classification. 5.16. Insulation: Introduction, function/objective & classification. 5.17. Surface preparation for coating & Painting 5.18. Painting: Introduction, function, ingredients, application. 5.19. Environment friendly painting.

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	Basics of piping.	08	4	3	4	11
II	Piping components.	12	4	7	4	15
III	Piping drawing.	12	3	4	7	14
IV	Fluid mechanics & pipe sizing.	12	3	7	4	14
V	Piping fabrication& coating.	12	6	10	-	16
	TOTAL	**56**	**20**	**31**	**19**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note: *This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks and marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly 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 perform following activities in group and prepare reports/charts for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Prepare solutions of different assignments given by subject faculty.
b) Prepare a list of specifications for various tools/equipment/machines used for piping.
c) Visit the local metal trader/ fabricator and collect all relevant information regarding piping fittings/instruments.
d) Download videos showing correct practices for piping.
e) Student will visit the respective discipline industry / site and will prepare different procedures for piping.
f) Prepare a chart on different piping fittings &
g) Collect piping drawings from internet & prepare report on it.
h) Collect videos, animation showing piping fabrication.
i) Prepare power point presentation on any piping codes/standards.
j) Prepare report piping coatings/paintings.

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) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.

d) 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.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

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-projects are group-based (group of 3 to 5). However, **in the fifth and eighth 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 micro project 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:

a) Prepare special tools/projects/fixtures/models used for piping e., pipe rotator, positioner, piping component fit up set up fixtures etc.,
b) Prepare a typical programme used for piping calculation in Microsoft excel or suitable software e.g., pipe sizes, elbow centre line to edge distance.
c) Survey/Visit nearby vendor, prepare sample specifications of piping components/instruments.
d) Maintenance of available infrastructure related to piping equipments e.g., air compressor, Bench vice, Pipe vice.
e) Prepare his/her video on demonstrating different piping processes.
f) Prepare different types of flanges from card board or suitable material.
g) Prepare different fit up & set up models of piping from suitable material.
h) Prepare typical piping spool from PVC or suitable piping fittings.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Pipinghand book	Mohinder L. Nayyar.	Peter H. O. Fischer, Manager, Pipeline Operations, Bechtel
2	The piping guide	David R. Sherwood Dennis J. Whistance	Syentek Books company Inc, ISBN 0-914082-04-3
3	Fluid mechanics and hydraulics	Bansal	Laxmi Publication Pvt. Ltd.

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
4	Fluid mechanics	R.K Rajput	S. Chand & Co. Ltd.
5	Fluid mechanics and hydraulics	R. S. Khurmi	S. Chand & Co. Ltd.
6	Welding Engineering & Technology	Dr. R. S. Parmar	Khanna Publishers
7	Maintenance Engineering and management	Sushil Kumar Srivastava	PHI Learning Pvt. Ltd.
8	Modern arc welding	S. V. Nadkarni	Oxford Publication
9	Handbook of piping design	S. K. Sahu	Elsevier Publishers
10	Pipe Fabrication - Materials, Drawing and Fabrication Methods	Government of Western Australia	WestOne Services
11	Industrial pipework	D.N.W. KENTISH	McGRAW HILL book company (UK) limited
12	Piping design for process plants	Howard F. Rase	JOHN WILEY & SONS, INC.,
13	ASME PIPING CODES	ASME	ASME
14	API CODES	API	API
15	ASTM CODES	ASTM	ASTM

14. SOFTWARE/LEARNING WEBSITES

- https://www.processconstruction.com/services/piping-fabrication/
- https://www.allaboutpiping.com/
- https://whatispiping.com/
- https://www.dtwd.wa.gov.au/sites/default/files/teachingproducts/ENG2068_CCBY.PDF
- https://www.youtube.com/watch?v=tv6SMLH1A4Q&list=PLduofSZeZdCWtvM-jZEUZPi6R1j317STP
- https://www.theprocesspiping.com/introduction-to-piping-system/
- https://www.youtube.com/watch?v=xcB2fyMOJyw
- https://www.youtube.com/watch?v=WtjLaGgBRcs

15. PO-COMPETENCY (CO) MAPPING

Semester V	Process Piping Fabrication (Course Code: 4355502)						
	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, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Manage-ment	PO 7 Life-long learning
Competency	• Fabricate process piping as per drawing by using concept of fluid mechanics, tools & equipments, qualifying to the applicable codes & standards.						
Course Outcomes CO 1) Describe importance of process plant piping & piping codes/standards used in fabrication field.	3	1	1	-	-	-	1
CO 2) Describe the functions and features of various piping components/elements.	3	1	-	2	-	-	2
CO 3) Interpret piping isometric/spool drawing in a given situation.	3	1	2	-	1	1	2
CO 4) Describe concept of fluid mechanics applicable in process piping.	3	2	1	1	-	-	1
CO 5) Fabricate process piping by appropriate tools, equipments & piping elements.	3	-	1	2	1	-	1

*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
1.	Mr. Ashoksinh M. Gohil Lecturer – Fabrication Technology	Sir Bhavsinhji Polytechnic Institute Bhavnagar	9924682010	amgohilges@gmail.com
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