GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Fabrication Technology-II
(Course Code: 4345504)

Diploma programmer in which this course is offered	Semester in which offered
Fabrication Technology	4th Semester

1. RATIONALE

This course focuses on different types of process equipment fabrication work. Student will develop capability to read and interpret process equipment drawing. This course also helps students to understand application of different tools, equipment & machineries used in fabrication of process equipment. This course also tries to develop safety consciousness & constructiveness for process equipment fabrication work. Students also become conversant with related manufacturing codes & standards of process equipment e.g., ASME, TEMA, BIS - 2825, BS - 5500. This also provides opportunity for hands on practice for student to understand basic technical requirement for process equipment fabrication. This course provides necessary knowledge and skills required in the process equipment fabrication industry, and hence it is a key course for fabrication engineers.

2. COMPETENCY

The course content is leading to the achievement of the following competency:

- **Student will be able to use appropriate tools, equipments & jig fixtures for fabrication of different parts & attachments of process equipment.**
- **Student will be able to supervise process equipment fabrication.**

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) Describeprocess equipment fabrication process.
b) Interpretgiven process equipment fabrication drawing.
c) Determine method to make shell, cone & dish end for pressure vessel.
d) Describedifferent attachments for process equipments.
e) Determine the method to assemble different parts of process equipment.

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	4	6	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	Demonstrate various tools, equipments &personal protective equipment with safe operating procedurefor process equipment fabrication.	III	02
2	Draw sequence of process equipment fabrication in chart form.	I	02
3	Calculate required plate dimension & diagonal length of plate as per given data for shell preparation with neat sketch.	II, III	02
4	Perform shell plate marking & cutting for shell fabrication as per given data/drawing.	II, III	04
5	Prepare template for shell weld edge preparation & perform weld edge preparation on given shell as per drawing.	II, III	04
6	Prepare template for shell forming and perform pre-bending of shell as per given data.	III	04
7	Perform rolling (forming) operation of shell as per given data.	III	04
8	Perform long seam set up of shell with run in and run out plate as per given data.	III	04
9	Perform dimensional inspection of shell with ovality calculation.	III	02
10	Prepare list of shell fabrication forming defects & identify defects from the prepared shell and suggest remedies to correct it.	III	02
11	Perform circumferential orientation marking on given shell & Prepare shell to shell circular seam set up operation.	V	04
12	Perform nozzle cut out marking on given shell & dish end as per given drawing.	IV, V	04
13	Perform limpet coil marking on a given shell as per given data/drawing.	II, IV	04
14	Perform blind flange marking on given plate with all required calculation.	IV	02
15	Prepare a tube sheet hole marking as per given drawing.	IV	02
16	Prepare template for inspection of given dish end.	II, III	02
17	Calculate tank rotator safe angle from the given data/situation	V	02
18	Draw a typical cone development as per given data.	II	02
19	Drawtype of dish ends.	III	02
20	Draw type of nozzles& flanges.	IV	02

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
		TOTAL HRS.	**56**

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. 4 to 16 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: 1, 4 to 16		
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: 3,17,19,20		
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: 2,18		
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 specificationsfor the PrOsis 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.	PPE'S :Hand gloves, Welding face guard, Safety goggles, Hand sleeve, Leg guard.	1
2.	Mild steel plate/flat	4 yo 8
3.	Fabrication tools & equipments anything from the listed below items: Flat files, Hand files, Bench vice, C-clamp, Hammer, Inside caliper, Outside caliper, Odd leg caliper, Wedges, Divider, Metal sheet cutter, Portable drill machine, Portable grinding machine,	1 to 16
4.	Marking & measuring instrument & tools anything from the listed below items: Tri square, Scriber Spirit level, Chalk stick, Scriber, Steel tape, Steel rule,Marking punch, string, transparent plastic tube.	1 to 16
5.	Three roller plate bending machine	6
6.	Galvanized sheet	5,6
7.	Welding rectifier, Electrodes	8,11

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample***Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs andPrOs.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, moresuch 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 Introduction to process	1a. Describe need &importance of process equipment fabrication.	1.1 Need, scope&importanceof process equipment in industries. 1.2 Definition, classification&function of

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
equipment	1b. Classify process equipments. 1c. Describe sequenceofprocess equipmentsfabrication. 1d. Describe importance of different codes and standards used inprocess equipment fabrication industries.	different process equipments. 1.3 Manufacturing terminology of pressure vessel. 1.4 Sequenceof process equipments fabrication. 1.5 Fundamentalunitsand itsconversion. 1.6 Volume capacity calculation of pressure vessel. 1.7 Introduction & scope of differentcodes/standards used in process equipment fabrication industries. 1.8 Qualities of shop floor supervisorin process equipment fabrication industries. 1.9 Major process equipment fabrication industries in India.
Unit:II Process equipment drawing.	2a. Interpret GA drawing of process equipment. 2b. Interpret detail drawing of process equipment.	2.1 Introduction of process equipment drawing. 2.2 Types of process equipment drawing. 2.3 Study of title block in process equipment drawing. 2.4 General notes & bill of material in GA drawing. 2.5 Design data table. 2.6 Typical pressure vessel drawing with its terminology. 2.7 Detailing of process equipment drawing. 2.8 Weld joint geometry/nomenclature/ terminology/types & weld symbols. 2.9 Detail drawing. 2.10 Nozzle schedule table. 2.11 Cone layout development.
Unit:IIIShell, Cone & dish end fabrication	3a. Calculate plate development length & diagonal length required as per given drawing. 3b. Describe plate cutting processes for process equipment. 3c. Prepare shell as per given requirement. 3d. Prepare inspection report for shell, cone & dish end.	3.1 Introduction of shell fabrication. 3.2 Plate length calculation & marking for shell fabrication. 3.3 Advanced cutting processes (plasma cutting, water jet cutting, laser cutting) 3.4 Shell forming from plate (Plate rolling) 3.5 Longitudinal seam fit up & set up of shell 3.6 Run in, run out plate & PTC for shell. 3.7 Inspection of plate & shell. 3.8 Definition, introduction & types of cones or reducer. 3.9 Cone fabrication.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		3.10 Inspection of cone. 3.11 Definition& Introduction of heads or dish ends. 3.12 Types of dish end. 3.13 Factors affecting selection of dish end. 3.14 Manufacturing processes of dish ends. 3.15 Blank diameter calculation of dish ends. 3.16 Development of hemispherical dish ends. 3.17 Different marking in dish ends. 3.18 Inspection of dish end. 3.19 Shell, cone & dish end forming defects. 3.20 Safe operating procedures for plasma cutting &forming(rolling) operation.
Unit– IVprocess equipment attachments.	4a. Describe function of different process equipment attachments. 4b. Describe procedure of nozzle marking on shell &dish end. 4c. Prepare marking oftypical blind flange. 4d. Prepare marking of limpet coil vessel as per data/drawing. 4e. Describe tube bundle fabrication for heat exchanger.	4.1 Definition & introduction & function of nozzles. 4.2 Types of nozzles 4.3 Nozzle elevation, height & centerline marking. 4.4 Nozzle orientation calculations. 4.5 Definition, introduction, function& types of flanges. 4.6 Flange marking & calculations. 4.7 Process equipments supports. 4.8 Reinforcement pad&telltale hole. 4.9 Introduction & function of limpet coil 4.10 Limpet coil marking on shell. 4.11 Lifting lug/lifting trunnion 4.12 External& internals ofprocessequipment like insulation cleat, laddersupports, platform cleat, trays and tray support ring 4.13 Tube bundle fabrication for heat exchanger. 4.14 Elements of tube bundle like Tube Sheet, Tube, Baffles, TieRod, Spacers, Impingement Plate, etc.,
Unit– V Assembly of process equipment.	5a. Describe nozzle to shell fit up & set up. 5b. Prepare shell to shell circular seam fit & set up. 5c. Select different tools& equipment for fabricationof process equipment.	5.1 Shell to shell fit up & set up. 5.2 Ovality calculation of shell. 5.3 Dish end to shell fit up & set up 5.4 Nozzle to shell fit up & set up 5.5 Nozzle to dish end fit up & set up 5.6 Shell to support fit and set up 5.7 Equipment & tools for process equipment fabrication like tank rotator, spider etc.,

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	5d. Describe standard tolerance for pressure vessel.	5.8 Jigs & fixtures used for process equipment. 5.9 Standard tolerances for pressure vessel as per codes/standards.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introductionto process equipment	08	4	7	0	11
II	Process equipment drawing	10	3	4	7	14
III	Shell, Cone & dish end fabrication	14	3	7	7	17
IV	Process equipment attachments	12	3	4	7	14
V	Assembly of process equipment	12	3	7	4	14
	TOTAL	**56**	**16**	**29**	**25**	**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 M.C.Q.type questions from given process equipment drawing.
b) Prepare solutions of different assignments given by subject faculty.
c) Prepare a list of specifications for various tools/equipment/machines used for process equipments.
d) Visit the local metal trader/ fabricator and collect all relevant information regarding process equipment tools & equipments.
e) Download videos showing correct practices for pressure vessel fabrication.
f) Student will visit the respective discipline industry / site and will prepare different procedures for process equipment fabrication.
g) Prepare a chart on shell fabrication, types of dish end, types of nozzles or other attachments.
h) Collect process equipment drawings from internet & prepare report on it.
i) Collect videos, animation showing shell, dish end, nozzle preparation for pressure vessel.
j) Prepare power point presentation on any process equipment codes/standards.
k) Prepare report on dish ends.
l) Prepare report on nozzles.

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 assessedusing 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 process equipment fabrication e.g., tank rotator, spider etc.,
b) Prepare a typical programme used for different fabrication calculation in Microsoft excel or suitable softwaree.g., plate length & diagonal calculation from data.
c) Survey/Visit nearby vendor, prepare sample specifications of fabrication tools & equipments.
d) Maintenance of available infrastructure related to fabrication e.g., air compressor, plate forming (rolling) machine.
e) Prepare his/her video on demonstrating different fabrication processes or process equipment part fabrication.
f) Prepare typical tube sheet for heat exchanger from mild steel plate.
g) Prepare different types of nozzles from card board or suitable material.
h) Prepare different types of flanges from card board or suitable material.
i) Prepare different fit up & set up models from suitable material.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Practical guide to pressure vessel manufacturing.	Sunil pullarcot	Marcel dekker inc. ISBN: 0-8247-0740-0
2	Process Equipment Design	V.V.Mahajani	Macmillan Publishers India Ltd.
3	Chemical equipment design	B.C.Bhattacharya	CBS publishers
4	Production Technology vol-1&2	O.P.Khanna	Dhanpat Rai & Sons Publication. Latest edition
5	Basic Welding & Fabrication	W.Kenyon	-
6	Welder fitter guide	John P. Stewart	D.B.Tarapurwala
7	Design data handbook	PSG	PSG College of Technology
8	Introduction to Chemical Engineering	Salil K Ghosal & Siddhartha Datta	Tata Mc graw Hill
9	Welders guide handbook	Jems E. Brumbaugh	D.B.Tarapurwala
10	ASME Sec - VIII	James R. Farr &Maan H. Jawad	ASME
11	TEMA Standards	TEMA	Tubular Exchanger Manufacturers Association, Inc.
12	IS 2825: Code for Unfired Pressure Vessels	BIS	Bureau of Indian Standards

14. SOFTWARE/LEARNING WEBSITES

- https://www.youtube.com/watch?v=vgANh1L9fvU
- https://workshopinsider.com/welding-symbols/
- https://www.youtube.com/watch?v=-t2FYGaH5IQ&t=12s
- https://www.youtube.com/watch?v=vgANh1L9fvU
- https://www.youtube.com/watch?v=-t2FYGaH5IQ&t=12s
- https://www.youtube.com/watch?v=LojEHJ5vuQg&t=10s
- https://www.youtube.com/watch?v=7XMUxbULo1A
- https://www.pveng.com/wp-content/uploads/2016/06/Sample2_Drawing.pdf
- https://letsfab.in/guidelines-for-fabrication-of-pressure-vessels/
- https://www.thefabricator.com/thefabricator/article/bending/dished-end-manufacturing-for-beginners

15. PO-COMPETENCY-CO MAPPING

Semester IV	Fabrication technology-II (Course Code:4345504)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ develop-ment of solution	PO 4 Engineering Tools, Experimen-tation&Tes	PO 5 Engineering practices for society, sustainability &	PO 6 Project Manage-ment	PO 7 Life-long learning

			s	**ting**	**environment**		
Competency	• **Student will be able to use appropriate tools, equipments & jig fixtures for fabrication of different parts & attachments of process equipment.** • **Student will be able to supervise process equipment fabrication.**						
Course Outcomes							
co 1) Describeprocess equipment fabrication process.	3	1	-	-	-	-	-
co 2) Interpret given process equipment fabrication drawing.	3	1	-	-	-	-	2
co 3) Determine method to make shell, cone & dish end for pressure vessel.	3	2	-	1	1	1	2
co 4) Describe different attachments for process equipments.	3	2	-	1	-	1	2
co 5) Determine the method to assemble different parts of process equipment.	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	Sir Bhavsinhji Polytechnic Institute Bhavnagar	9924682010	amgohilges@gmail.com
2.	Mr. Nilesh M. Bhangale	Sir Bhavsinhji Polytechnic Institute Bhavnagar	9016926792	nileshbhangalefabtechbpi@gmail.com
3.	Mr. Parthiv T. Trivedi	Sir Bhavsinhji Polytechnic Institute Bhavnagar	99924185501	trivediparthivbpti@gmail.com

ANNEXURE-1

❖ SAMPLE SEFTY CONTRACT:

(To be filled by the students and submitted to concerned faculty/staff)

-- Use for reference purposes only --

1. You have to read and sign the safety contract.
2. The safety contract says that you understand that safety is your responsibility.
3. The safety contract to be signed before you carry out any work in the laboratory and if you don't observe and obey the safety rules, you will not be allowed in the laboratory.

::

Safety Contract

Date: ______________

Name of Institute: ____

Name of Course with Code: Fabrication Technology-II (4345504)

Name of Faculty/Staff with Designation: 1. ____

2. ____

3. ____

I RECOGNIZE THAT:

1. Safety is my responsibility when using a tool.
2. Safety regulations have been provided to me.
3. The possibility of accident and injury increases if I do not follow all the safety guidelines.
4. I must act responsibly to ensure my own safety & the safety of others in the work area.

I AGREE TO:

1. Never work in the shop without my faculty's/instructor's supervision.
2. Read and practice all the safety regulations that have been distributed to me in this course or have beenposted in the work areas.
3. Act in a responsible manner at all times in the laboratory.
4. Follow all instructions given by the faculty.
5. Immediately report any unsafe condition or activity to my faculty/instructor.
6. Wear eye protection at all times when working with tools or working anywhere near someone who is usingtools.
8. Cut or Tie back long hair, remove jewellery, secure loosed clothing, and wear boiler suit & safety shoes in thelaboratory.
9. Clean all work areas and put equipment away before leaving the laboratory.

I, ____, have read and agree with all the safety instructions.

Particulars:

Programme: _______________________ Student Signature

Batch No.: _______________________ _________________________

Enrollment No.: ___________________