

**GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)****Competency-focused Outcome-based Green Curriculum-2022(COGC-2021)**

Semester - VIII

Course Title : **Process Equipment Design**

(Course Code : 4385503)

<b>Diploma programmer in which this course is offered</b>	<b>Semester in which offered</b>
Fabrication Technology	Eight

**1. RATIONALE**

This course provides scope for students to design different machine elements and major parts of process equipments. Student get knowledge about different loading condition affect on process equipments and corresponding stresses produced in it. Student will acquire knowledge of different design codes and standards used for process equipments. Student can prepare design consideration of heat exchanger, reaction vessel, distillation tower, absorption column, separator, evaporator etc. Student will get knowledge about process hazards in chemical plants. He/she will aware about safety consideration required in process equipment design. Students will have hand on practice for solid modeling by using CAD Software.

**2. COMPETENCY**

The course content leading to the achievement of the following competencies:

- Design various parts of process equipment as per ASME- Sec VIII Div. 1.
- Design various machine elements used in process equipment.
- Able to draw 3D solid modeling by using CAD software.

**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:

- i. Design basic elements of Process equipments as per applicable codes and standards.
- ii. Describe different machine elements used in process equipments.
- iii. Describe design consideration of various process equipments used in chemical industries.
- iv. Describe different hazards in process industries and its safety measures required in process equipment design.
- v. Draw AutoCAD 3D drawing for given Job.

#### 4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
L	T	P		Theory Marks		Practical Marks		Total Marks
			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 3D Drawing of given job by using CAD software.	5	8
2	To study various clauses of ASME SECTION VIII, DIVISION 1.	1	2
3	Calculate thickness of cylindrical shell of Pressure Vessel as per ASME Sec VIII Div 1.	1	2
4	Calculate thickness of different types of dished end used in process equipments as per ASME Sec VIII Div 1.	1	2
5	Perform Exercise of Pressure Vessel Heads using Software.	1	2
6	Select material as per various ASME BPVC codes for process equipments.	1	4
7	Design the shaft based on different criteria.	2	2
8	Prepare design consideration of various process equipments.	3	4
9	To study about process Hazards in chemical industry and required Safety Measures In Process Equipment Design.	4	2
<b>Total Hours</b>			<b>28</b>

#### 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. Boiler suit, safety shoes and necessary tools & instruments are compulsory while attending laboratory and has to be brought 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 %
<b>For PrOs no:2,8,9</b>		
1	Knowledge of experiment	30
2	Quality of report	30
3	Participation	20
4	Originality	10
5	Punctuality	10
<b>Total</b>		<b>100</b>

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
<b>For PrOs no: 1</b>		
1	Knowledge	20
2	Quality of drawing	30
3	AutoCAD commands and tools	20
4	Dimensions (accuracy)	20
5	Punctuality	10
<b>Total</b>		<b>100</b>

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

## 6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment 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.	Computer & its Set, Projector.	1,3,4
2.	Scientific Calculators, Stationary sets.	7
3.	AutoCAD Software, Different Software.	1,3,4
4.	Multi functional printer (A0/A2/A4 sizes)	1

## 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 1<sup>st</sup> year
- ii. 'Organisation Level' in 2<sup>nd</sup> year.
- iii. 'Characterization Level' in 3<sup>rd</sup> year & 4<sup>th</sup> 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
<b>Unit-I</b>  <b>Basic Consideration In Process Equipment Design</b>	1a. Classify different process equipments. 1b. Describe different factors affecting design of process equipments. 1c. Design cylindrical shell and dished end used in process equipments. 1d. Select material for various process equipments. 1e. Describe different types of corrosion occurs in process equipment & its prevention techniques	1.1 Introduction 1.2 The general design procedure 1.3 Fabrication techniques 1.4 Equipment classification 1.5 Power for rotational motion 1.6 Drives for process equipment 1.7 Factors affecting design of process Equipment 1.8 Failures in pressure vessel 1.9 Loadings on pressure vessel 1.10 Design of cylindrical shell and spherical head as per ASME sec VIII Div-1 1.11 Comparison of ASME Sec VIII Div-1,2 & 3 1.12 Stresses in pressure vessel 1.13 Mechanical properties 1.14 Material types 1.15 Corrosion 1.16 Corrosion prevention 1.17 Selection of material

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
<b>Unit– II</b> <b>Design Of Machine Elements</b>	2a. Design the shaft. 2b. Describe various keys and couplings. 2c. Describe different types of bearing used in process equipments. 2d. Describe different leakage prevention devices used in process equipments.	2.1 Shaft 2.2 Coupling 2.3 Bearing 2.4 Gear box 2.5 Packing and gasket 2.6 Stuffing Box & gland 2.7 Mechanical seal
<b>Unit-III</b> <b>Design consideration of different process equipments</b>	3a. Describe design consideration of reaction vessel 3b. Describe design consideration for heat exchanger 3c. Describe design consideration for evaporators & crystallizers & separators. 3d. Describe design consideration for distillation tower & absorption column.	3.1 Introduction & material of construction 3.2 Agitation & types of agitator 3.3 Classification of reaction vessel 3.4 Heating system 3.5 Design consideration 3.6 Introduction of heat exchanger 3.7 types of heat exchanger 3.8 Design of shell and tube types heat-Exchanger 3.9 Introduction & types of evaporator, separators & crystallizer. 3.10 Design consideration of evaporator, separators & crystallizer. 3.11 Introduction 3.12 Basic features of tower / column 3.13 Tower / column internals 3.14 Design and construction features of column internals
<b>Unit- IV</b> <b>Process Hazards and Safety Measures In process Equipment Design</b>	4a. Describe various hazards in process industries. 4b. Describe safety measures in process industries. 4c. Describe various safety measures in process equipment design 4d. Describe various pressure relief devices used in process equipments.	4.1 Introduction 4.2 Hazards in process industries 4.3 Analysis of hazards 4.4 Safety measures 4.5 Safety measures in equipment design 4.6 Pressure relief device
<b>Unit- V</b>	5a. Describe various AutoCAD	5.1 Introduction to different

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
<b>Computer Aided Drafting</b>	commands. 5b. Convert 2D screen into 3D screen. 5c. Apply appropriate command for making 3D drawing. 5d. Use standard dimensioning methods in CAD software. 5e. Plot/Print the drawing.	AutoCAD commands 5.2 Simple 3D drafting of process equipment 5.3 Solid modeling

## 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	Basic Consideration In Process Equipment Design	12	3	4	7	14
II	Design Of Machine Elements	10	-	7	7	14
III	Design consideration of different process equipments	22	6	22	-	28
IV	Process Hazards And Safety Measures In process Equipment Design	6	3	4	-	7
V	Computer Aided Drafting	6	-	-	7	7
	<b>TOTAL</b>	<b>56</b>	<b>12</b>	<b>37</b>	<b>21</b>	<b>70</b>

**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 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:

- Prepare solutions of different assignments given by subject faculty.
- Download videos showing correct practices for process equipment used in chemical industries.
- Download videos showing correct practices for AutoCAD 3D modelling.
- Visit at local manufacturer place and prepare the report on it.
- Fill up the lab manual.

## 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) **Chart making:** Student have to prepare a chart on various topics given by the subject teacher.
- b) **Model Making:** Students should build 3D model of various object as per shape and dimension from thermocol, hardboard scrap, wooden scrap, plastic or metal scrap or drawing sheet etc.
- c) **Video Preparation:** Student has to prepare his/her video with various topics given by the subject teacher.
- d) **E-learning projects:** Students have to use internet and other online resources for preparation of report and/or download video on the topic given by the subject teacher within the syllabus or beyond the syllabus.
- e) **Report preparation:** Student has to use different books, technical magazine, journals etc. for preparation of a report on the topic given by the subject teacher within the syllabus or beyond the syllabus.
- f) **Power point presentation:** Students has to prepare a power point presentation of 10 to 15 slides on the topic given by the subject teacher within the syllabus or beyond the

syllabus. In the end of presentation student has to ask at least 3 to 5 MCQ based question to identify the gain of listeners at the end presentation.

### 13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Joshi's Process Equipment Design	V. V. Mahajani S. B. Umreji	Trinity press
2	A text book of machine design	R.S. Khurmi J.K. Gupta	Euresia Publishing House (Pvt.) Ltd.
3	Chemical Equipment Design	B. C. Bhattacharya	CBS publications & distributors
4	Materials & Metallurgy	O. P. Khanna	Dhanpat Rai Publication
5	Pressure vessel design manual	Deniss R More	Gulf publishing company
6	ASME Sec –II,V,VIII,IX	ASME	ASME
7	TEMA Standards	TEMA	Tubular Exchanger Manufacturers Association, Inc.
8	Introduction to Chemical Engineering	Salil K Ghosal & Siddhartha Datta	Tata Mc graw Hill
9	Pressure vessel design – Guide & procedure	Mr. Ghader Ghanbari Mr. Mohammad Ali Liaghat	

### 14. SOFTWARE/LEARNING WEBSITES

<https://youtu.be/d2-D8dTrEWM?si=YRDGU5oEwBK7gIlb>  
[https://youtu.be/rpfqPAM\\_kRE?si=BVYtZyGKW4hzMdkJ](https://youtu.be/rpfqPAM_kRE?si=BVYtZyGKW4hzMdkJ)  
[https://youtu.be/bHKPwoinc14?si=6sTLW0y5YGTVI\\_VL](https://youtu.be/bHKPwoinc14?si=6sTLW0y5YGTVI_VL)  
<https://youtu.be/r4Xytb-KEao?si=hJdpnnpXP7HFlm45>  
[https://youtu.be/LxtDvKOca9w?si=KrCdB9ZzeJX\\_inao](https://youtu.be/LxtDvKOca9w?si=KrCdB9ZzeJX_inao)  
[https://youtu.be/6UfOit5L\\_BU?si=IUtZAfNSe8MT6X5D](https://youtu.be/6UfOit5L_BU?si=IUtZAfNSe8MT6X5D)  
<https://youtu.be/2ua0T2rZacM?si=gY61vBu8d7uGjSvi>  
<https://youtu.be/dKfriV8H9-8?si=evs84P9Tm0vi5U8H>  
<https://youtu.be/uGxfchLe-I?si=lfuZjG-3aw2iMtX8>  
[https://youtu.be/64EfZpMuOho?si=ZInF70\\_IWM7ONZws](https://youtu.be/64EfZpMuOho?si=ZInF70_IWM7ONZws)  
<https://youtu.be/n1EzCOnZn3s?si=-JGnaJlC0SjSFNmc>  
[https://youtu.be/AS0zQhMfJUw?si=r1f\\_OQppWy-LUP4P](https://youtu.be/AS0zQhMfJUw?si=r1f_OQppWy-LUP4P)  
[https://youtu.be/QMSi7COOQ8E?si=HJJUQ6EZchuG\\_xOM](https://youtu.be/QMSi7COOQ8E?si=HJJUQ6EZchuG_xOM)  
<https://youtu.be/oN92OYyTyeA?si=RVie8010j644VzPW>  
[https://youtu.be/3aZvtBGSG\\_k?si=u95kOa7f9SWYkOgu](https://youtu.be/3aZvtBGSG_k?si=u95kOa7f9SWYkOgu)

[https://youtu.be/3t-Pk9aiUtE?si=UMk-wrf\\_8XwlpBIS](https://youtu.be/3t-Pk9aiUtE?si=UMk-wrf_8XwlpBIS)  
<https://youtu.be/MKox2mbwn3I?si=FZc6vTwKUOWgNMNn>  
<https://youtu.be/Ltk-B4Da9Gw?si=47RO5gY5-5rOfvYD>  
[https://youtu.be/Msvh\\_nvjJjU?si=4WVw12utVH6\\_mGx9](https://youtu.be/Msvh_nvjJjU?si=4WVw12utVH6_mGx9)  
<https://youtu.be/W8-6FxFwSr4?si=18wli0mKuRoHpDP3>  
[https://youtu.be/\\_vEt68WvesY?si=qCo9OQz\\_I2PE3-Ps](https://youtu.be/_vEt68WvesY?si=qCo9OQz_I2PE3-Ps)  
<https://youtu.be/PTqa4JNnOS4?si=qz6Hn5BJ6XJcbad>  
<https://youtu.be/ZMURHY1K1KI?si=nrxz2WQOdDKhETI>  
<https://youtu.be/SzrzVXRm5Go?si=XZZYodaFK2kxD2O5>  
<https://youtu.be/T7kMpd17hkw?si=Acpxwmj0erRWhB7v>  
[https://youtu.be/kiW0MK1OI5c?si=MsxFIT3\\_58ENs-dy](https://youtu.be/kiW0MK1OI5c?si=MsxFIT3_58ENs-dy)  
<https://youtu.be/RXAelnun3II?si=8VyWCJewO3Uff4-2>  
<https://youtu.be/b1NMLXv7kZo?si=d-pO3GggwhjWc8OF>  
<https://youtu.be/tfNwUAZUU-O?si=PcsF1x8XXj8Od5q3>  
[https://youtu.be/iCLGQNEAs7o?si=s5nn\\_pYJwbkVYdRW](https://youtu.be/iCLGQNEAs7o?si=s5nn_pYJwbkVYdRW)  
[https://youtu.be/2xqCvoCI2\\_4?si=VsywHQmJ8tkaNenf](https://youtu.be/2xqCvoCI2_4?si=VsywHQmJ8tkaNenf)  
<https://youtu.be/2FsJAHOeAWM?si=MH5a6P3kAbgarG1F>

### 15. PO-COMPETENCY-CO MAPPING

Semester VIII	Process Equipment Design (Course Code: 4385502)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
<b>Competency</b>	<ul style="list-style-type: none"> <li>Design various parts of process equipment as per ASME- Sec VIII Div. 1.</li> <li>Design various machine elements used in process equipment.</li> <li>Able to draw 3D solid modeling by using CAD software.</li> </ul>						
CO1) Design basic elements of Process equipments as per applicable codes and standards.	3	2	2	-	-	-	2
CO2) Describe different machine elements used in process equipments.	3	2	2	-	-	-	2
CO3) Describe design consideration of various process equipments used in	3	-	1	-	-	-	3

chemical industries.							
<b>CO4)</b> Describe different hazards in process industries and its <b>safety measures</b> required in process equipment design.	2	-	-	-	2	-	2
<b>CO5)</b> Draw AutoCAD 3D drawing for given Job.	2	-	1	1	-	-	2

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. Samirbhai Y. Merchant <i>I/C H.O.D Fabrication Technology Department</i>	Sir Bhavsinhji Polytechnic Institute Bhavnagar	9428408314	<a href="mailto:symerchant72@gmail.com">symerchant72@gmail.com</a>
2.	Mr. Rohankumar B. Zapadiya <i>Lecturer in Fabrication Technology</i>	Sir Bhavsinhji Polytechnic Institute Bhavnagar	9033219351	<a href="mailto:rohan.zapadiya@gmail.com">rohan.zapadiya@gmail.com</a>
3.	Mr. Parthiv T. Trivedi <i>Lecturer in Fabrication Technology</i>	Sir Bhavsinhji Polytechnic Institute Bhavnagar	9924185501	<a href="mailto:trivediparthivbpti@gmail.com">trivediparthivbpti@gmail.com</a>

ANNEXURE-1

❖ SAMPLE SAFETY 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: Process Equipment Design (4385502)

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 been posted in the work areas.
- 3. Act in a responsible manner at all times in the laboratory.
- 4. Follow all instructions given by the faculty/Instructor.
- 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 using tools.
- 8. Cut or Tie back long hair, remove jewellery, secure loosed clothing, and wear boiler suit & safety shoes in the laboratory.
- 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: \_\_\_\_\_

Batch No.: \_\_\_\_\_

Enrolment No.: \_\_\_\_\_

Student Signature

\_\_\_\_\_