GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)
Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester - 6
Course Title: Process Equipment Design
(Course Code: 4360507)

Diploma programme in which this course is offered	Semester in which offered
Chemical Engineering	6

1. RATIONALE

Equipment design encompasses the process of defining various aspects of dimensions of equipments, such as diameter and length, along with the specification of thickness and the overall weight distribution across its components. Standard simulation software tools are readily available for the purpose of equipment design. Nevertheless, to effectively utilize these software applications and ensure their accurate implementation, a fundamental understanding of this field is crucial. Considering the rapid pace at which knowledge continues to evolve, it is imperative that students are well-informed about the most recent advancements in equipment design. This knowledge is especially vital for individuals aspiring to pursue careers as Design Engineers, Process Engineers, or Process Development Engineers. Furthermore, it proves beneficial for Production Engineers engaged in process plants, aiding them in effectively troubleshooting issues related to equipment operation.

2. COMPETENCY

To design various parts of process equipments and select the suitable equipment for the desired operation.

3. COURSE OUTCOMES (COs)

After applying the knowledge of chemical engineering in the field of the process design of the will achieve the following outcomes:

1. Understand the need of the process design in chemical engineering.
2. Apply the flow devices equipment design concept
3. Design of Heat Transfer Equipments
4. Design of Mass Transfer Equipments
5. Design of Chemical Process Reactors

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	
3	0	0	3	30*	70	0	0	100

(*):Out of 30 marks under the theory CA,10 marks are for assessment of the micro-project to facilitate the integration of COs, and the remaining 20 marks are the average of 2 tests to be taken during the semester for 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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
Not Applicable			

S.No.	Sample Performance Indicators for the PrOs	Weightage in %
Not Applicable		

6. MAJOR EQUIPMENTS/ 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.

S. No.	Equipment Name with Broad Specifications	PrO. No.
Not Applicable		

7. AFFECTIVE DOMAIN OUTCOMES

The following sampleAffective 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) Work as a leader/a team member.

b) Follow ethical practices c) Practice environmentally friendly methods and processes (environmental related).

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.

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) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Introduction to Process Engineering Design	1a. Describe the scope of Process Engineering 1b. Convert units 1c. Calculate the numericals of Dimensionless Number 1d. Draw block diagram, PFD and P&ID for given manufacturing process.	1.1Introduction to Process Engineering 1.2 Calculations related to Unit conversions 1.3 Define and Calculate various dimensionless numbers used in Process Design 1.4 Introduction to Block Diagram, PFD and P&ID
Unit– II Design of Piping, Fluid Moving Devices and Flow Meters	2a. Discuss methods of Piping design 2b. Write down design steps of Fluid Moving devices. 2c. Calculations related Schedule Number 2d. Discuss on trouble-shooting of Fluid Flow Systems 2e. Discuss Rules of Thumb for process design of fluid flow systems	2.1 Introduction to Process Design of Piping and Fluid Moving Devices 2.2 Numericals on Schedule Number Equation 2.3 Power Required in Fan, Blower and in Adiabatic Compressor 2.4 Troubleshooting of Fluid Flow Systems 2.5 Rules of Thumb for process design of fluid flow systems
Unit– III Design of Heat Transfer Equipments	3a. Classify Heat Exchangers 3b. Discuss types of S&T HE 3c. Describe the various parts of S&T HE 3d. Compare different S&T HE 3e. Explain different types of TEMA designations 3f. List steps for general design method of S&T HE 3g. Explain criteria of selection between Horizontal and Vertical Condenser 3i. Recall rule of thumb for Process Design of Heat Exchanger	3.1 Various types of Heat Exchangers 3.2 Types of Shell and Tube Heat exchangers and its parts 3.3 Advantages and Disadvantages of Different Types of Shell and Tube Heat Exchangers Over Each Other 3.4 Different Types of TEMA Designations 3.5 Steps to Design Shell and Tube Heat Exchangers 3.6 Criteria of Selection between Horizontal Condenser and Vertical Condenser 3.7 Rules of Thumb for Process Design of Heat Exchanger

Unit– IV Design of Mass Transfer Equipments	4a. Classify Mass Transfer Equipments 4b. Recall the general steps for design of distillation column. 4c. Discuss the advantages and disadvantages of Vacuum distillation 4d. Discuss the ways of Identifying VLE of system 4e. Calculate No. of theoretical steps for binary distillation using McCabe-Thiele Method 4f. Discuss the criteria for selection of an absorber 4g. Describe various internals for packed tower. 4h. Describe various internals for tray tower. 4i. Explain Phase Equilibrium Diagram for LLE 4j. Discuss the selection criteria of solvent for LLE 4k. Write the general design steps for counter-current LLE. 4l. Recall the industrial applications for Mass Transfer Operations 4m. Recall rules of thumb for Process Design of Distillation Column, Absorber and LLE.	4.1 Introduction to Mass Transfer Equipment 4.2 General steps for design of distillation column. 4.3 Advantages and Disadvantages of Vacuum distillation 4.4 Determination of VLE data 4.5 No of theoretical stages using McCabe Thiele Method 4.6 Criteria for selection of absorber 4.7 Internals for packed and tray columns 4.8 Phase Equilibrium Diagram for LLE 4.9 Choice of Solvent for LLE 4.10 General design steps for counter-current LLE 4.11 Industrial applications of various mass transfer operations 4.12 Rules of Thumb for Process Design of Distillation Column, Absorber and LLE.
Unit– V Design of Reactors	5a. Classify reactors 5b. Discuss different types of mixing devices used in Reaction systems 5d. Types of Heating Jackets and Coils 5e. Classify multi-phase reactors 5f. Recall Rules of Thumb for process and mechanical design of reactors	5.1 Introduction to Process Design of Reactors 5.2 Different types of Reactors 5.3 Different Types of Agitators 5.4Heat Transfer in Batch Reactors 5.5 Introduction to different types of multi-phase reactors 5.6 Rules of Thumb for process and mechanical design of reactors

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	**Introduction to Process Engineering Design**	5	3	3	3	9

II	**Design of Piping, Fluid Moving Devices and Flow Meters**	8	3	4	7	14
III	**Design of Heat Transfer Equipments**	9	3	4	7	14
IV	**Design of Mass Transfer Equipments**	14	6	7	10	23
V	**Design of Reactors**	6	3	4	3	10
Total		**42**	**18**	**22**	**30**	**70**

Examiners' and Paper Setters must follow the marks scheme while design of Question Papers, however a difference (∓5%) is acceptable.

10. SUGGESTED STUDENT ACTIVITIES

- Open source software like DWSIM, Thermosolver, ChemSep can be used for property prediction and design.
- Students can refer to video lectures available on the websites including NPTEL lecture series.
- Students can develop their own programs/spreadsheets for the solution of problems.
- Students' must go through handbooks to learn how to find and estimate literature data.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

- Case Studies of Process Design Engineering Problems
- Suggest students how advancement in design can solve major engineering problems in manufacturing

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. In the first four semesters, the micro-project is group-based (group of 3 to 5). However, in the fifth and sixth 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 the integration of PrOs, UOs, and ADOs. Each student will have to maintain dated work diary consist in go find individual contributions 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 (so that they develop industry-oriented COs).

A suggestive list of micro-projects is given here

1. Create drawing sheets on design of various parts of chemical engineering equipments.
2. Create drawing sheets for PFD and P&ID of various manufacturing process
3. Simulate chemical engineering processes in open sources process simulators
4. Use of spreadsheets for solving process calculations case study
5. Create small modular programs in open source softwares for iterative calculations

Faculties can give one or more of the above suggested micro-projects. This should relate highly to the competency of the course and the COs. Similar micro-projects could be added by the concerned course teacher.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Introduction To Process Engineering And Design	Shuchen B Thakore Bharat I Bhatt	Publisher: McGraw Hill Education; 2nd edition (2017), New Delhi ISBN-10: 935134178X ISBN-13: 978-9351341789
2	Chemical Engineering Design: Principles, Practice And Economics Of Plant And Process Design	Gavin Towler Ray Sinnott	Publisher: Butterworth-Heinemann Inc; 3rd edition (2021) ISBN-10 : 0128211792 ISBN-13: 978-0128211793
3	Ludwig's Applied Process Design for Chemical and Petrochemical Plants	A. Kayode Coker	Publisher: Gulf Professional Publishing; 4th edition (2010), ISBN-10: 075068366X ISBN-13: 978-0750683661
4	Perry's Chemical Engineers' Handbook	Don W. Green, Marylee Z. Southard	Publisher: McGraw Hill; 9th edition (2018), ISBN-10: 0071834087 ISBN-13: 978-0071834087
5	Chemical Process Equipment: Selection and Design	James R. Couper, W Roy Penney, James R. Fair	Publisher: Butterworth-Heinemann; 3rd edition (2012), ISBN-10 : 012396959X ISBN-13 : 978-0123969590
6	Rules Of Thumb For Chemical Engineers: A Manual Of Quick, Accurate Solutions To Everyday Process Engineering Problems	Carl Branan	Publisher: Elsevier (2008) ISBN-10: 813121737X ISBN-13: 978-8131217375
7	Process Engineering and Plant Design: The Complete Industrial Picture	Siddhartha Mukherjee	Publisher: CRC Press; 1st edition (2021), ISBN-10 : 0367248417 ISBN-13 : 978-0367248413
8	Chemical Process Equipment: Design And Drawing	Maidargi Suresh C.	Publisher: PHI Learning Pvt Ltd (2015), ISBN-10 : 9788120351509 ISBN-13 : 978-8120351509

14. SOFTWARE/LEARNING WEBSITES

1. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SCH1307.pdf
2. https://msubbu.in/ln/design/index.html
3. https://archive.nptel.ac.in/courses/103/107/103107207/

15. PO-COMPETENCY-CO MAPPING

Semester							
	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**
Competency							
CO1: Understand the need of the process design in chemical engineering.	3	-	-	2	1	-	1
CO 2: Apply the flow devices equipment design concept	2	3	2	1	-	-	2
CO 3: Design of Heat Transfer Equipments	3	3	3	1	1	-	2
CO 4: Design of Mass Transfer Equipments	3	3	3	1	1	-	2
CO 5: Design of Reactors	3	3	3	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

S. No.	Name and Designation	Institute	Contact No.	Email
1	Shri Parth S. Shah	Government Polytechnic, Gandhinagar	-	parthgcet@gmail.com
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