

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**Competency-focused Outcome-based Green Curriculum-2023(COGC-2021)**

Semester-V

Course Title: Chemical Engineering Project -I

(Course Code: 4350503)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5 th Semester

1. RATIONALE

Project work serves as a means for students to utilize their coursework knowledge and skills to solve particular problems or execute projects, ultimately fostering innovative skills. In addition, Developing a plant for a chemical product is a complex task that requires a comprehensive report encompassing various aspects such as the chemical process and unit operations, properties of raw materials and products, economic factors, safety and pollution issues, and material and energy consumption. Chemical engineering students need to prepare such reports to become successful entrepreneurs while keeping in mind sustainability factors. A wide range of sustainable chemical products can be chosen from different sectors, including petrochemicals, fertilizers, pharmaceuticals, pesticides, natural products, polymers, and dyes. Careful consideration must be given to major equipment specifications, plant layout, and location to ensure the sustainability and success of the project. The syllabus provided is a guide, and instructors have the option to motivate students to develop prototypes, conduct experiments, or generate novel ideas that spark innovation.

2. COMPETENCY

The course should be taught and curriculum should be implemented with the aim to develop required skills so that students are able to acquire following competency:

- **Identifying a chemical product, evaluating its essential features and characteristics, understanding the manufacturing processes involved, and selecting appropriate Process, equipment and instruments for the production.**

3. COURSEOUTCOMES(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 a chemical product based on market demand, raw material availability, and potential profitability.
- b) Analyze the market and historical trends of a chemical product and explain its essential features and characteristics.
- c) Evaluate the properties and applications of chemical products in different contexts.
- d) Identify critical steps involved in production process.
- e) Select major equipments and instruments for chemical manufacturing processes.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	4	2	0	0	50	50	

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. Some of the PrOs marked “*” (in approx. Hrs column) are compulsory, as they are crucial for that particular CO at the ‘Precision Level’ of Dave’s Taxonomy related to ‘Psychomotor Domain’.

Sr. No.	Practical/Exercise (Course Outcomes in Psychomotor Domain according to NBA Terminology)	Unit No.	Approx. Hrs Required
1	selecting one chemical product based on specific criteria such as demand, availability of raw materials, and potential profitability	1	8
2	Evaluate the historical development of the selected chemical product, including major breakthroughs, challenges	2	4
3	Compare the chemical and physical properties of the selected chemical product with other similar products in the market	3	4
4	Identify the various applications of the selected chemical product in different industrial and commercial contexts	3	8
5	Analyze the advantages and disadvantages of each manufacturing process for the selected chemical product to determine the most suitable sustainable process.	4	12
6	Create a flow diagram of the manufacturing process for the selected chemical product, including inputs and outputs at each step.	4	8
7	select and use appropriate equipment and instruments for the selected chemical process	5	12
Total			56

Note

- 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.
- 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 (The instructor is permitted to make slight modifications as deemed necessary).	Weight age in %
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1	Clarity and organization of the report	20
2	Demonstration of technical knowledge	25
3	Significance of problem/solution/conceptual feasibility analysis	15
4	Rigor and appropriateness of the methodology	15
5	Accuracy and relevance of the results	15
6	Analysis and interpretation of the results	05
7	Overall contribution to the field	05
Total		100

6. MAJOREQUIPMENT/INSTRUMENTSANDSOFTWAREREQUIRED: N/A

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 competency.

- a) Work as a leader/a team member.
- b) Follow ethical practices
- c) Observe safety measures
- d) Good house keeping
- e) Time management
- f) Practice environmentally friendly methods and processes.

The ADOs are best developed through 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. COURSE DETAILS

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit-I Chemical Product Selection and Market Analysis	1.1 Identify a chemical product by conducting a market survey	1. Choose a chemical product from a range of chemical sectors, including but not limited to petrochemicals, fertilizers, pharmaceuticals, pesticides, natural products, polymers, acids and alkalis, specialty chemicals, dyes, and pigments.
	1.2 selecting one based on specific criteria such as demand, availability of raw materials, and potential profitability.	

Unit-II Product survey and Industry Analysis	2.1 Explain the essential features and characteristics of the selected chemical product.	2.1 Introduction of the selected chemical product, including its essential features and applications
	2.2 Examine the current trends in the market and industrial landscape of the selected chemical product.	2.2 Historical development of the selected chemical product, including major milestones and breakthroughs.
	2.3 Evaluate the historical development of the selected chemical product, including major breakthroughs, challenges.	2.3 The current state of the selected chemical product, including market trends and major industries involved in its production.
Unit-III Characteristics and Application of chemicals involved in process	3.1 Discuss the chemical and physical properties of the raw materials used in the production of the selected chemical product, and their impact on the final product.	3.1 The properties of raw materials used in the production of the chemical product.
	3.2 Compare the chemical and physical properties of the selected chemical product with other similar products in the market (if any).	3.2 chemical and physical properties of the final product
	3.3 Identify the various applications of the selected chemical product in different industrial and commercial contexts.	3.3 Application of final product in different industrial and commercial contexts (Instructors are requested to stimulate students to think creatively and unconventionally).
Unit-IV Process Analysis for Sustainable Manufacturing	4.1 Understand the different manufacturing processes involved in producing a chemical product and their respective steps, inputs, and outputs.	4.1 Different manufacturing processes with flow diagram involved in producing the chemical product and their respective steps, inputs, and outputs.
	4.2 Analyze the advantages and disadvantages of each manufacturing process for the selected chemical product to determine the most suitable sustainable process.	4.2 Merits, demerits, and engineering challenges of each manufacturing process for the selected product.
	4.3 identify the critical steps in the production process.	4.3 Various critical steps in the production process.
	4.4 Create a flow diagram of the manufacturing process for the selected chemical product, including inputs and outputs at each step.	4.4 waste generation/environmental impact of each process.

Unit-V Selection of Major Process Equipments and Instrumentation	5.1 Identification of the necessary equipment and instruments for the selected chemical process	5.1 Description of the necessary equipment and instruments for the selected chemical process.
	5.2 Understanding the functions and roles of each equipment and instrument in the manufacturing process	5.2 Advantages and disadvantages of selected instruments.
		5.3 The functions and roles of each equipment and instrument in the manufacturing process.
	5.3 select and use appropriate equipment and instruments for the selected chemical process	5.4 Selection criteria for instrument

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN: N/A

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Following are the suggested student-related activities which can be undertaken to accelerate the attainment of the various outcomes in this course:

1. Industrial visit
2. Laboratories experiment
3. Literature Study
4. Attend Workshops
5. Internships
6. Take Part in Competitions
7. Course/topic based presentation

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) Faculty can act as mentors to their students, providing guidance and support as they work on their final year projects.
- b) Faculty can facilitate group work, encourage peer feedback and provide

- opportunities for students to work together on projects.
- c) Faculty can provide opportunities for students to work with laboratory equipment and conduct experiments, for example.
 - d) Guide students to address issues on environment and sustainability with reference to using the knowledge of this course.
 - e) Provide regular feedback and assessment on student work.
 - f) Faculty can provide resources and support for students to pursue their own interests and areas of study.
 - g) Faculty can provide opportunities for students to share their work with their peers and receive feedback.
 - h) Faculty can incorporate active learning strategies, such as group discussions and problem-solving activities, into their final year project instruction.

12. SUGGESTED MICRO-PROJECTS: N/A

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Books	Author	Publication with place, year and ISBN
1	Encyclopedia of Chemical Processing and Design	Jhon J. McKetta, William A. Cunningham	Marcel Dekker Inc., New York and Basel
2	Encyclopedia of Chemical Technology	Kirk and Othmer	John Wiley and Sons, Wiley Interscience
3	Ullman's Encyclopedia of Industrial Chemistry	Ullman	VCH Publishers, Germany
4	Chemical Process Technology Encyclopedia	Coincidine	McGraw-Hill
5	Perry's Chemical Engineers' Handbook	Robbert H. Perry, Down W. Green	McGraw-Hill
6	Plant Design and Economics for Chemical Engineers	Max Peters, Klaus Timmerhaus	McGraw Hill
7	Chemical Engineering Plant Design	Frank C. Vilbrandt, Charles E. Dryden	McGraw Hill
8	Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design	Gavin Towler, R. K. Sinnott	Butterworth-Heinemann
9	Process Engineering	James R. Couper	Marcel & Dekker Economics
10	Stoichiometry	B. I. Bhatt, S.M. Vora	Tata McGraw Hill
11	Safety and Accident Prevention in Chemical Operation	Faweett, Wood	Interscience Publishers
12	A course in Industrial Safety	K.U. Mistry	N.K.M. Publication

13	Pollution Control in Process Industries	S.P. Mahajan	Tata-McGrawHill
14	Safe Handling of Hazardous Chemicals	A.K. Rohatgi	J.K. Enterprise

14. SUGGESTED LEARNING WEBSITES

- <https://archive.nptel.ac.in/course.html>
- <https://chemicalengineeringworld.com>
- <https://www.chemengonline.com/>
- <https://chemicalengineeringsite.in/>

15. PO-COMPETENCY-CO MAPPING

Semester V	Chemical Engineering project –I (4350503)						
	POs						
Competency & Course Outcomes	PO1 Basic & Discipline-specific knowledge	PO2 Problem Analysis	PO3 Design/development of solutions	PO4 Engineering Tools, Experimentation & Testing	PO5 Engineering practices for society, sustainability & environment	PO6 Project Management	PO7 Life-long learning
Competency	Supervise operation and maintenance of various heat transfer equipments						
CO1: Select a chemical product based on market demand, raw material availability, and potential profitability.	3	1	-	1	1	-	1
CO2: Analyze the market and historical trends of a chemical product and explain its essential features and characteristics	1	2	1	2	-	-	3
CO3: Evaluate the properties and applications of chemical products in different contexts	2	-	-	-	2	-	2
CO4: Identify critical steps involved in production process	3	2	1	-	-	1	2
CO5: Select major equipment and instruments for chemical manufacturing processes.	2	-	2	1	1	1	1

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email ID
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