

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023(COGC-2021)

Semester-VI

Course Title: Chemical Engineering project -II

(Course Code: 4360505)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	6 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 Material balance, Energy balance, Economic evaluations, Safety, 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:

- **Experimentation/Research/ Understanding the manufacturing processes involved, Carry out material balance, Economic evaluations, Pollutions control, Safety and Waste Treatment etc.**

3. COURSE OUTCOMES(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) Apply the principles of material balance to calculate the mass flow in and out of a chemical process.
- b) Select appropriate utilities for chemical production process.
- c) Prepare plant layout for chemical production process.
- d) Examine economic feasibility of the chemical plant.
- e) Develop a strategy for ensuring safety and environmental protection.

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	100

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	Apply the principles of material balance to quantitatively calculate the mass flow in and out of a chemical process, ensuring the conservation of mass.	1	12
2	Select utilities for chemical manufacturing process.	2	4
3	Describe various utilities for chemical manufacturing process.	2	4
4	Evaluating a range of potential locations for a chemical plant.	3	8
5	Prepare plant layout	3	4
6	Explain Site selection parameters	3	4
7	Identify and categorize the various costs associated with plant establishment, operation, and maintenance.	4	4
8	Prepare Economic evaluation of plant.	4	8
9	Prepare MSDS for raw materials and Product.	5	4
10	Discuss appropriate waste treatment method.	5	4
Total			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. 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 %
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. MAJOR EQUIPMENT/INSTRUMENTS AND SOFTWARE REQUIRED: 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. SUGGESTED COURSE DETAILS:

Unit	Major Learning Outcomes(Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit-I Material Balance Calculations for Chemical Processes	Apply the principles of material balance to quantitatively calculate the mass flow in and out of a chemical process, ensuring the conservation of mass.	1. Balancing Reactors: Mass in and out of chemical reactors, stoichiometry, extent of reaction, and conversion. 2. Distillation and Separation Processes: Mass in and out of distillation columns, separation efficiency, and component recovery. 3. Filtration and Separation: Mass flow in filtration, separation factors, and solid-liquid separation. 4. Sequential Processes: Mass balance through a series of unit operations, cumulative material balance. 5. Recycle and Bypass Streams: Handling recycle streams, calculating fresh feed requirements, and bypass streams.
Unit-II Utilities in Chemical Manufacturing Processes	Select utilities for chemical manufacturing process. Describe various utilities for chemical manufacturing process.	Utilities such as: Electricity, Water, Steam, Gases etc. in Chemical Processes.
Unit-III Site selection and plant layout	Evaluating a range of potential locations for a chemical plant. Prepare plant layout	1) Site Selection Parameters: Geographic Location, Infrastructure Availability, Environmental Impact and sustainability.

	Explain Site selection parameters	2) Plant Location: Market Accessibility, Infrastructure Assessment, Cost Analysis, Site Evaluation.
		3) Plant Layout: Space utilization and optimization, Material Handling, Safety Design, Environmental Considerations
Unit-IV Economic assessment	Identify and categorize the various costs associated with plant establishment, operation, and maintenance.	Various costs associated with the design, construction, and operation of the plant such as: ROI, Revenue and Profitability, Payback Period, Total capital investment, Fixed Capital Investment, Working Capital Investment, Depreciation, Break even analysis etc.
	Prepare Economic evaluation of plant.	
Unit-V Material Safety Information and Effective Waste Handling	Identifying, evaluating, and communicating the hazards, safety measures with these substances, ensuring the safety and well-being of individuals and the environment.	<p>1) For Raw Materials: Identification and Classification, Physical and Chemical Properties, Hazards Identification, First Aid Measures, Fire-Fighting Measures, Accidental Release Measures, Handling and Storage.</p> <p>2) For Products: Transport Information, Disposal Considerations, Physical and Chemical Properties, Stability and Reactivity and remaining same as raw material.</p>

	Discuss appropriate waste treatment method for environmental safety and sustainability.	1) Waste Minimization and Source Reduction, Physical, chemical and biological Treatment. Recycling and Reuse, Emerging green Technologies and Innovations.
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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 –II(4360505)						
	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	Understanding the manufacturing processes involved, Carry out material balance, Energy balance, Economic evaluations, Pollutions control, Safety and Waste Treatment						
CO-1 Apply the principles of material balance to calculate the mass flow in and out of a chemical process.	2	1	1	1	-	1	-
CO-2 Select appropriate utilities for chemical production process.	1	-	2	-	2	1	1
CO-3 Prepare plant layout for chemical production process.	1	1	1	-	2	2	1
CO-4 Examine economic feasibility of the chemical plant.	2	1	1	-	1	2	2
CO-5 Develop a strategy for ensuring safety and environmental protection.	1	-	1	1	3	1	2

16. SUGGESTIVE PROJECT REPORT FORMAT

Diploma Engineering

Project Report

(Chemical Engineering project –I /II)

(4350508/4360505)

[CHEMICAL SEM-5/6]

Enrolment No	
Name	
Branch	
Academic Term	
Institute	



**Directorate Of Technical Education
Gandhinagar - Gujarat**

DTE's Vision:

- To provide globally competitive technical education;
- Remove geographical imbalances and inconsistencies;
- Develop student friendly resources with a special focus on girls' education and support to weaker sections.
- Develop programs relevant to industry and create a vibrant pool of technical professionals.

Institute's Vision:**Institute's Mission:****Department's Vision:****Department's Mission:**

Certificate

This is to certify that Mr./Ms
Enrollment No. of Semester of *Diploma*
in.....of.....
..... (GTU Code) has satisfactorily completed the Project work in course
Chemical Engineering project –I/II (4350508/4360505) for the academic year:
Term: Odd/Even prescribed in the GTU curriculum.

Place:.....

Date:

Signature of Project Guide

Head of the Department

Instructions:

- Report should start with cover page consisting of GTU logo, institute logo and department logo, along with project details such as name and enrolment number of students, guide name, project title, and year of submission, semester etc.
- The report should consist of above three pages after the cover page.
- Report should include Acknowledgement, Abstract, Index, conclusion and references along with content.
- Report should be in Times new roman fonts only, with Main title size 16-bold, heading size 14 –bold, Sub heading 12-bold and main content size 12.
- Report should contain proper header and footer. The header should contain project title, subject code and year of project. Whereas footer should contain page number and department name. Size should be 10 in both header and footer.
- Please ensure that the project report adheres to the correct format, using your discretion.

- **Suggestive index for reference-Chemical engineering project-I**

Sr No.	Title	Page no.
1	Chemical Product Selection and Market Analysis	
	1.1 Introduction	
	1.2 Market analysis-Market size ,List of manufacturer, Availability of raw material etc.	
2	Product survey and Industry Analysis	
	2.1 Essential features and applications	
	2.2 Historical development	
	2.3 Current market trends	
3	Characteristics and Application	
	3.1 Chemical and physical properties of Raw materials	
	3.2 Chemical and physical properties of Final product	
	3.3 Application of final product	
4	Process Analysis	
	4.1 Different manufacturing processes	
	4.2 Merits, demerits of manufacturing processes	
	4.3 Engineering challenges of manufacturing processes	
	4.4 Various critical steps of production processes	
	4.4 Determine the most suitable sustainable process	
	4.5 Flow diagram of selected process with description	
	4.6 waste generation and environmental impact	
5	Major Process equipments and Instrumentation	
	5.1 Necessary equipments and instruments	
	5.2 Advantages and disadvantages of instruments and equipments	
	5.3 Selection criteria	
	5.4 Functions and roles of equipments and instruments	
6	Conclusion	
7	References	

- **Suggestive index for reference-Chemical engineering project-II**

Sr No.	Title	Page no.
1	Material Balance	
2	Utilities in Chemical Manufacturing Processes	
	2.1 List of utilities	
	2.2 Justification for selected utilities	
3	Site selection and plant layout	
	3.1 Site Selection Parameters	
	3.2 Plant Location Analysis	
	3.3 Plant layout	
4	Economic assessment	
	4.1 Costs associated with the design, construction, and operation	
5.	Material Safety Information	
	5.1 Raw Materials	
	5.2 Product	
	5.3 Specific safety concern	
6	Effective Waste Handling	
	6.1 List of waste generated	
	6.2 Waste treatment method	
	6.3 Emerging Sustainable- Green Technologies and Innovations	
7	Conclusion	
8	References	

17. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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