

**COURSE CODE:** ENE-435  
**COURSE NAME:** Cleaner Production Techniques  
**CREDIT HOURS:** Theory = 2 Practical = 0 Total = 2  
**CONTACT HOURS:** Theory = 32 Practical = 0 Total = 32  
**PREREQUISITE:** None  
**MODE OF TEACHING:** Two hours of lecture per week

**COURSE DESCRIPTION:**

The course will present issues involved in developing and implementing cleaner production techniques. Current developments in industrial approaches towards equipment selection will be discussed. The course will also help students to learn simple basic design of engineering systems based on the given set of engineering data.

**COURSE OBJECTIVES:**

The primary objectives of this course are to acquire basic understanding and technical knowledge on greener and cleaner production options so that students can proactively decide and select better options relevant to good housekeeping, process optimization, product modification and better process control.

**RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**

The course is designed so that students will achieve the PLOs:

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|------------------------------------|-------------------------------------|-----------------------------------|--------------------------|
| 1 Engineering Knowledge:           | <input checked="" type="checkbox"/> | 7 Environment and Sustainability: | <input type="checkbox"/> |
| 2 Problem Analysis:                | <input type="checkbox"/>            | 8 Ethics:                         | <input type="checkbox"/> |
| 3 Design/Development of Solutions: | <input checked="" type="checkbox"/> | 9 Individual and Teamwork:        | <input type="checkbox"/> |
| 4 Investigation:                   | <input type="checkbox"/>            | 10 Communication:                 | <input type="checkbox"/> |
| 5 Modern Tool Usage:               | <input type="checkbox"/>            | 11 Project Management:            | <input type="checkbox"/> |
| 6 The Engineer and Society:        | <input checked="" type="checkbox"/> | 12 Lifelong Learning:             | <input type="checkbox"/> |

**COURSE LEARNING OUTCOMES:**

Upon successful completion of the course, the student will demonstrate competency by being able to:

S. No.	CLOs	Domain	Taxonomy Level	PLOs
1	<b>UNDERSTAND</b> the basic concept and knowledge of cleaner production techniques.	Cognitive	2	1
2	<b>ANALYZE</b> decisions to select required technology for cleaner production	Cognitive	4	6
3	<b>EXAMINE</b> calculations to work out required sizing of the process and equipment.	Cognitive	4	3

#### **Complex Engineering problem**

4	<b>ANALYZE</b> and examine an engineering solution for solid or liquid waste recycle and reuse to make valuable products from industrial waste using concepts of cleaner production techniques, then based on the solution students will propose suggestions for implementation to the industry administration.	Cognitive	4	3
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#### **PRACTICAL APPLICATIONS:**

The course will help the students to understand the modern concepts of cleaner production and the applications for improving industrial operations. Moreover, this course will also help the students interested in further pursuing research in various environmental domains including green chemistry, circular economy and technoeconomic analysis.

#### **TOPICS COVERED:**

Week	Topics Covered	Reading Assignment/ Homework	CLO #
1-2	Basic definitions. Introduction to processes and techniques for cleaner production, Phases in cleaner production	Chapter 1 Assignment 1 Quiz 1 & 2	1
3-4	Drivers of cleaner production Cleaner production strategies		
5-6	Water and Energy Audit. Management practices for cleaner production Concept of recycle & reuse.	Chapter 2 Quiz 3	1, 2
7-8	Case studies and calculation examples	Chapter 2	3
<b>Mid Semester Exam</b>			
9-10	Alternate energy to replace conventional fossil fuels for industrial application	Chapter 3	2, 3

11-12	Off Grid Solar Design to Minimize Carbon Emissions.	Quiz 4 Assignment 2	
13	ISO Certifications and Their Importance, ISO 14000 & 9000 - Clauses, Sub-Clauses and Documents Legal Terminologies in Clean Production Techniques.	Chapter 4 Quiz 5	1, 2
14	<b>CEP</b>		4
15-16	Concept of Future Sustainability in Clean Production, Discussion on Case Studies.	Chapter 5 Quiz 6	2
<b>End Semester Exam</b>			

### TEXT AND MATERIAL:

#### Textbook (s)

1. Sustainable Industrial Design and Waste Management: cradle to cradle for sustainable development by Salah El Haggag 2010 version.

#### References Material:

2. Kenneth L. Mulholland, Identification of Cleaner Production Improvement Opportunities, 2006, Wiley-Blackwell, ISBN: 0471794406
3. E-book: Separation Process Engineering, Includes Mass Transfer Analysis, Third Edition by Phillip C. Wankat, Chap 12
4. Wastewater Engineering: Treatment and Reuse by Metcalf-eddy

### ASSESSMENT SYSTEM:

<b>Theoretical/Instruction</b>	<b>100%</b>
Assignments	10%
Quizzes	15%
Mid Semester Exam	25%
End Semester Exam	50%
<b>Practical Work</b>	<b>0%</b>
Lab Attendance	0%
Lab Report	0%
Lab Quiz	0%
Lab Rubrics	0%