

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**ENVIRONMENTAL SCIENCE AND TECHNOLOGY (35)**  
**SUSTAINABLE DEVELOPMENT & GREEN TECHNOLOGIES**  
**SUBJECT CODE: 2183504**  
**B.E. 8<sup>TH</sup> SEMESTER**

**Type of course:** Process modification in Environmental Science & Technology

**Prerequisite:** Basic Concepts and equations regarding organic and inorganic chemistry and some basic knowledge of sustainability.

**Rationale:** This subject introduces concepts green chemistry and different techniques to achieve sustainability.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		ESE (V)		PA (I)		
				PA	ALA	ESE	OEP			
3	0	2	5	70	20	10	20	10	20	150

**Content:**

Sr. No.	Content	Total Hrs	% Weightage
1.	Principles of sustainable developments, Concepts of green chemistry, atom economy, waste prevention and minimization of waste generation. Catalysis and green chemistry, solvent free systems, super critical fluids, ionic liquids, microwave and sono chemistry.	18	30
2.	Concept of Cleaner Production ,Definition of Cleaner Production, Cleaner Production and End of Pipe Solution, Good House Keeping checklist, tools to be discuss in details with example, Material and Energy Balance of Process , CP Methodology, Barriers and Drivers in cleaner production, Case studies	18	30
3.	Green Productivity concepts, methodology & techniques, Guidelines of APO on Green Productivity, CEPI Index	10	20
4.	Emerging technologies and their techno economic evaluation	10	20

### Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
28	24	26	11	8	-

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

### Reference Reference Books:

- 1) An Introduction to Green Chemistry Matlack A.S., Marcel Dekker, 2001
- 2). Green Chemistry: Theory and Practice, Anastas P.T. and Wavner J.C.;Oxford University Press, 1998
- 3) An Introductory Text on Green Chemistry, Lancaster M., Royal Society of Chemistry, Cambridge, 2002
- 4) Handbook of Green Chemistry and Technology, Clark J.H. and Macquaries, Blackwell Publishers, 2002
- 5) Cleaner Production and its implementation in Industries , Dr Bharat Jain, GCPC

**Note: Apart from above references one can use some other books and material if required.**

### Course Outcome:

After learning this course the students should be able to

- 1) Understand and choose the different principles of green chemistry and sustainable development for various applications.
- 2) Understand the concepts of Cleaner Technologies.
- 4) Practical applications of Green Productivity and emerging technologies

### List of experiments

1. Atom economical reactions
2. Acetylation of primary Amine.
3. Base catalyzed aldol condensation.
4. Halogen addition to C=C bond.
5. [4+2] Cycloaddition Reaction.
6. Green Photochemical Reaction.
7. Assessment for cleaner production
8. Calculation of CEPI index

### Open ended project

Minimum 5 practical to be performed and remaining time should be allotted to open ended projects/ study reports/ latest outcomes in technology study:

1. In the beginning of the academic term, faculties will have to allot their students at least one Open ended Project / Study Report / Latest outcome in technology.
  2. Literature survey including patents and research papers of fundamental process - Design based small project or
- Study report based on latest scientific development or
  - Technology study report/ modelling/ simulation/collection report or

- Computer based simulation/ web based application/ analysis presentations of basic concept field which may help them in chemical engineering.

3. These can be done in a group containing maximum three students each.

4. Faculties should cultivate problem based project to enhance the basic mental and technical level of students

5. Evaluation should be done on approach of the student on his/her efforts (not on completion) to study the design module of given task

6. In the semester student should perform minimum 5 set of experiments and complete one small open ended dedicated project based on engineering applications.

**ACTIVE LEARNING ASSIGNMENTS:** Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.