

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**CIVIL AND INFRASTRUCTURE ENGINEERING**  
**GREEN CHEMISTRY AND TECHNOLOGY**  
**SUBJECT CODE:2134004**  
 B.E. 3<sup>rd</sup> Semester

**Type of course:** Foundation course of Civil & Infrastructure Engineering

**Prerequisite:** No Prerequisite

**Rationale:** Green Chemistry and Technology is providing conceptual understanding of environmental chemistry and engineering.

**Teaching and Examination Scheme:**

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

**Topics:**

Sr. No.	Content	Total Hours	% Weightage
1	<p><b>Principles and Concepts of Green Chemistry:</b> Sustainable development, atom economy, reducing toxicity. Waste: production, problems and prevention, sources of waste, cost of waste, waste minimization technique, waste treatment and recycling.</p> <p><b>Green energy:</b> sources, efficiency and sustainability, energy from biomass and solid waste, Biofuels, alcohol, hydrogen production technology, biofuels from Jatropa</p>	8	19
2	<p><b>Introduction to renewable energy sources:</b> solar, wind, hydro, geothermal, ocean, fuel cells.</p> <p><b>Solar Energy:</b> Sun as Source of Energy, Availability of Solar Energy, Nature of Solar Energy, Solar Energy &amp; Environment. Various Methods of using solar energy –Photothermal, Photovoltaic, Photosynthesis, Present &amp; Future Scope of Solar</p> <p><b>Bio-mass Energy:</b> Biomass: Generation and utilization, Properties of biomass, Agric ulture Crop &amp; Forestry residues used as fuels. Biochemical and Thermo-chemical Conversion, Combustion, Gasification.</p>	20	47

	<p><b>Bio Energy:</b> Importance of biogas technology, Different Types of Biogas Plants. Aerobic and anaerobic bioconversion processes, various substrates used to produce Biogas (cow dung, human and other agricultural waste, municipal waste etc.); Removal of CO<sub>2</sub> and H<sub>2</sub>O, Application of Biogas.</p> <p><b>Wind, Geothermal, Tide and Wave Energy:</b> Wind Energy, Basics &amp; Power Analysis, Wind resource assessment, Power Conversion Technologies and applications, Wind Power estimation techniques, Site Selection, Concept of wind farm, Availability of Geothermal Energy-size and Distribution, Recovery of Geothermal Energy, Various Types of Systems to use Geothermal Energy.</p>		
3	<p><b>Green Environmental Issues:</b> Introduction – Ecological and carbon foot print, carbon credits, clean development mechanism</p>	6	14
4	<p><b>Air Pollution:</b> Definition, Composition of atmospheric air, Classification and sources of air pollutants. Effects of air pollution on human, plant and material, Air pollution control methods.</p>	4	10
5	<p><b>Water &amp; Waste Water Characteristics:</b> Indian standards for water and waste water, Analytical methods of commonly encountered water and waste water quality parameters: pH, Alkalinity, Odor, Color, Solids, Turbidity, Hardness, Chlorine dose, etc.</p>	4	10

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

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	35	20	10	10	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above

**Course Outcome:**

After learning the course the students should be able to:

- Understand the principles, concepts and waste minimization of Green Chemistry
- Understand the concepts of green environmental issues
- Understand the quality and characteristics of water and waste water
- Determine various water/air quality parameters
- Understand the basic principles of house drainage and solid waste management
- Understand the fundamentals of air pollution

**List of Experiments:**

- Introduction to Equipment in Environmental Engineering Laboratory
- Introduction to Standards, Sampling, Collection and Preservation of samples
- Determination of pH and conductivity for water and wastewater

- Determination of Solids ( suspended, dissolved and settleable)
- Determination of Acidity and Alkalinity
- Determination of hardness and residual chlorine
- Determination of fluoride and nitrate
- Determination of chloride and residual chlorine of water samples
- Ambient air quality measurement using High Volume sampler
- Exhaust gas analysis for air pollutants

**Reference:**

- P. T. Anastas and J.C. Warner, Green Chemistry, Theory and Practice Oxford, 2000.
- M. Doble and A. K. Kruthiventi, Green Chemistry and Engineering, Academic Press, Amsterdam, 2007.
- Mike Lancaster, Green Chemistry: An Introductory Text, Royal Society of Chemistry, 2002.
- R. E. Sanders, Chemical Process Safety: Learning from Case Histories, Butterworth Heinemann, Boston, 1999.
- H.S. Peavy, D.R. Rowe and G. Tchbanoglous, Environmental Engineering, McGraw Hill International Edition.
- M. L. Davis, Water and waste water Engineering, Mc Graw Hill education (India) Pvt. Ltd. 2013 edition.
- A.P. Sincero and G.A. Sincero, Environmental Engineering, Prentice Hall of India, New Delhi.
- G. Tchabanoglous, Solid Waste Treatment and Disposal, McGraw Hill Pub.
- G.S. Birdie and J.S. Birdie, Water Supply and Sanitary Engineering, Dhanpat Rai Publishing Co. New Delhi.
- H.C. Parkins, Air Pollution, McGraw-Hill Pub.
- J.A. Salvato, Environmental Sanitation, Wiley Interscience.
- L.W. Canter, Environmental Impact Assessment, McGraw Hill Pub.
- M.L. Davis and D.A. Cornwell, Introduction to Environmental Engineering, McGraw Hill International edition.
- Metcalf and Eddy,(Revised by G. Tchobanoglous Wastewater Engineering:Treatment, disposal Reuse, Tata-McGraw Hill, New Delhi. V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, Ane Books India, New Delhi, 2006.
- M. M. Srivastava, R. Sanghi, Chemistry for Green Environment, Narosa, New Delhi, 2005.

**Major Equipment:**

1. pH meter
2. TDS meter
3. High volume sampler
4. Exhaust gas analyser
5. Ion selective meter for Fluoride and Chloride estimation

**List of Open Source Software/learning website:**

1. ocw.mit.edu
2. nptel.ac.in

**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.