GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160514
Semester – VI
Subject Name: Green Technology and Sustainable Development

Type of course: Open elective course

Prerequisite: None

Rationale:
To provide an idea on Green Technology with an approach towards the design, manufacturing and use of chemical products to reduce or eliminate the chemical hazards intentionally. Green Technology is a new and rapidly emerging branch of chemistry. The goal of Green Technology is to create better and safe chemicals while choosing the safest and the most efficient ways to synthesize them. The main goal of Green Technology is to eliminate hazards right at the design stage. The principles of Green Technology demonstrate how chemical production could be achieved without posing hazard to human health and environment.

Students will learn the concept of sustainable development including different perspectives, consequences of societal resource use and strategies for changing this concept towards a sustainable direction.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs	% weightage
1	**Principles of Green Technology and Green Engineering:** To learn to modify the processes and products to make them green safe and economically acceptable to the society, Concepts of green chemistry and Process intensification.	07	15
2	**Green Synthesis and Catalysis:** Green oxidation and photochemical reactions, Microwave and Ultrasound assisted reactions, Synthesis of Green Reagents, Green solvents, Green nanotechnology and Ionic liquids.	07	20
3	**Green Industrial Processes:** Pollution statistics from various industries like polymer, textile, pharmaceutical, dyes, pesticides and wastewater treatment. A greener approach towards all these industries.	07	15
4	**Meaning of Sustainable Development:** Understand the Sustainable Development, three principal dimensions: the ecological, the economic and the social dimension, including intergenerational justice; use a systems perspective, to describe sustainability challenges and possibilities for major technical systems and for their transformation to meet sustainability requirements	07	15
5	**Concepts of Cleaner Technologies:** Cleaner Production (CP), Definition, methodology, Role of CP in Achieving Sustainability, Benefits, Role of Industry, Government and Institutions, Environmental Management	10	20

	Hierarchy, Relation of CP and EMS. CP case studies: Ammonical nitrogen recovery from wastewater, Fluoride removal from wastewater, Reuse of water from sewage treatment plant, Gas quenching process: replacement of oil with nitrogen and Reduction of hydrogen cyanide from process stack. Reuse of liquid industrial waste from several industries.		
6	**Challenges and Practical Implementation:** Responsibilities and potentials of companies for action. Green Productivity and emerging technologies. Implementation of the practical applications of Green emerging technologies and sustainable development. Case studies in Green Technology. Green laws compliance.	**07**	**15**

Reference:

1. Chemistry for Environmental Engineering and Science, Sawyer C.N, McCarty P.L and Parkin G.F. 5th ed. McGraw-Hill Professional, 2003.
2. Environmental Chemistry with Green Chemistry, Das A. K. Books and Allied (P) Ltd., Kolkata, India, 2012.
3. Green Chemistry: Environmentally Benign Reactions, Ahluwalia, V.K. Ane Books India, New Delhi, India, 2006.
4. Green Chemistry: An Introductory Text, Lancaster M. Royal Society of Chemistry, Cambridge, 2002.

Text Books

1. Introduction to Green Chemistry, Matlack A.S. Publisher: Marcel Dekker, Newyork, 2001.
2. Green Chemistry: Theory and Practice, Anastas P.T. and Warner J.C. Oxford University Press, 1998.
3. Pollution Prevention: Fundamentals and Practice, Bishop P. L. McGraw-Hill, Boston, 2000.
4. Cleaner Production Audit Environmental System Reviews, Modak P., Visvanathan C. and Parasnis M. Asian Institute of Technology, Bangkok, 1995.
5. Handbook of Green Chemistry and Technology, Clark J.H. and Macquarrie D.J. Wiley-Blackwell Publishers, 2002

Other references

List of Open Source Software/learning website: www.nptel.iitm.ac.in/courses/

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	**15**	**15**	**5**	**5**	**0**

Legends: R: Remembrance, U: Understanding, A: Application, N: Analyze, 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.

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Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To understand the principles of green chemistry and engineering	15
CO-2	To understand the field of Green Technology and its approach towards the new discovery and innovation	20
CO-3	To gain knowledge on Green industrial processes	15
CO4	To understand the concept of sustainable development and its importance	15
CO-5	Ability to describe Cleaner Production measures applicable to different industries	20
CO-6	Understand and select the different principles of green chemistry and sustainable development for various applications.	15

List of Tutorials: Students can select any type of green technology and sustainable development method. Each group of students is expected to create a way to utilize green technology and sustainable development process of industry in an innovative way and prepare report of project assigned to his/her group. In addition, each group is expected to give a power point presentation during the semester. The presenter will be selected randomly just prior to the presentation.

List of Open Source Software/learning website: Students can refer to video lectures available on various websites including NPTEL. Students can refer to the CDs which are available with some reference books for the solutions of problems using software's. Students can develop their own programs for the solutions using excel, ChemCAD and other simulation software's.