SEMESTER 7th **Subject: Chemistry**
CONTACT HOURS: 64 **CREDIT: 04**
COURSE: MAJOR/MINOR
Title: GREEN CHEMISTRY

CHMC1722M

Learning objectives:

To transmit to the students the knowledge of green Chemistry and its future aspects.

Learning Outcomes:

After completion of the course, the students shall be able to

- *Understand the need to study Green Chemistry and its principles.*
- *Know the different techniques employed in Green Chemistry.*
- *Comprehend real cases of green synthesis and know the future trends in green Chemistry.*

Unit-I: Green Chemistry and Green Chemical Synthesis (16 hours)

Green Chemistry-need and goals, twelve basic principles of green Chemistry, Practical limitations in the pursuit of Green Chemistry goals.

Green solvents- Supercritical fluids, water as a solvent for organic reactions, ionic liquids. Energy requirement for the reactions- alternative sources of energy, careful use of protecting groups, catalysis and green chemistry, comparison of homogenous and heterogeneous catalysis, biocatalysts, asymmetric catalysis and photo catalysis. Improvement of analytical techniques to prevent generation of hazardous substances in chemical processes.

Unit-II: Examples of Green Synthesis and Selected cases of real world cases (16 hours)

Green synthesis of adipic acid, disodium iminodiacetate (alternative to Strecker synthesis). Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols: microwave assisted reactions in organic solvents, Diels-Alder reaction and Decarboxylation reaction. Ultrasound assisted reactions: sonochemical Simmons-Smith reaction. Surfactants for carbon dioxide replacing- smog producing and ozone depleting solvents with carbon dioxide, Oxidation reagents and Catalysis; Biomimetic, multifunctional reagents; Proliferation of solvent free reactions

Unit-III: Sustainable Energy Resources (16 hours)

Energy Sources: Energy resources (Conventional and nonconventional) and their classification, Energy needs of India, and energy consumption patterns. Introduction to energy sustainability; Introduction to Sustainable Energy Systems including thermal (Rankine/Brayton cycle) conversion.

Solar Energy: Types of collectors, Collection systems, efficiency calculations, applications- solar heating and cooling techniques, solar distillation and drying, photovoltaic energy conversion, solar cells, cell technologies

Wind Energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics.

Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India. OTEC: Principles, utilization, setting of OTEC plants, thermodynamic cycles.

Unit-IV: Alternative Energy Resources **(16 hours)**

Fuel Cells: Fundamentals of fuel cells, including thermodynamics, electrochemistry, and basic principles of operation. Types of fuel cells (e.g., PEMFC, SOFC, AFC) and their specific characteristics, components, and applications.

Nuclear Energy: Nuclear fusion, Nuclear fission, Applications of Nuclear energy. Advantages and disadvantages.

Batteries: Primary and Secondary Battery, Lithium Ion Battery, Lead Storage Battery, Nickel Metal Hydride Battery.

Supercapacitors. Hydrogen as fuel, its generation and storage, Hydropower-advantages and drawbacks.

Books Recommended:

1. V.K. Ahluwalia and M.R. Kidwai, New Trends in Green Chemistry, Annamalaya Publishers, 2005.
2. V.K. Ahluwalia, Green Chemistry: A Textbook, Alpha Science International limited, 2013.
3. M.Lancaster, green Chemistry; An Introductory Text, RSC Publishing, 2nd Edition, 2010.
4. P.T. Anastas and J.C. Werner, Green Chemistry; Theory and Practice, Oxford University, 1998.
5. Renewable Energy sources and Emerging Technologies; D. P. Kothari, K. C. Singal, Rakesh Ranjan, PHI Learning, 3rd Edn. 2022.
6. Renewable Energy- Power for Sustainable Future; 3rd Edn. Godfrey Boyle, Oxford University Press 2012.
7. Sustainable Energy – Choosing Among Options. J.W. Tester, E.M. Drake, M.W. Golay, M.J. Driscoll, and W.A. Peters. MIT Press (2005)
8. Energy and the Environment, James A. Fay & Dan S. Golomb
9. Energy and Civilization: A History, Vaclav Smil, The MIT Press (2017).
10. Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers. C. S. Solanki, PHI Learning Pvt. Ltd. 2013.
11. S. P. Sukhatme and J. K. Nayak, "Solar Energy: Principles of Thermal Collection and Storage"