24MS802 CARBON CAPTURE, STORAGE AND UTILIZATION 4-0-0-4

Prerequisites: NIL

Syllabus

Module – I
Climate Change and Greenhouse Gas Emissions: Emission Trends and Drivers, Anthropogenic Activities, Consequences of GHG Emissions – Global Warming, Ocean Acidification, Extreme Climate Events, Desertification, Glacial Melting, Sea Level Rise, Species Extinction; Carbon Footprint and Its Evaluation; Emission Targets and Net Zero Emission Management.

Module – II
Carbon Capture Technologies: Pre-Combustion, Post-Combustion, Oxyfuel Combustion Technologies; Direct Air Capture, Chemical Looping Combustion, Integrated Gasification Combined Cycle, CO_2 Capture from Post-Combustion Flue Gas, Water Gas Shift Reactions, Reactive CO_2 Absorption, Pressure Swing Adsorption.

Materials for CO_2 Capture (Selection of systems such as): MOFs, Ionic Liquids, Gas Hydrates, CO_2 Separation Membranes, Catalysts in Reactive Systems, Hydrogen and Carbon Capture, Polymer Membranes, Porous Carbon Membranes, Zeolites, Composites.

Module – III
Carbon Sequestration Technologies: Underground Storage, Offshore Storage, Geological Storage, Deep Saline Aquifers, Reservoirs, Coal Fields, Forests and Nature-based Solutions, Biomimetic and Bio-Sequestration of CO_2, Enhanced Oil Recovery, Deep Eutectic Solvent and Amines.

Module – IV
CO_2 Conversion and Utilization: CO_2 Reduction to Feedstock Chemicals – Thermochemical, Photocatalytic, Electrocatalytic and Photoelectrocatalytic Processes; Designing Catalysts for CO_2 Conversion; Bioenergy with carbon capture and storage (BECCS) and bioenergy with biological carbon capture and storage (BEBCCS) technologies.

TEXTBOOK/REFERENCE:
1. M. Goel, M. Sudhakar, R. V. Shahi (ed.), "Carbon Capture, Storage and Utilization: A Possible Climate Change Solution for Energy Industry", Routledge, 2018.
2. H. Suleman, P. L. Fosbøl, R. Nasir, M. Ameen (ed.), "Sustainable Carbon Capture: Technologies and Applications", CRC Press, 2022.
3. K. Ballerat-Busserolles, Y. Wu, J. J. Carroll, "Cutting-Edge Technology for Carbon Capture Utilization and Storage", Wiley Scrivener Publishing, 2018.
4. D.-E. Jiang, S. M. Mahurin, S. Dai, "Materials for Carbon Capture", Wiley, 2020.
5. Relevant recent journal and popular articles on Carbon Capture, Utilization and Storage.

Course Outcomes:

CO Code 24MS802	**Course outcome statement**
CO.1	Describe the linkages between CO_2/other GHG emissions and climate change. Explain emission trends, drivers, and consequences, emission targets & net zero emission management. Calculate carbon footprints.
CO.2	Evaluate the major carbon capture technologies, their critical parameters, and develop strategies for designing materials used in them.
CO.3	Evaluate the major carbon storage technologies, their critical parameters, and develop strategies for designing materials used in them.
CO.4	Evaluate the major carbon conversion and utilization technologies, their critical parameters, the major feedstock chemicals, and develop strategies for designing materials used in them.

Outcome Mapping:

CO Code 24MS802	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO.1	2		1	1	1	1
CO.2	2		1	2	2	3
CO.3	2		1	2	2	3
CO.4	2		1	2	2	3