CEPE4003 CATALYSIS AND MATERIAL PROPERTIES (3-0-0)

Overall Course Objective:

To provide students with a comprehensive understanding of catalytic principles, catalyst design and characterization techniques, and the relationship between material structure and properties for applications in chemical, environmental, and energy-related processes.

Course Outcomes:

After the completion of course students will be able to;

CO1: Explain the fundamental principles of catalysis, catalytic reactions, and adsorption phenomena.
CO2: Analyse catalyst preparation methods and interpret catalyst characterization data.
CO3: Evaluate the mechanical, thermal, electrical, and structural properties of engineering materials.
CO4: Apply material characterization techniques to determine structure-property relationships.
CO5: Assess advanced catalytic and functional materials for industrial, environmental, and energy applications.

Course Attainment Matrix:

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	1	-	-	-	-	-	-	-	1
CO2	2	3	-	3	3	-	-	-	-	-	-	2
CO3	3	3	1	2	1	-	1	-	-	-	-	1
CO4	2	3	2	3	3	-	-	-	-	-	-	2
CO5	2	3	2	2	2	1	3	1	-	-	-	2

Module I: (12 hrs)

Introduction to catalysis and catalysts, Homogeneous, heterogeneous, and bio-catalysis, Catalyst activity, selectivity, and stability, Adsorption theories and adsorption isotherms, Catalytic reaction mechanisms, diffusion and mass transfer limitations in catalytic reactions.

Module II: (12 hrs)

Catalyst synthesis methods: precipitation, impregnation, sol-gel, hydrothermal techniques, Catalyst supports and promoters, Surface area and pore structure analysis, Characterization techniques: BET surface area measurement, XRD, SEM/TEM, FTIR, TGA/DTA, Catalyst deactivation and regeneration.

Module III: (12 hrs)

Nanomaterials and nano-catalysts, Zeolites and porous materials, Ceramic, polymeric, and composite materials, Catalysts for environmental applications, Catalysts for renewable energy and hydrogen production, Recent advances in catalytic and functional materials

Text Books:

1. Fundamentals of Industrial Catalytic Processes, 2nd ed. 2011, by C. H. Bartholomew and R. J. Farrauto, Wiley.
2. Elements of Chemical Reaction Engineering, 6th (Global Edition, 2022) by H. Scott Fogler, Pearson Education Inc.
3. Materials Science and Engineering: An Introduction, by William D. Callister Jr. (coauthor: David G. Rethwisch), John Wiley & Sons.

Reference Books:

1. Introduction to Materials Science for Engineers, 9th Edition (2021 U.S.; 2022 Global) by James F. Shackelford, Pearson Education.
2. Heterogeneous Catalysis: Principles and Applications, by Geoffrey Colin Bond, Clarendon Press (Oxford University Press).
3. Catalyst Characterization: Physical Techniques for Solid Materials by B. Imelik, J. C. Vedrine, Academic Press.