

Course Type	Course Code	Name of Course	L	T	P	Credits
DE	NGLD406	Nanotechnology in Mineral and Hydrocarbon Exploration	3	0	0	3

Course Objective

The primary objective of the course is to introduce students to the fundamental aspects and applications of nanotechnology in mineral and hydrocarbon exploration.

Learning Outcomes

Upon completing the course, students will be able to understand the basic concepts and uses of nanotechnology in mineral and hydrocarbon exploration. Students will apply their knowledge of nanotechnology to propose solutions for real-world challenges in mineral and hydrocarbon exploration, demonstrating an ability to integrate innovative technologies into practical applications.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Nanogeoscience in ore systems research: Introduction, principles, methods, and their applications.	03	Students will understand the basic concept of nanogeosciences, methodology & its application in ore system research.
2	Nano-ores: High-resolution techniques for studying ore samples at the nanoscale; Nanomaterials in Earth Science.	04	Students can apply high-resolution techniques to analyze ore samples at the nanoscale, enabling detailed observation of mineral structures, textures, and compositions.
3	Trace elements systematics: Understanding nanoscale incorporation of trace metals in ore samples.	05	Students will understand the systematic relationships between trace elements and ore mineralogy, including how the presence and distribution of trace metals can provide insights into the conditions of ore formation and alteration processes.
4	Ore mobility: Colloidal transport, precipitation, and isotopic fractionation in supergene settings. Implications for hydrothermal precious metal ore formation.	05	Students will be able to describe the mechanisms of colloidal transport of ore minerals and trace elements in supergene environments, including the roles of particle size, surface charge, and environmental conditions.
5	Nanoscale investigation of Carlin-type gold deposits: An atom scale elemental and isotopic perspective.	04	Students will understand the nanoscale phenomena and its regional or local implications in forming carlin type ore deposits.
6	Ore depositional mechanism: The effects of atomic and nanoscale processes on ore stability.	05	Students will be able to describe how atomic and nanoscale processes influence the stability and formation of ore deposits. Students will be able to use their understanding of atomic and nanoscale processes to contribute to predictive models of ore deposit stability, helping to forecast changes in ore deposit characteristics over time due to geological or environmental factors.

7	Introduction: Introduction, New forms of matter, Nanopowders and nanomaterials, nanopores and their properties, Structure of nanomaterials, Fullerene structures, new forms of carbon, carbon nanotubes (CNT)	03	Students will acquire a foundational understanding of nanomaterials and their various forms, including the structure, properties, and applications of nanopowders, nanomaterials, nanopores, fullerenes, and carbon nanotubes. This knowledge will provide them with the tools to engage with advanced material science concepts and contribute to innovations in nanotechnology.
8	Processes: Processes for CNT production; Utilization of coal for production of CNT; Application of CNT- vacuum microelectronics, energy storage.	03	Students will develop a thorough understanding of the processes involved in CNT production, the use of coal as a source material, and the diverse applications of CNTs in vacuum microelectronics and energy storage. This knowledge will equip them to contribute to advancements in nanotechnology and its practical applications.
9	Analytical methods: Analytical methods for studying nanomaterial: Scanning Tunneling Microscope, Atomic Force Microscope (AFM), Raman Spectroscopy.	03	Students will gain practical skills in using advanced analytical methods to study and characterize nanomaterials. They will be equipped to effectively apply these techniques in research and development, contributing to nanotechnology and material science advancements.
10	Applications: Dynamics of natural gas adsorption; Application of Nanotechnology: gas separation and storage; Removal of SO _x and NO _x , Coal Bed Methane, Petroleum exploration; CO ₂ sequestration and CO ₂ adsorption dynamics of nanopores; Molecular sieves; Nanoprobes and sensors.	04	Students will understand how nanotechnology can be applied to various aspects of gas adsorption, environmental management, and energy resources. They will be equipped with the knowledge to leverage nanotechnology to solve gas separation, pollution control, and resource extraction challenges.

Recommended Books/References:

Carbon Nanotubes Synthesis, Structure, Properties, and Applications: Mildred S. Dresslhaus, Gene Dresslhaus and Phaedon Avouris (Eds), 2001 (Springer).