Course Type	Course Code	Name of Course	L	T	P	Credit
DE8	MND 407	UNDERGROUND SPACE TECHNOLOGY	3	0	0	9

Course Objective
To provide an advanced insight/concept into various underground space applications in soil and rock for meeting the space needs of the country for various engineering facilities/structures
Learning Outcomes
Students will be able to plan and design underground facilities for meeting varied needs such as transportation, storage, waste disposal and defense.

Sl. No.	Course contents	No. of Lectures	Learning Outcomes
1	**Introduction:** Natural caves, archeological caves and their construction; Tunnels for various purposes like road, rail, and hydropower tunnels.	2	Tunnelling needs for various purposes
2	**Need for underground space:** Congestion in cities and its impact on development of social infrastructure for transport, water and power supply, separation of pedestrian and motorized vehicles and its movements, storage of materials, defence facilities including civil shelters.	4	Factors governing tunneling needs and various applications for civil, mining, defence and other purposes
3	**Engineering utilities:** Hydropower tunnels and caverns; Underground storage for LPG and crude oil.	5	Hydel and LPG storage cavern construction
4	**Geo-engineering investigations:** Topographic and geological survey, auguring, drilling, soil and rock sampling, and testing; Preparing sub-surface geological cross section; Geo-radar use and data analysis for shallow tunnels; Geophysical investigations to prove deeper sub-surface features; Physico-mechanical properties and collection of rock mechanical data.	5	Knowledge on geo-investigation techniques for siting various underground facilities
5	**Planning and design:** Assessment of behaviour of tunnelling media, deformation modulus and rock pressure assessment; determination of appropriate size and shape; Design of openings in rocks with the help of field data; Instrumentation and monitoring; Numerical modelling to assess the stability.	5	Planning and design inputs and methodologies for design
6	**NATM/NTM/ Soft ground Tunnelling Methods**	4	Modern techniques of tunneling in soft and hard grounds
6	**Support design and stabilization techniques for underground tunnels and caverns:** Steel supports, rock bolts, shotcrete, wire mesh, chainlink fabric and fibre reinforced shotcrete and other ground consolidation/grouting techniques.	5	Support types, design and stabilization techniques
7	**Other storage:** Grain storage, their advantages, disadvantages, underground cold storage and cellar for	4	Storage concepts for grains and food

27/5/24 31/5/24 31-05-2024 (Secretary, DAC)

Sl. No.	Course contents	No. of Lectures	Learning Outcomes
	foods and beverages.		
8	**Nuclear waste disposal:** Conditions for waste disposal, effect of radioactivity and heat on surrounding rocks; Conceptual design of a nuclear waste disposal facility.	4	Nuclear waste disposal strategies and design architectures
9	**Modern developments:** Underground ring roads/bye-passes in mega cities, metro, parking lots, shopping centres; Submerged and floating tunnels, underground libraries, museums, dwelling units, and resorts.	4	Innovative underground space applications
		42	

Text Books

1. Planning, design and construction of tunnels: B.N.Whittaker & C.Frith
2. Rock Mechanics Applied to Mining and Civil Engineering, Z.T.Bieniawsky
3. Underground Excavation of Rocks : Hoek and Brown

References:

1. Comprehensive Rock Engineering Ed. by J.Hudson
2. Tunneling and Underground Space Technology Journal