

<b>B. Tech. Civil Engineering</b>				
<b>Course code: Course Title</b>	<b>Course Structure</b>			<b>Pre-Requisite</b>
<b>CE312: Analysis And Design of Underground Structure</b>	L	T	P	CE 206: Soil Mechanics
	3	1	0	

<b>Course objective:</b> <ul style="list-style-type: none"> <li>• To understand the Fundamentals and Analyse geotechnical and Geological aspects,</li> <li>• To Apply Structural Analysis and Design Principles.</li> <li>• To Explore Tunnel Design and Construction Techniques.</li> <li>• To develop Practical Engineering and Research Skills.</li> <li>• To incorporate Seismic and Safety Considerations.</li> </ul>
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<b>S. No</b>	<b>Course Outcomes (CO)</b>
<b>CO1</b>	Understand the Fundamentals and Analyse Geotechnical and Geological Aspects
<b>CO2</b>	Perform Structural Analysis and Design
<b>CO3</b>	Apply Tunnelling and Excavation Techniques
<b>CO4</b>	Design for Seismic and Safety Considerations
<b>CO5</b>	Analyse Case Studies and Industry Applications

<b>S. No</b>	<b>Contents</b>	<b>Contact Hours</b>
<b>UNIT 1</b>	Introduction to Underground Structures, Importance and applications (Tunnels, Caverns, Subways, etc.), Historical perspective and case studies, Advantages of underground construction, Geotechnical Considerations, Soil and rock mechanics fundamentals, Geotechnical site investigation, Ground classification systems (RMR, Q-system, GSI), Stress-strain behaviour of soil and rock, Groundwater considerations and drainage.	10
<b>UNIT 2</b>	Loading Conditions and Stress Analysis, Structural Analysis of Underground Openings, Elastic and plastic behaviour of soil and rock. Analytical methods: Elastic solutions, Convergence-Confinement Method, Numerical modelling techniques (FEM, FDM, DEM).	8
<b>UNIT 3</b>	Design Methods for Underground Structures, Empirical methods (Rock Mass Rating, Q-System, NATM), Analytical and numerical approaches, Support system design (Shotcrete, Rock bolts, Steel ribs, TBM linings), Segmental lining and its behaviour. Tunnel Design and Construction Methods, Drill and blast method, Tunnel Boring Machines (TBM), Cut-and-cover method, NATM (New Austrian Tunnelling Method), Sequential Excavation Method (SEM).	8

<b>UNIT 4</b>	Introduction to Seismic Design of Underground Structures, Waterproofing and Drainage Systems, Monitoring and Instrumentation.	8
<b>UNIT 5</b>	Case Studies and Practical Applications, Metro tunnels, road and railway tunnels. Underground caverns and storage facilities, Large-scale hydro projects, and underground power plants.	8
	<b>Total</b>	<b>42</b>

<b>REFERENCES</b>		
<b>S. No.</b>	<b>Name of Books/Authors/Publishers</b>	<b>Year of Publication / Reprint</b>
<b>1</b>	Design of underground structure- by Zhen-Dong Cui, Zhong-Liang Zhang, Li Yuan, Zhi-Xiang Zhan, Wan-Kai Zhang.	2020
<b>2</b>	Rock Mechanics Design in Mining and Tunnelling, by Z.T. Bieniawski, Pub: A.A. Balkema.	1984
<b>3</b>	The Handbook of Tunnel Engineering (Vol. 1 & 2) – Bernhard Maidl, Markus Thewes, Ulrich Maidl.	2014
<b>4</b>	Fire Safety in Tunnels – Alan Beard & Richard Carvel.	2005