



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Geotechnical Engineering

Subject Code: ME02076051

Subject Name: Rock Opening and Tunneling

w.e.f.Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Courses

<b>Prerequisite:</b>	Advanced Soil Mechanics, Foundation Engineering and Fluid Mechanics.
<b>Rationale:</b>	<p>A specialized structural and geotechnical component, rock openings and tunnels involve topics such as rock geology and formation, rock strength and failure, stress distribution and propagation, and the design and stability of subterranean structures. Understanding rock mechanics properly entails deep mining, rock bursts, failure criteria of rock, laboratory research and testing, and result interpretation. The most significant aspect of designing rock openings and tunnels is the theoretical and empirical generalizations of rock stresses and their implications for underground excavations in rock through a variety of models and laboratory studies. It will eventually be fully useful and stable against a variety of forces if it is chosen properly. Students enrolled in the Rock Opening and Tunnels course gain a foundational understanding of rock classification, mechanical properties, testing, analytical methods for rock opening, opening design, tunneling and its intentions, mining and its engineering applications, and current field practices and codal provisions. Their ability to analyze and design appropriate opening shapes, underground structures, and mining applications for a variety of infrastructure projects and needs will be aided by this.</p>

## Course Outcome:

After Completion of the Course, Student will able to:

No.	Course Outcomes
01	Student will be able to justify marine environmental conditions for offshore structures and specify suitable type of remedial measures for marine deposits.
02	Students can execute investigation program for marine soil deposits and select necessary design parameters.
03	Student will be able to differentiate and analyse wind and wave forces required for design as per location and standards.
04	Student will be able to develop numerical models for response of offshore foundation under various conditions
05	Student will be able to Design suitable offshore foundation as per project requirement



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## Teaching and Examination Scheme:

Teaching Scheme(in Hours)			Total Credits L+T+(PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial/Practical		
				ESE (E)	PA/ CA (M)	PA/CA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150

## Course Content:

Unit No.	Content	No.of Hours	% of Weightage
1.	Introduction to rock mechanics: Basic terminology, classification and index properties of rocks, rock mass classification, engineering properties of rocks, rock testing, sub-surface investigation in rock deposits.	7	15
2.	Rock strength and failure: Rock strength, types of failure, theories of failure (Coulomb-Navier, Mohr, Griffith), absolute stress by bore hole deformation method, flat jack method, propagation velocity method, friction on rock surfaces and strength criteria of jointed rocks, rock pressure theories.	10	25
3.	Rock openings: Single opening, multiple opening, design of opening under various stress fields, stress concentration, circular opening, elliptical opening, ovaloidal opening, rectangular opening with rounded corners, opening in massive rock (2D), opening in laminated rock, examples.	11	25
4.	Rock tunneling and mining: Energy released during excavations, Criteria of design in underground excavations, purposes and classification of tunnels, geological factors affecting tunnels, Tunnel ventilation, Tunnel inspection and maintenance. Introduction to Tunnel Boring Machine (TBM)	6	15
5.	Mine pillar structures: Design of two dimensional and three dimensional rib pillars- compressive strength of rib pillars, influence of support, reciprocal theorem, examples	5	12
6.	Engineering applications: Bearing capacity of rocks/jointed rocks, Rock bolting, reinforcement of laminated rock, grouting and freezing	3	8



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	<b>Total</b>	<b>45</b>	<b>100</b>
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## Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
<b>10</b>	<b>20</b>	<b>25</b>	<b>25</b>	<b>10</b>	<b>10</b>

Where R: Remember; U: Understanding; A: Application; N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

## References/Suggested Learning Resources:

### (a) Books:

1. Goodman, R. E. Introduction to Rock Mechanics. John Wiley and Sons, 1989.
2. John Jaeger and N. G. Cook. Fundamentals of Rock Mechanics. Wiley-Blackwell. 2007.
3. Ramamurthy, T. Engineering in Rocks for Slopes, Foundations and Tunnels. Prentice Hall India, 2007.
4. Vutukuri, V.S., Lama, R.D. and Saluja, S.S. Handbook on Mechanical Properties of Rocks. Vol. 1, Trans Tech. Publications, 1974.
5. Zhang Lianyang. Engineering Properties of Rocks. Elsevier, 2005.
6. Bieniawski, Z.T.. Engineering Rock Mass Classifications. John Wiley and Sons, 1989.
7. Ramsay, J.G. and Huber, M.I. The Techniques of Modern Structural Geology, Academy Press, London, 1987
8. B.E.Hobbs, W.Means and P.F.Williams An Outline of Structural Geology, Wiley Int.Edition, 1976
9. R.J.Twiss and E.M.Moores Structural Geology, W.H.Freeman and Co, 2007.
10. Szechy, K. The Art of Tunneling, Akadémiai Kiadó, 1973.
11. Bengt Stillborg. Professional Users Handbook for Rock Bolting. Trans Tech Publications. 1986.
12. Hoek, E., Brown, E. Underground excavations in Rock, CRC Press, 1980.
13. Nick Barton, Tunnel Boring Machines, 2000.
14. Indian Standard Codes and ASTM codes.



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## (b) Open source software and website:

1. <https://nptel.ac.in/courses/>
2. <https://ocw.mit.edu/courses/civil-and-environmental-engineering/>

## List of Experiments/ Tutorials:

1. Rock Classification/Identification
2. Rock Specimen Coring/Specimen preparation
3. Rock Triaxial Test
4. Unconfined Compression Test
5. Slake Durability Index Test
6. Brazilian Test
7. Point Load Index Test
8. Tutorial on Rock Classification and its Interpretation /Rock Bore log
9. Tutorial on Design of Openings
10. Tutorial on Tunnels and Design of rib-pillars for mining

## . Suggested Project List: ---

Apart from above tutorials/experiments a group of students has to undertake one open ended problem/design problem. Few examples of the same are given below:

1. Study Geology of your local area/region and classify rocks based on IS guidelines
2. Design of Openings using Software's
3. Design of Rock bolting/reinforcement- Real life examples and case studies.

Suggested Activities for Students: --- Refer periodicals/journals/handbooks and Visit to Rock Testing labs/research organization and construction of foundations on any rocky strata (site visit)

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