



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Mining Engineering

Subject Code: BE04022011

Subject Name: Rock Mechanics

w. e. f. Academic Year:	2024-25
Semester:	4
Category of the Course:	Professional Core Course

Prerequisite:	Mechanics of Solids
Rationale:	The course aims to help students understand the mechanics' principles and the behaviour of rocks and rock masses. In the mining fields, it will help them to understand rock behaviour, which helps prevent accidents and ensure safe excavation and mining practices. This course informs the design and construction of mines, tunnels and other underground structures.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Use the knowledge of the various terminologies of rock mechanics and their importance in mining.	10
CO-2	Apply the knowledge and skills to understand stress and strain in rocks and the physio-mechanical properties of rock.	12
CO-3	To understand the methods of in-situ stress measurement of rock mass, rheological models and elastic constraints.	18
CO-4	Develop the ability to identify the engineering classification of rock masses.	18
CO-5	Develop the ability to identify the requirements of primary supports with their mechanisms.	12

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	PBL	Total no of hours per semester		Theory		Tutorial / Practical			
						ESE (E)	PA / CA (M)	PA/CA (I)	PBL (I)	ESE (V)	
45	0	30	45	120	4	70	30	20	30	50	200



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Content:

Sr. No.	Content	Total Hrs
1	Introduction Definitions and terms used in rock mechanics; Present scope, importance, constraints, development, and application of the rock mechanics; Introduction to stress analysis; Principles of stress and strain; Mohr's circle of stress and circle of strain; Stress-strain relationship; Differential equation of static equilibrium.	05
2	Physico-Mechanical Properties of Rock Physical properties of rock: density, porosity, moisture content, degree of saturation, permeability, swell index, slake durability index, thermal conductivity, anisotropy, electrical properties, and durability. Mechanical properties of rock: strength, deformability, elasticity, plasticity, and hardness. Preparation of test specimens, Laboratory determination of compressive, tensile, shear strength, modulus of elasticity, Poisson's ratio, and tri-axial strength of rock. Mohr's envelope, in-situ strength. Effect of geological parameters on engineering properties of rock mass. Time-dependent properties of rock mass: Creep deformation and strength behaviour; creep test and rheological models.	06
3	Stress Analysis around Openings Introduction, Pre-mining and induced stresses, Pressure Arch Theory. stress distribution around single, circular, multiple, pillar, and irregularly shaped excavations. Analytical approaches: Numerical models; FEM; BEM; ANSYS; etc Types of stress-strain measuring instruments include load cells, strain gauges, and others. Convergence measurement instruments: dilatometers, extensometers, optical gauges, compressometers, etc. In-situ strength properties of rocks, In-situ stress measurement: plate load test, cable jack test, borehole test, dilatometer test, hydrofracturing, etc. Monitoring of rock movement instruments: instrumented rock bolts and their merits and demerits. Dynamic properties of rock and rock mass. Failure Criteria for rock and rock mass: Theory; Coulomb; Mohr's and Griffith's criteria; empirical criteria.	12
4	Rock Mass Classification Classification systems in rock engineering: Classification of intact rocks. Classification of rock masses -Terzaghi's rock load, RQD, Rock Structure Rating (RSR), Bieniawski's RMR, Barton's Q-System, Laubscher 's-MRMR, Hoek 's-GSI, Palmstrom's RMi. Recent developments: correlations between different classification systems. Applications of rock mass classification in rock engineering.	12



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5	Rock supports Theory of rock mass reinforcement by rock bolting, its types and cable bolting, shotcreting, etc. Mechanism of support, forces and displacements associated with bolting.	10
TOTAL		45

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
40	40	10	10	00	00

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Introduction to Rock Mechanics	Richard E. Goodman	Wiley India Pvt Ltd. Second Edition 978-8126525669
2.	Rock Mechanics and Design of Structures in Rock	Leonard Obert and Wilbur I. Duvall	John Wiley & Sons Inc. 978-0471652359
3.	Introduction to Rock Mechanics	A. R. Jumikis	Oxford & IBH Publishing Company
4.	Underground Excavations in Rocks	E.T. Brown and E. Hoek	Taylor & Francis Group 9780429178122
5.	Engineering Rock Mechanics- An introduction to the principles	John A Hudson and John P Harrison	Elsevier Science Ltd 978-0080438641



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6.	Fundamentals and Applications of Rock Mechanics	A. K. Verma and Debasis Deb	PHI Learning Pvt. Ltd. 978-8120351820
7.	Rock mechanics: an introduction	Braja M Das.; Sanjay Kumar Shukla; Sivakugan, Nagaratnam	CRC Press 9780415809238
8.	Rock Mechanics and Rock Engineering: Volume 1: Fundamentals of Rock Mechanics	Ömer Aydan	CRC Press 9780367822309

List of Experiments:

- i. Preparation of rock samples for laboratory tests as per ISRM standards.
- ii. Determination of RQD and core recovery factor for borehole logs.
- iii. Determination of density, porosity and void ratio for a given rock sample.
- iv. Determination of UCS, Young's Modulus and Poisson's ratio of prepared rock samples.
- v. Determination of tensile strength of the samples by Brazilian test.
- vi. Determination of UCS by Schmidt hammer: Non-destructive test (NDT).
- vii. Determination of the slake durability index of given rock samples.
- viii. Determination of Protodykonov strength index of rock samples.
- ix. Determination of the point load strength index of given rock samples.
- x. Determination of shear strength of given rock samples.

Major Equipment:

- i. Universal Testing Machine
- ii. Punch Shear Test apparatus
- iii. Core cutting machine
- iv. Core polishing machine
- v. Schmidt hammer
- vi. Point load testing machine
- vii. Shear strength machine

List of Open-Source Software/learning website:

<https://archive.nptel.ac.in/courses/105/107/105107208/>

<https://archive.nptel.ac.in/courses/105/105/105105212/>

List of suggested activities for Problem Based Learning:

- a. **Assignments:** (Seminar Topics/ Visits/Self-Learning Topics) Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.)



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- i. Collect detailed data regarding the borehole to identify the rock quality at various locations in the field.
- ii. Collect detailed data on stress-strain generated during various mining operations and analyse it.
- iii. Visit and understand the design and mechanics of rock at mining activities, tunnels, and other underground structures.

b. Micro Projects: A Suggested list of course-wise micro-projects is mentioned herewith

- i. Design the numerical model for stress distribution at various openings.
- ii. Design the layout of the support system required at various locations of mining activity-based rock strata.
