GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering
Subject Code 3724309
Semester – II
Subject Name: Rock Opening & Tunnels

Type of course: PE-IV

Prerequisite: Rock Mechanics**,** Geotechnical Engineering, Foundation Engineering.

Rationale: Rock openings and tunnels is an specialized structural cum geotechnical component involving rock geology/rock formation, rock strength, rock failure, distribution and propagation of stresses, design and stability of underground structures. Proper understanding of rock mechanics involves laboratory investigation/rock testing, interpretation of results, failure criterion of rock, deep mining and rock bursts. Theoretical and empirical generalizations of rock stresses and its implication on underground excavations in rock through various models and laboratory studies is the most important part in design of rock openings and tunnels. Its proper selection will ultimately lead to its full utility and proper stability against various forces. The course on *Rock Opening and Tunnels* provides the students basic knowledge on rock classification, mechanical properties of rock, rock testing, analytical approach for rock opening, design of openings, tunnelling and its purposes, mining and its engineering applications acquainted with latest field practices and codal provinces. This will help them to analyze and design suitable shape of openings, underground structures and mining applications for various types of infrastructural projects/need.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE(E)	PA (M)	ESE (V)	PA(I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
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.	07
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.	09
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	12

	rock, examples.	
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.	07
5	**Mine pillar structures** Design of two dimensional and three dimensional rib pillars- compressive strength of rib pillars, influence of support, reciprocal theorem, examples	05
6	**Engineering applications** Rock bolting, reinforcement of laminated rock, grouting and freezing	02

Reference Books:

1. K.Szechy "Art of Tunnelling" Publised by – "Atademiaikiado , Budapest 1973"
2. Obert & Duall- "Rock Mechanics & Design of Structures in Rock"
3. Jager & Cook " Fundamentals of Rock Mechanics"
4. Verma B.P."Rock Mechanics Engineers", Khanna Publishers. New Delhi 1985

Course Outcomes: Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Selection of proper classification system of rock, rock testing, rock sample preparation, methodology of testing, as per type of project conditions based on codal provisions and theoretical practice. It will provide good understanding of rock mechanics and its simulations in various engineering applications like openings, tunnels and mining operations.	20
CO-2	Analyze various shapes of openings (single and multiple) under various stress fields based on empirical and theoretical models.	25
CO-3	Distinguish between two and three dimensional openings/ rib pillars and determination of compressive strength with and without support for design of mine pillars and underground excavations.	25
CO-4	Selection of tunnel as per purpose and geological conditions, tunnel ventilation and its maintenance as per general practice and codal guidelines. Design for rock reinforcement by means of rock bolting, rock grouting and rock freezing.	20
CO-5	Understand a role of geotechnical engineer as mining engineer/ tunnel specialist and its implication for proper execution of any project.	10

List of Experiments/Tutorial:

Design problem for single/multiple openings in massive rock (2D & 3D case) under various stress fields supported by at least two case studies. Design of rock bolting for laminated rock based on codal provinces. Maximum no of problems may be equal to 15-20.

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. Development of spread sheets/computer programmes for the determination of various index and engineering properties of rock.
2. Determination of rock parameters based on stress-strain relationships and various rock failure criteria.
3. Design of multiple openings or simulation of stresses using either photo-elastic models or using software's like PLAXIS, ANSYS

List of Open Source Software/learning website:

1. NPTEL lecture series
2. MIT open source material