Course Type	Course Code	Name of Course	L	T	P	Credit
Open Elective	MNO 202	ROCK MECHANICS	3	0	0	11

Course Objective

To impart the basic concepts, principles and techniques for developing a deep understanding of theoretical and applied rock mechanics in mining and rock engineering and to provide an overview of their application in ground control, mine excavations and geo-engineering design.

Learning Outcomes

- Upon successful completion of this course, students will have an understanding of various engineering properties of rocks and soil; engineering behavior of rocks and soil; concept of Stress, strain and failure of rock; strength and deformability of rock mass; response of rock mass and soil to mine excavations; various strata control techniques in mining and rock engineering.
- Able to learn about the basics of theoretical and practical aspects of rock mechanics and its importance in the design & operation of surface and underground excavations for safe & productive mining operations

Unit No.	Topics to be Covered	Lecture & Tutorial Hours	Learning Outcome
1	**Geotechnical Investigations and Classification of rock mass and soil** • Engineering properties of intact rock – physico-mechanical • Overview of requirements, methods and analysis of engineering-geological investigation methods • Rock mass classification methods and their applications • Soil classification methods and their applications	8	Understanding of various engineering properties of rocks and soil; rock mass classification and soil classification methods and their application in the design of structures in rock and soil
2	**Concept of Stress, strain and failure of rock** • Analysis of stress, Analysis of strain, Constitutive relations, Parameters influencing strength/stress-strain behavior • Failure Criteria for Rock and Rock Mass Classical theories of rock failure: Coulomb's criterion, Mohr's criterion, Griffith's theory, Empirical failure criteria. Behaviour of jointed rock mass. • Pre-mining state of Stress Stresses in rock mass, Factors influencing the in situ state of stress, Estimating in situ stresses; Methods of Stress determination- Hydro fracturing, stress relief methods. • Overview of shear strength and compressibility of soil	14	Understanding of concepts of stress and strain and failure criteria for rock and rock mass. Understanding of concepts of stress and strain; engineering behaviour of rocks and failure criteria for rock and rock mass. Understanding of pre-mining stresses in rock and various methods of rock stress determination; its importance in mining applications and design of various surface and underground structures in rock.
3	**Rock mass properties** • Strength and Deformability of Rock Mass In situ shear tests; Evaluation of shear strength; In situ bearing strength test; In situ deformability tests- Plate Loading Test, Plate Jacking Test and Borehole Jack Tests	3	Understanding of various strength properties and deformability of rocks; various in-situ methods of rock deformability; basic concepts of soil properties and their applications in mining

Unit No.	Topics to be Covered	Lecture & Tutorial Hours	Learning Outcome
	• Field measurement of soil properties		
4	**Response of rock mass and soil to excavation** • Response of rock mass to Excavations Underground, Induced stresses and displacements around single opening in rock mass; • Design of excavations in massive elastic rock • Design of mine pillars • Ground support interaction analysis and reinforcement of ground (rock mass and soil), selection and design of support systems. • Slope Engineering: Slope failure and causes; Basic approaches to slope stability analysis and stabilisation • Monitoring of Excavation Stability: Purpose and nature of monitoring, Instrumentation and monitoring systems - Load; Stress and Deformation measuring devices; Interpretation of monitoring data; Practical aspects of monitoring.	7	The students will learn about the response of rock mass and soil to mine excavations; design principles in rock excavation, selection of mining methods, mine pillar design, selection and design of support systems and rock slope stability analysis and design for various mining applications. Understanding of instrumentation and monitoring systems used in surface and underground mine excavation stability.
5	• **Groundwater flow**: Permeability and pressure Groundwater flow within soil and rock masses; Permeability conditions; Influence of groundwater soil and rock mass behaviour; Measurement of groundwater pressure and permeability	2	Understanding of groundwater flow within soil and rock and its influence on soil and rock mass behavior; Measurement of groundwater pressure and permeability for design of mining excavations.
6	• Ground improvement; grouting, fore polling, pre-reinforcement, shotcreteing and other	2	Understanding of various ground improvement techniques and methods for safe mining operations
7	• **Subsidence**: Types, causes and impacts of subsidence; Factors influencing subsidence; subsidence prediction and control	3	Understanding of basic mechanics of mine subsidence, various types of subsidence and its prediction and control in mining operations.
8	**Numerical methods :** basics of FEM, FD and BE methods	3	Basic understanding of various numerical methods in simulation and modelling of geo-engineering problems;
	Total	42	

Text Books

1. Fundamental of Rock Mechanics by Jaeger, J.C. and Cook, NGW
2. Underground Excavation in Rock, Hoek, E and Brown, ET
3. Rock Mechanics for Underground Mining, Brady, BHG and Brown, ET
4. Introduction to Rock Mechanics, Goodman, RE.

References:

1. Comprehensive Rock Mechanics, Ed. Hudson
2. Coal Mine Ground Control: Syed Peng
3. Engineering Rock Mechanics-An Introduction and Principles: Pergamon, Hudson, J.P. and Harrison,J.P
4. Principal of Geotechnical Engineering, BM Das
5. Finite Element method: Concepts and Applications in Geomechanics by D. Deb
6. Computational Geomechanics by Zienkiewicz, Chan, A. H. C. M. Pastor, B. A. Schrefler, T. Shiomi - -Wiley (1999)
7. Concept and Application of Finite Element Analysis by RD Cook
8. Finite element procedures by (1996) K. J. Bathe