| Course Type | Course Code | Name of Course | L | T | P | Credit |
|---|---|---|---|---|---|---|
| DC4 | MNC 205 | 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**<br>• Engineering properties of intact rock – physico-mechanical<br>• Overview of requirements, methods and analysis of engineering-geological investigation methods<br>• Rock mass classification methods and their applications<br>• 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**<br>• Analysis of stress, Analysis of strain, Constitutive relations, Parameters influencing strength/stress-strain behavior<br>• 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.<br>• 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.<br>• Overview of shear strength and compressibility of soil | 14 | Understanding of concepts of stress and strain and failure criteria for rock and rock mass.<br><br>Understanding of concepts of stress and strain; engineering behaviour of rocks and failure criteria for rock and rock mass.<br><br>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**<br>• 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<br>• Field measurement of soil properties | 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 |
|---|---|---|---|
| 4 | **Response of rock mass and soil to excavation**<br>• Response of rock mass to Excavations Underground, Induced stresses and displacements around single opening in rock mass;<br>• Design of excavations in massive elastic rock<br>• Design of mine pillars<br>• Ground support interaction analysis and reinforcement of ground (rock mass and soil), selection and design of support systems.<br>• Slope Engineering: Slope failure and causes; Basic approaches to slope stability analysis and stabilisation<br>• 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.<br><br>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 | 3 | 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 | 2 | 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