| Course Type | Course Code | Name of Course | L | T | P | Credit |
|---|---|---|---|---|---|---|
| DE3 | MND 402 | OPEN PIT SLOPE ANALYSIS AND DESIGN | 3 | 0 | 0 | 9 |

| Course Objective |
|---|
| This course will impart knowledge to the students to analyse stability of slopes in open pit mines. |
| **Learning Outcomes** |
| The outcome of the course are as follows;<br>• Students will learn the various methods for analyzing stability of slope in mines<br>• Handling different numerical approaches to analyse stability of slope<br>• Designing various types of slope in open pit mine |

| Sl. No. | Course contents | No. of Lectures | Outcomes |
|---|---|---|---|
| 1 | Introduction: Types and formation of slopes in surface mines, pit slope vis-à-vis mine economics, mechanism of common modes of slope failure, factors influencing stability of slopes, and planning of slope stability investigations. | 3 | Basic understanding about slope stability in mines. |
| 2 | Geotechnical Information: Site investigation and geological data collection for highwall slope, Waste Overburden Dump, Tailings Pond Embankment and their interpretation for stability studies. Physico-Mechanical Properties of rock, soil, tailings slime, fly-ash | 4 | Geotechnical data collection and different characterisation technique will be understood for different types mine slopes |
| 3 | Fundamentals of Stress and Strength: Concept and Analysis of Stress and Strain, Mohr Circle, Shear strength of intact rock, discontinuity surfaces, filled discontinuities and rock-mass estimation and determination; Surface roughness, joint roughness coefficient –estimation and determination. Shear strength of weathered rock masses, Failure Criteria for Rock and Soil : Mohr–Coulomb criterion, Hoek–Brown strength criterion, Rock mass strength | 5 | Basic stress and strength concept useful for slope stability analysis. Concept of joints and associated material constitutive criteria will be explained. |
| 4 | Water Flow: Concepts of water flow through a material and its permeability; water flow through rock-mass, water flow through soil type material and broken spoil material; Estimation and measurement of permeability and water pressure; Graphical solution of seepage problems (flow nets), seepage forces and seepage patterns under different conditions.<br>Hydraulic conductivity of weathered rock, Measurement of water pressure, Field measurement of hydraulic conductivity: Variable head tests and Pumping test | 5 | The role of groundwater in slope stability investigation will be understood. |
| 5 | Slope Failure Analysis Methods: Plane Failure, Wedge Failure, Circular Failure and Toppling Failure. Analysis and Design of Pit Slope and Waste Dump Slope stability assessment methods and techniques; Analysis and design criteria and methodology for highwall slopes and backfill and waste dumps; Probabilistic approaches of slope analysis and design. | 7 | Learning different types of failure in mine slope and associated techniques to analyse the same. |
| 6 | Tailing Pond Embankment Slope Stability, Analysis | 6 | Special types of slope namely |

| Sl. No. | Course contents | No. of Lectures | Outcomes |
|---|---|---|---|
| | and Design<br>Ash Dyke Embankment Slope Stability, Analysis and Design | | tailings pond embankment and ash dyke embankment slope slope stability concept will be detailed. |
| 7 | Slope Stabilisation and Monitoring Methods | 3 | Methods of stabilisation and monitoring instrumentation will be learned. |
| 8 | Numerical Analysis for Slope Stability Analysis: Finite Element Method, Finite Difference Method, Discrete Element Method and Hybrid Method; Comparison of numerical and limit equilibrium analysis methods | 5 | Introduction of different numerical approaches used in slope stability analysis |
| 9 | Discussion on Case studies on Mine Bench Slope, Waste Dump Slope, Tailings Pond Embankment Slope and Ash Dyke Embankment Slope | 4 | 4 case studies will be shared so that students will get the idea how to handle similar cases. |

**Text Books:**


1. Rock Slope Stability: Charles A. Kliche, Published By Society for Mining, Metallurgy, and Exploration, Inc.
2. Rock Slope Engineering Civil Applications, Fifth Edition, Duncan C. Wyllie, Crc Press, 2017


**Reference Books:**


1. Rock Slope Engineering, 3rd Ed., Evert Hoek And John Bray, Taylor & Francis Routledge, 1981
2. Slope stability In Surface Mining, William A. Hustrulid, Michael K. Mccarter And Dirk J.A. Van Zyl, Society For Mining, Metallurgy, And Exploration
3. Slope Stability Analysis By The Limit Equilibrium Method, Yang H. Huang, Asce
4. A Short Course In Soil And Rock Slope Engineering, Noel Simons, Bruce Menzies And Marcus Matthews, Thomas Telford Publishing