

Course Type	Course Code	Name of the Course	L	T	P	Credits
DE2	NMND504	Analysis and Design of Slopes	3	0	0	3

Course Objective

The course aims to provide necessary exposure to graduate students and teach them the basics of slope stability investigation. At present, Indian mines are facing problems with Waste Dump stability and Tailings Pond Embankment stability, and the course has been designed to address the issue in detail with case studies. The numerical methods, namely Finite Element and Finite Difference, will be taught to give students flavours of present-day advancement in various software in this particular field of study.

Learning Outcomes

Upon successful completion of this course, students will:

- Develop an ability to identify, formulate, and solve complex geotechnical engineering problems by applying principles of slope engineering and geomechanics.
- An appreciation of the structural and safety issues involved in mining slope engineering.
- Acquire the skills necessary to be successful geotechnical personnel in mining engineering.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
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 the stability of slopes, and planning of slope stability investigations.	3	The basics of rock slope engineering principles will be taught.
2	Geotechnical Information: Site investigation and geological data collection for high-wall slope, Waste Overburden Dump, Tailings Pond Embankment and their interpretation for stability studies. Physico-Mechanical Properties of rock, soil, tailings slime, fly-ash	4	The importance of geotechnical engineering in rock slope stability will be taught, and their interrelationship will be covered
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	Concepts of stress and strain and constitutive criteria will be taught.
4	Ground Water Flow: Concepts of water flow through the material and its permeability; water flows 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. Hydraulic conductivity of weathered rock, Measurement of water pressure, Field measurement of hydraulic conductivity: Variable head tests and Pumping test	5	The whole gamut of groundwater problems in slope engineering will be covered.
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 high-	7	Different slope failure models will be enumerated.

	wall slopes and backfill and waste dumps; Probabilistic approaches of slope analysis and design		
6	Tailing Pond Embankment Slope Stability: Analysis and Design Ash Dyke Embankment Slope Stability, Analysis and Design	6	Introduction to tailings dam and ash dyke embankment will be taught.
7	Slope Stabilisation and Monitoring Methods	3	All methods of stabilisation will be covered here
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. Discussion on Case studies: on Mine Bench Slope, Waste Dump Slope, Tailings Pond Embankment Slope and Ash Dyke Embankment Slope	9	Various numerical methods and their principles will be taught and Slope engineering case studies will also be illustrated
	Total	42	

Text Books:

1. Rock Slope Stability: Charles A. Kliche, Published By Society For Mining, Metallurgy, And Exploration, Inc., 1919 (Latest Edition)

Reference Books:

1. Rock Slope Engineering Civil Applications, Fifth Edition, Duncan C. Wyllie, CRC Press
2. Rock Slope Engineering, 3rd Ed., Evert Hoek and John Bray, Taylor & Francis Routledge
3. Slope stability In Surface Mining, William A. Hustrulid, Michael K. Mccarter and Dirk J.A. Van Zyl, Society for Mining, Metallurgy, And Exploration