Advance Rock Mechanics

1.1. Course Number: GE511

1.2. Contact Hours: 3-0-0 Credits: 9

1.3. Semester Offered: 5th Year-Odd

1.4. Prerequisite: Engineering geology

1.5. Syllabus Committee Members: Dr. Alok Kumar Singh & Dr. Hemant Kumar Singh

2. **Objective:** The aim of this course is to provide a comprehensive understanding of physio-mechanical properties of intact rock, rock masses, failure criteria, rock discontinuities, deformations around the excavation, in-situ stresses, and its measurement.

3. **Course Content:** Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topics	Lectures
1	Introduction	Concept, Scope, field of application & its relationship with other subjects, Index properties of rock materials and its laboratory determination: porosity, density, permeability, specific gravity, hydraulic conductivity, strength, slaking and durability, sonic velocity as an index to degree of fissuring, hardness, elasticity, and stress-strain coefficient.	8
2	Rock Mass classification	Intact rock classification: rock material, classification of rock material, class I and II rocks, Uniaxial compression, stability in water, classification based on Slake durability Index, Classification of Rock masses: Rock Quality Designation (RQD) and its measurement, Terzaghi's Rock Load Theory, Modified Terzaghi's Theory for tunnels and Caverns, Rock Mass Rating (RMR), Rock Mass Quality (Q-System), Rock Mass Number, Rock Mass Index, Geological Strength Index (GSI).	9
3	Rock Slopes Engineering	Strength of Discontinuities: Joint Wall Roughness Coefficient, Joint Wall compressive strength, Joint Matching Coefficient, Internal Friction Angle, Shear Strength, Shear Strength of Rock Masses in Slopes (Mohr-Coulomb Yield Criterion, Drucker-Prager Criterion, Hoek-Brown Criterion, Tensile Yield Criterion, Mohr's Coulomb strength parameters, Non-linear failure envelops), Types of Rock Slope failure (Planar, 3D wedge, circular, toppling failure), Effect of Height and Groundwater Condition on Safe Slope Angle, Slope Mass Rating (SMR), Kinematic Analysis of	9

		Slopes, Landslide Hazard Zonation (Landslide hazard zonation maps-The methodology, A case study).	
4	In-situ Stresses	In- situ stresses, need for in-situ stress measurement, classification of geological conditions and stress regimes, variation of in-situ stresses with depth	3
5	Tunneling	Tunnels- types, investigations for tunnel alignment, tunnel support design, tunnel linings, TBM, problems due to underground water and fault-shear zones, tunneling in hard and soft grounds, Rate of Tunneling, Strength enhancement of Rock mass in Tunnels (causes of strength enhancement, reason for strength enhancement in Tunnels and suggested new failure theory), Case study.	6
6	Miscellaneous	Allowable Bearing Pressure for Building Foundation, Rock Drillability, Method of Excavation, Rock Bolting, Gouge Material.	5
		Total	**40**

4. Readings:

4.1. Textbook:

- Bieniawski, Z. T. (1989): Engineering Rock Mass Classification, John Wiley.
- Goodman, R.E. (1980): Introduction to rock mechanics.
- Jagger, J. C. and Cook, N. G. W. (1979): Fundamental of rock Mechanics, Champman & Hall.

4.2. Reference books:

- Bell, F. G. (1999): Geological Hazards, Routledge, London.
- Bieniawski, Z. T. (1989): Engineering Rock Mass Classification, John Wiley.
- Goodman, R.E. (1980): Introduction to rock mechanics.

5. Outcome of the course:

On successful completion of this course, students will be able to:

- understand the basics and advancement of rock engineering subject, including determination physico-mechanical properties of intact rock and rock mass, rock discontinuities, stresses and deformations around the excavation, in-situ stresses and failure mechanisms in rocks.
- Know the application of rock mechanics in rock slopes sliding, tunneling and foundation engineering.