BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE PILANI
I SEMESTER 2023-24
MID-SEMESTER EXAMINATION
CE F325 FUNDAMENTALS OF ROCK MECHANICS (CLOSE BOOK)

Duration: 90 Mins **Max Marks: 35**

1. Determine the stability of a slope having a height of 130 m and slope face angle of 50^0. Investigations revealed chances of planar rock slope failure along a joint passing the toe at an angle of 35^0. Characterization of the rock mass suggests following properties.

Property	**Value**
Density (kN/m^3)	26.5
Cohesion of joint (kPa)	150
Friction angle of joint (^{0})	26
Cohesion of intact rock (kPa)	3000
Friction angle of intact rock (^{0})	32

a. Evaluate the FOS for the slope for the condition when the surcharge is not acting on the slope.
b. How much is the reduction in FOS if seismic forces act. Consider the value of α=0.18?
c. If the FOS evaluate in (a) needs to be improved by 30%, suggest suitable bolt force which will be required. Consider angle of installation of bolt to be 25^0 with the horizontal. Do not consider seismic force for this case.

[10 Marks]

2. A circular tunnel of diameter 12 m is proposed in the Himalayas with average rock mass conditions as shown. Considering full face excavation of tunnel evaluate the following for two tunnel sections at a depth of 500 m and 1100 m.

Property	**Values**
Unit weight (kN/m^3)	27
Cohesion (MPa)	3
Friction Angle (^{0})	18
Young's Modulus, E (MPa)	4305
Poisson's ratio	0.25

a. Support pressure required to ensure tunnel section does not yield
b. Maximum deformation corresponding to the case (a) above
c. Elastic and plastic deformation corresponding to radius of plastic zone of 7.5 m.
d. Maximum radius of plastic zone possible
e. Radius of plastic zone corresponding to 75% deconfinement
f. Elastic and plastic deformation with complete deconfinement

[14 Marks]

3. Answer the following in detail

a. Convergence Confinement Method has limited applicability in practicality and should be used only as a preliminary tool. **[1 Mark]**
b. Economy of tunnel construction depends on the interaction between GRC and SRC. Explain with the help of a neat diagram. **[1 Mark]**
c. Time delays and sequence of initiation are essential in blasting of rockmass. Provide diagram for explanation. **[1 Mark]**
d. Explain briefly the three types of plate boundaries. What is the mechanism leading to the plate movements? **[2 Marks]**
e. What information is derived from UCS test of intact rock? How is it useful? **[2 Marks]**
f. Differentiate between rock and rock mass. **[1 Mark]**
g. Why should the burden be neither less nor more in case of production blasting? **[2 Marks]**
h. Explain the significance of stemming in production blasting. **[1 Mark]**

The following expressions may be used for solving numerical problems.

$$p_{cr} = \frac{2p_0 - \sigma_{cm}}{1 + k_p}$$

$$k_p = \frac{1+\sin\phi}{1-\sin\phi}, \quad \sigma_{cm} = \frac{2c\cos\phi}{1-\sin\phi}$$

$$u_r^e = \frac{R(p_0 - p_i)}{2G_{rm}}$$

$$G_{rm} = \frac{E_{rm}}{2(1+\nu)}$$

$$R_{pl} = R\left[\frac{2(p_0(k_p-1)+\sigma_{cm})}{(k_p+1)((k_p-1)p_i+\sigma_{cm})}\right]^{1/(k_p-1)}$$

$$u_r^{pl} = \frac{R}{2G_{rm}}\left[2(1-\nu)(p_0-p_{cr})\left(\frac{R_{pl}}{R}\right)^2 - (1-2\nu)(p_0-p_i)\right]$$