FACULTY OF ENGINEERING AND ENVIRONMENT
DEPARTMENT OF MINING ENGINEERING

ROCK AND SOIL MECHANICS
EMN 3107
Examination Paper

Time Allowed: **3 hours**
Total Marks: **100**
Examiner's Name: Mr. T. Dombo

INSTRUCTIONS

1. This paper contains **ONE** section with **FIVE** questions.
2. Answer ALL **QUESTIONS IN SECTION A**
3. Each question **carries 20 marks**.
4. Where a question contains subdivisions, the mark value of each subdivision is shown in brackets.
5. Illustrate your answer, where appropriate, with large clearly labelled diagrams.
6. Start each question on a new page.
7. This paper comprises 3printed pages.

Additional Requirements

- Calculator
- Graph paper
- Formula Booklet

MARK ALLOCATION

Question 1 to 5	**Total 20 marks**
Part Questions	**As shown in each part question**
Total Attainable	**100 marks**

ANSWER ALL QUESTIONS

Question 1

A cylindrical rock specimen with a diameter of 54 mm and a length of 120 mm is subjected to a uniaxial compressive stress test. The following data is collected during the test:

- •The peak compressive stress at failure is 87.2 MPa.
- •The Young's modulus of the rock is 25.6 GPa.
- •The Poisson's ratio of the rock is 0.22.
- •The tensile strength of the rock, based on indirect tensile testing, is 8.4 MPa

Calculate the following:

a) The total axial deformation of the rock specimen at the peak compressive stress. (2)
b) The lateral deformation of the rock specimen at the peak compressive stress. (2)
c) The shear stress acting on a plane oriented at 30 degrees to the loading axis at the peak compressive stress. (3)
d) The factor of safety against tensile failure if the rock specimen is subjected to a compressive stress of 52 MPa. (3)
e) Sketch a typical stress-strain graph during a uniaxial compression test. What physical processes are occurring in the sample as the curve manifests significant gradient changes? (10)

Question 2

(a) Elaborate the fundamental purposes of excavation in:
Civil engineering,
Mining engineering and
Petroleum engineering. (9)

(b) Using a graph paper, draw and illustrate on the Mohr's Circle how you can determine the major, minor principle stresses and the maximum shear stress. Clearly explain and use formulas where necessary (11)

Question 3

The following strain components were measured at a point in a rock

$\varepsilon x = 0.003 \quad \varepsilon y = 0.00012 \quad \gamma xy = 0.0005$

(a) Determine the principal stresses in the x-y plane given that the modulus of elasticity is 72GPa and the Poisson's ratio is 0.2. (5)

(b) A rock mass is characterized by the following properties:

- Rock Quality Designation (RQD) = 75%
- Uniaxial compressive strength of intact rock (σci) = 65 MPa
- Geological Strength Index (GSI) = 60
- Intact rock constant (mi) = 15
- Unit weight of rock (γ) = 27 kN/m³
- Depth of excavation (H) = 150 m
- Groundwater pressure (u) = 0.6 MPa

The rock mass is subjected to in-situ stresses where the major principal stress ($\sigma 1$) is 18 MPa and the minor principal stress ($\sigma 3$) is 8 MPa.

(i) Calculate the Hoek-Brown strength parameters (mb, s, a) for the rock mass. (5)
(ii) Determine the Mohr-Coulomb equivalent cohesion (c) and friction angle (φ) for the rock mass. (5)
(iii) Estimate the vertical stress (σv) and horizontal stress (σh) acting on a potential failure plane oriented at 30 degrees to the major principal stress direction. (5)

Question 4

(a) Define the term rock mass and explain how it differs from an intact rock sample. (5)
(b) Describe the factors that influence the strength and deformation characteristics of a rock mass. (10)
(c) Discuss the concept of Rock Quality Designation (RQD) and its significance in rock mass classification. (5)

Question 5

(a) A soil sample has a void ratio (e) of 0.75 and a specific gravity (Gs) of 2.67. Calculate the following properties of the soil:
(i) Moisture content (w)
(ii) Degree of saturation (S)
(iii) Dry unit weight (γd)
(iv) Saturated unit weight (γsat)
(v) porosity (n). (10)

(b) Explain the significance each of the above properties in geotechnical engineering. (10)

END OF EXAMINATION