Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	GEOLOGY ENGINEERING
COURSE CODE	:	BFC 21303
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS
		2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**
		3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

Q1 A hilly residential area has an 80 m height of slope which cuts through a granite rock formation. The rock slope face cutting in the dip direction of 180^0 and dip angle 66^0. The rock slope has been mapped and analysed. **Table Q1** summarized the data of discontinuity sets, slope geometry, and rock parameters.

(a) Analyse the entire rock slope failure modes using **Figure Q1(a)** with its criterion based on **Table Q1(a)**.

(6 marks)

(b) Calculate the factor of safety for the planar failure mode using the formula in **Figure Q1(b)** when the tension crack is completely filled with water. Calculate the required anchor bars to stabilize the rock slope to the factor of safety 1.3.

(6 marks)

(c) Calculate the factor of safety for wedge failure mode using the formula in **Figure Q1(c)** when the tension crack is completely filled with water.

(8 marks)

(d) Recommend a new rock slope dip angle in order to avoid potential rock slope failure modes and predict the consequences of the recommendation.

(5 marks)

Q2 (a) List **THREE (5)** information that could be obtained from the geological map during the desk study in the site investigation stage.

(5 marks)

(b) Explain why rock coring depth must be drilled differently as a factor of rock formation, for example between limestone and igneous.

(5 marks)

(c) One borehole was drilled at the Bukit Soga site denoted as BH1 as shown in **Figure Q2(c)**. Rock coring at the length of 1500 mm. Calculate the rock quality designation, the total core recovery, and the solid core recovery.

(5 marks)

(d) Bukit Soga and Kluang sites are located at the granitic rock formation. The electrical resistivity tomography test was conducted at these locations. The electrical resistivity tomography for Bukit Soga and Kluang sites indicates the resistivity value at the bedrock level was 50 ohm.m and 5000 ohm.m, respectively. Explain the factors that make the resistivity values different even on similar bedrock.

(5 marks)

(e) Suggest the method of the geophysical survey should be adopted in order to identify the bedrock. Justify your answer.

(5 marks)

Q3 (a) Discuss **THREE (3)** facts of evidence that show the earth's crust is fragmented and slowly moving relatively apart.

(5 marks)

(b) Discuss the importance to understand Moh's scale of mineral hardness.

(5 marks)

(c) Discuss the statement mentioned that the chemical composition of magma influences the colour of igneous rock.

(5 marks)

(d) Differentiate the inorganic and organic chemical sedimentary rocks.

(5 marks)

(e) Explain how to differentiate via the naked eye between gneiss and quartzite.

(5 marks)

Q4 (a) The force directional angle towards foliation affects the rock strength. Explain this statement.

(5 marks)

(b) Sketch the typical weathering profile for a granitic rock formation.

(5 marks)

(c) Discuss the differences between soil-formed in situ from rock weathering and alluvium.

(5 marks)

(d) Discuss the geological structures like folds and faults which influence the ground stability.

(5 marks)

(e) Cenozoic era is less than 2 million years of sediment known as Quaternary deposit deposited along the west coast of Johor. Meanwhile, sedimentary rock formations such as the Gemas formation is formed around 345 million years ago located in the central part of the Malay Peninsula. Discuss the characteristic of the ground made of Quaternary deposit compared with the ground of Gemas formation.

(5 marks)

- END OF QUESTIONS –

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Table Q1: Parameter of granite rock slope

Parameters	Values
Joint set 1 (dip direction/dip angle)	070°/70°
Joint set 2 (dip direction/dip angle)	356°/76°
Joint set 3 (dip direction/dip angle)	190°/40°
Joint set 4 (dip direction/dip angle)	010°/10°
Slope face dip direction	180°
Slope face angle (slope angle)	66°
Upper slope face dip direction	180°
Upper slope face angle	0°
Height of slope / wedge	80 m
Unit weight of the rock	25 kN/m^3
Depth of tension crack	2 m
Unit weight of water	9.81 kN/m^3
The cohesion of all discontinuities	100 kPa
Friction angle for all discontinuities	25°
Inclined angle of anchor (Ω) = (ψ_T)	30°
Bars for Y25	10 ton = 100 kN

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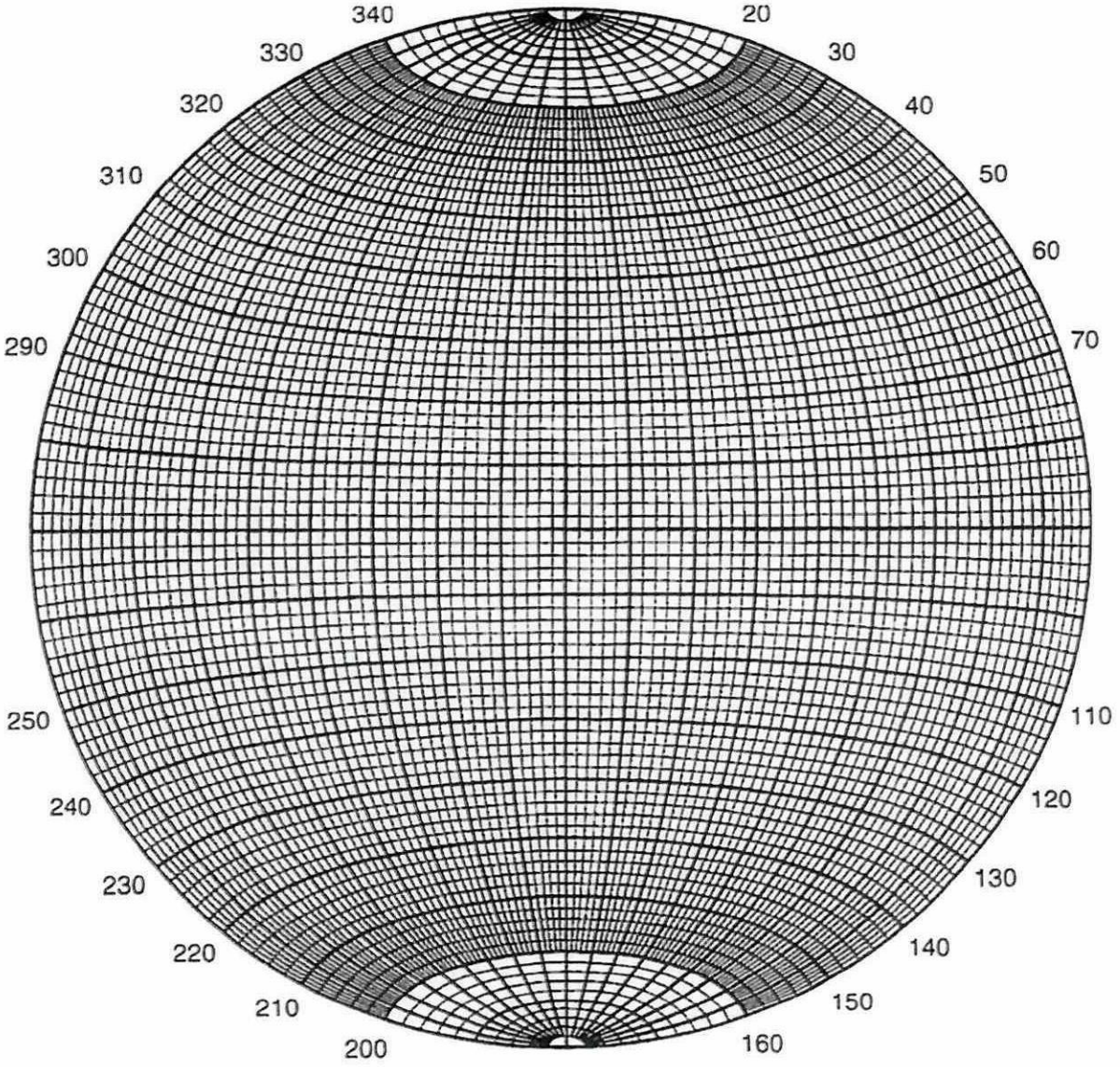

Figure Q1(a): Equatorial equal-area stereo-net marked in 2° intervals

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Table Q1(a): Parameter of granite rock slope

Modes of failure	Criteria are met
Circular	i. Very weak material, highly jointed or fractured or weak soil ii. Homogenous soil
Planar	i. The dip direction of the joint must be laid within $\pm 20^0$ from the slope dip direction. ii. $\psi_f > \psi_p > \phi$ (slope angle> plane angle > friction angle) iii. Release surfaces must be present to define the lateral boundaries of the slide.
Wedge	i. $\psi_f > \psi_i > \phi$ (slope angle > the intersection angle of 2 joints > friction angle)
Toppling	i. The dip direction of the joint must be laid between $\pm 10°$ in the opposite direction of the slope dip direction. ii. $(90^0 - \psi_f) + \phi \leq \psi_t$

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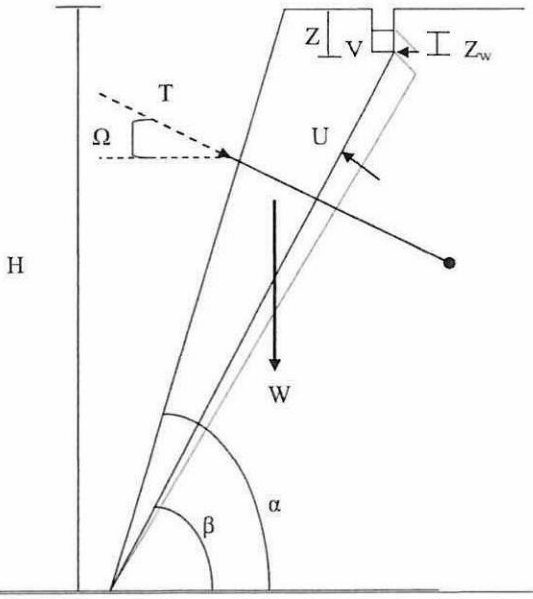

Given:

$$\textbf{FOS} = \frac{cA + (W\cos\beta - U - V\sin\beta + T\sin(\Omega+\beta))\tan\phi}{W\sin\beta + V\cos\beta - T\cos(\Omega+\beta)}$$

A= failure plane area
c = cohesion
W = weight of failure block
β =failure plane angle
H = height of plane
T = tension of anchor
γ_r= unit weight of rock
ϕ = friction angle
U = vertical water pressure
V = horizontal water pressure
α = slope angle
Z = tensional cracks
Ω = inclined angle of anchor
γ_w= unit weight of water

A = (H-Z).cosec β

$$W = \tfrac{1}{2}\gamma_r H^2\left[\left(1-\left(Z/H\right)^2\right)\cot\beta - \cot\alpha\right]$$

$U = \frac{1}{2}\gamma_w.Z_w.(H-Z).\text{cosec}\,\beta$

$V = \frac{1}{2}\gamma_w.Z_w^2$

$$\text{cosec}\beta = \frac{1}{\sin\beta} \quad \sec\beta = \frac{1}{\cos\beta} \quad \cot\beta = \frac{1}{\tan\beta}$$

Figure Q1(b): Planar failure mode formula

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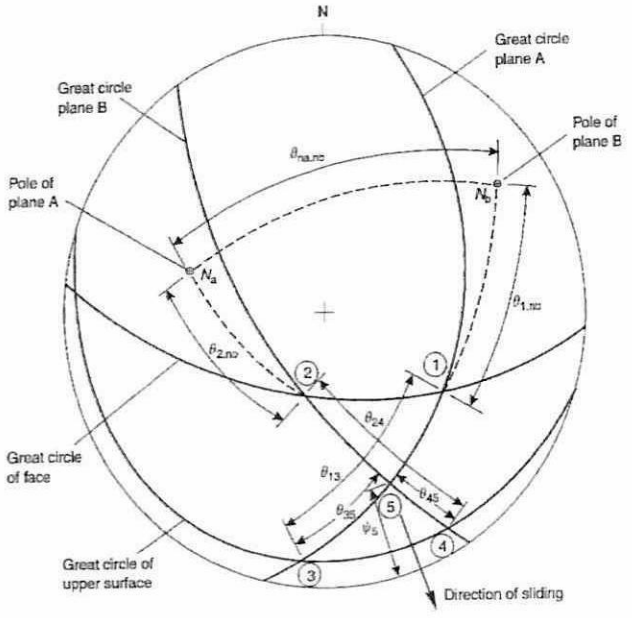

Given:

$$Fos = \frac{3}{\gamma H_t}(C_a.X + C_b.Y) + (A - \frac{\gamma_w}{2\gamma}.X)Tan\phi_a + (B - \frac{\gamma_w}{2\gamma}.Y)Tan\phi_b$$

C_a = Cohesion
ϕ_b = Friction angle
H_t = height of wedge
ψ_a = dip angle for plane a
ψ_b = dip angle for plane b
ψ_5= dip angle for wedge intersection
γ = unit weight of rock
γ_w = unit weight of water

X, Y, A, B is factor which depend upon the geometry of wedge

$$X = \frac{Sin\theta_{24}}{Sin\theta_{45}Cos\theta_{2.na}} \quad Y = \frac{Sin\theta_{13}}{Sin\theta_{35}Cos\theta_{1.nb}} \quad A = \frac{Cos\psi_a - Cos\psi_b Cos\theta_{na.nb}}{Sin\psi_5 . Sin^2\theta_{na.nb}}$$

$$B = \frac{Cos\psi_b - Cos\psi_a Cos\theta_{na.nb}}{Sin\psi_5 . Sin^2\theta_{na.nb}}$$

Figure Q1(c): Wedge failure mode formula

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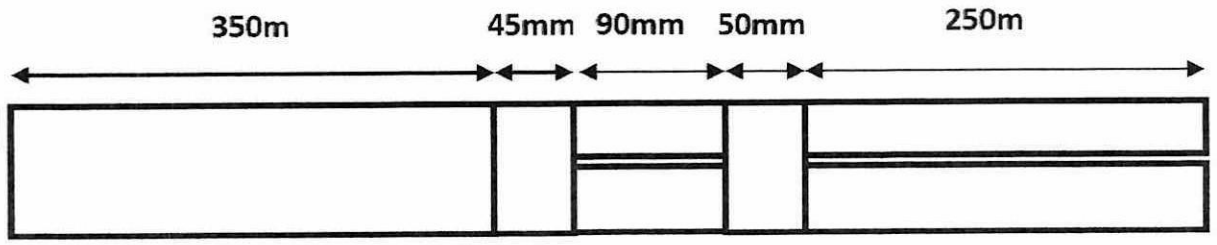

Figure Q2(c): Illustration of cylindrical core sample at 54mm diameter for BH1