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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2015/2016

COURSE NAME	:	ADVANCED GEOTECHNIC
COURSE CODE	:	BFG 40203
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE / JULY 2016
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

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Q1 (a) Explain briefly the differences between plane strain and axisymmetric conditions?
(5 marks)

(b) A cylindrical soil, 100 mm in diameter and 200 mm long, is axially compressed. The length decreases to 180 mm and the radius increases by 1.5 mm. Calculate:

(i) The axial and radial strains
(2 marks)

(ii) The volumetric strains
(2 marks)

(iii) Poisson's ratio
(1 mark)

(c) The Unconsolidated Undrained (UU) triaxial test with cell pressure (σ_3) of 200 kN/m^2 was conducted on unsaturated residual soil sample with the initial height h_o, = 200 mm and $h_o/d = 2$. The data obtained are as outlined in **Table Q1 (c).**

TABLE Q1(c)

Axial Strain, ε_1 (%)	Axial load, (N)	Pore pressure, u (kN/m^2)
0	0	32
0.34	29	34
0.69	223	34
1.37	497	37
2.06	618	39
3.43	695	43
5.15	703	45

(i) Plot the deviator stress versus axial strain.
(5 marks)

(ii) Determine the Young's modulus, tangent and secant stiffness at failure.
(5 marks)

(iii) Determine the effective shear stress, τ_f of the soil.
(5 marks)

Q2 (a) The matric suction ($u_a - u_w$) is the difference between the pore air and pore water pressure. It can measure easily using filter paper method. Outline the procedure in determining the matric suction of unsaturated soil in terms of total suction and matric suction.

(8 marks)

(b) The following data given in **Table Q2(b)** were obtained from modified direct shear test for unsaturated residual soil specimen size of 100 mm x 1000 mm.

TABLE Q2(b)

Matric suction, (u_a-u_w) (kN/m^2)	Net stress, (σ- u_a) (kN/m^2)	Shear stress, τ (kN/m^2)
0	0	10
93	50	44
159	100	68
225	150	92
288	200	115
354	250	139
420	300	163

(i) Plot the graph matric suction versus shear stress, and net stress versus shear stress.

(6 marks)

(ii) Determine the shear strength of the soil if the applied matric suction and the net stress are 500 kN/m^2 and 550 kN/m^2 respectively.

(4 marks)

(iii) If the soil becomes saturated, predict the strength of the soil when the effective normal stress is 700 kN/m^2. Comment your answer.

(7 marks)

Q3 (a) Explain briefly how to plot the yield surface and show clearly the elastic and elastoplastic stress state in your sketch.

(5 marks)

(b) The following data were obtained from a consolidation phase of a standard triaxial CU test on a clay soil. Determine the λ, κ, C_c and C_r.

Mean effective stress *(p')*	25	50	200	400	800	1600	800	400	200
Void ratio (e)	1.65	1.64	1.62	1.57	1.51	1.44	1.45	1.46	1.47

(6 marks)

(c) In the critical state model, the behavior of soil under loading depending on many factors such as drain condition (drained or undrained) and normally consolidated or overconsolidated soil. Discuss in detail the behavior of normally consolidated soil under drained and undrained condition. Your sketches should consist of the following graphs:

(i) Deviator stress (q') versus mean effective stress (p');
(ii) Void ratio (e) versus mean effective stress (p').

(14 marks)

Q4 (a) In the physical modeling, the full scale model, small scale model and centrifuge modeling can be adopted to simulate the soil behavior during loading. Explain briefly their advantages and disadvantages in soil modeling.

(6 marks)

(b) Critically discuss the difficulties of adopting physical models in geotechnical engineering. Your answer must consist of the dimensional analysis and scaling law.

(9 marks)

(c) The dimensions in the full scale model can be scaled linearly in a centrifuge model. Sketch and discuss on how to scale the soil sample at 15 m depth with density of 1800 kg/m^3 in centrifuge model. What is the scale factor that should be applied for this situation?

(10 marks)

Q5 (a) Briefly explain **TWO (2)** advantages and **TWO (2)** disadvantages in solving problem using finite element analysis and physical modeling.

(5 marks)

(b) The excavation of sandy soil required support from the concrete diaphragm walls and ground anchor as shown in **Figure Q5 (b)**. Using your own experience, discuss in details with sketches the procedure in modeling the construction of excavation in the Plaxis finite element software. Your answer should consist of soil parameters, structures, boundary condition, initial condition, mesh and stage construction.

(10 marks)

(c) Construction of embankment on soft soil is very challenging. The selection of correct soil model in numerical modeling is essential and critical. Based on your experience and reading, discuss in details the best soil model to represent the behavior of soft soil under loading. Note that the available soil model are linear elastic, Mohr-Coulomb, Hardening Soil, Hardening Soil Small Strain, Soft Soil and Soft Soft Creep model.

(10 marks)

-END OF QUESTIONS-

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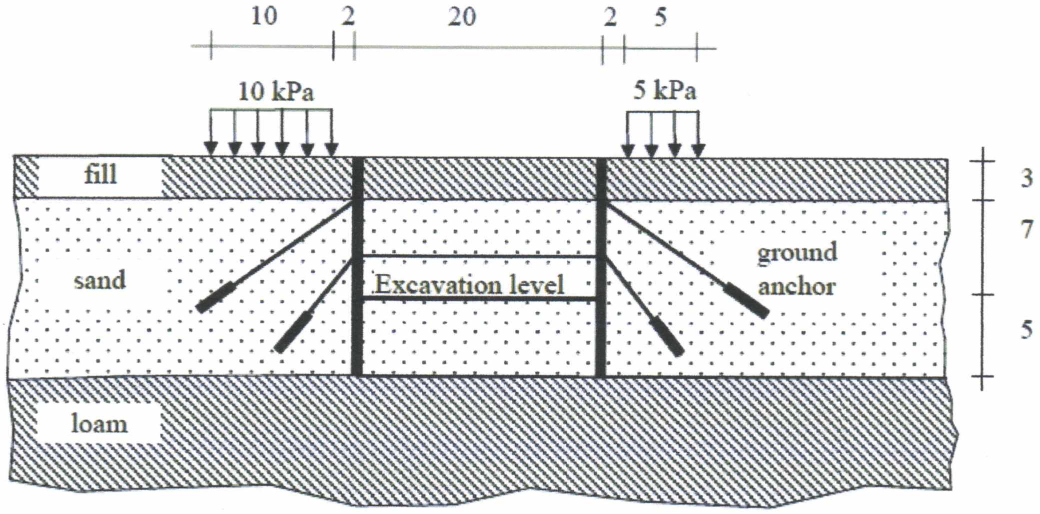

Note: The scale is in meter (m)

Figure Q5(b)

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LIST OF FORMULA

STRESS STRAIN PARAMETERS

$$q' = \sigma'_1 - \sigma'_3$$

$$p' = \frac{1}{3}(\sigma'_1 - \sigma'_3)$$

$$\varepsilon_s = \frac{2}{3}(\varepsilon_1 - \varepsilon_3)$$

$$\varepsilon_v = \varepsilon_1 + 2\varepsilon_3$$

$$K' = \frac{\delta p'}{\delta \varepsilon_v}$$

$$3G' = \frac{\delta q'}{\delta \varepsilon_s}$$

$$E' = \frac{\delta' \sigma'_1}{\delta \varepsilon_1}$$

$$\upsilon' = -\frac{\delta' \varepsilon_3}{\delta \varepsilon_1}$$

$$G' = \frac{E'}{2(1+\upsilon')}$$

$$K' = \frac{E'}{3(1-2\upsilon')}$$

UNSATURATED SOIL

$$(u_a - u_w) = \frac{4T}{(\nu - 1)d_s}$$

$$d_v = (\upsilon - 1)d_s$$

$$T\pi d_v = (u_a - u_w)\frac{\pi d_v^2}{4}$$

$$\tau' = c' + (\sigma_n - u_a)\tan\phi' + (u_a - u_w)\tan\phi'^b$$

CRITICAL STATE

$$e_f = e_\Gamma - \lambda \ln p'_f$$

$$\lambda = \frac{C_c}{2.3}$$

$$\kappa = \frac{C_r}{2.3}$$

$$q = \pm Mp'\sqrt{\left(\frac{p'_c}{p'} - 1\right)}$$

$$q_f = Mp'_f$$

$$M_c = \frac{6\sin\phi'_{cs}}{3 - \sin\phi'_{cs}}$$

$$M_e = \frac{6\sin\phi'_{cs}}{3 + \sin\phi'_{cs}}$$

$$q_f = M\exp\left(\frac{e_\Gamma - e_o}{\lambda}\right)$$