UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2012/2013

COURSE NAME	:	ADVANCED GEOTECHNIC
COURSE CODE	:	BFG 4023/ BFG 40203
PROGRAMME	:	4 BFF
EXAMINATION DATE	:	JUNE 2013
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

Q1 (a) What are the differences between plane strain and axisymmetric conditions? (5 marks)

(b) A cylindrical soil, 75 mm in diameter and 150 mm long, is axially compressed. The length decreases to 147 mm and the radius increases by 0.3 mm. Calculate:

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

(ii) The volumetric strains (2 marks)

(iii) Poisson's ratio (1 mark)

(c) A consolidated undrained test was carried out on silty clay that was isotropically consolidated using a cell pressure of 125 kN/m^2. The following data were obtained.

Axial load (kN/m^2)	Axial strain, ε_1 (%)	Δu (kN/m^2)
0	0	0
5.5	0.05	4.0
11.0	0.12	8.6
24.5	0.29	19.1
28.5	0.38	29.3
35.0	0.56	34.8
50.5	1.08	41.0
85.0	2.43	49.7
105.0	4.02	55.8
120.8	9.15	59.0

(i) Plot the deviatoric stress against axial strain. (5 marks)

(ii) Determine the total and effective undrained shear strength. (5 marks)

(iii) Determine the Young's modulus, E at failure. (5 marks)

Q2 (a) Briefly explain the importance of knowledge of unsaturated soil mechanics in the following conditions:

(i) In construction and operation of earth dam

(4 marks)

(ii) Natural slope subjected to environmental changes

(4 marks)

(b) The following data were obtained from modified direct shear test for unsaturated residual soil specimen size of 50 mm x 50 mm.

(u_a-u_w) (kN/m^2)	$(\sigma- u_a)$ (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, what is the strength of the soil when the effective normal stress is 500 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 and κ.

p'	25	50	200	400	800	1600	800	400	200
e	1.65	1.64	1.62	1.57	1.51	1.44	1.45	1.46	1.47

(6 marks)

(c) A saturated sample of soil 38 mm in diameter and 76 mm high was isotropically consolidated to 200 kN/m^2 in a triaxial cell. It was decided to stop the consolidation when the excess porewater pressure (Δu) was 20 kN/m^2. The sample was subjected to a standard undrained test (σ_3 = 200 kN/m^2 is kept constant). Failure (critical state) was recorded when q_f = 64 kN/m^2. The water content was 40%, $\lambda = 0.16$, and $\kappa = 0.03$.
Determine:

(i) e_Γ
(ii) M
(iii) Δu_f

(14 marks)

Q4 (a) Explain briefly the importance of centrifuge modeling in geotechnical field.

(5 marks)

(b) The dimensions in the full scale model can be scaled linearly in a centrifuge model. Sketch and explain 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)

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

(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) With the aid of sketches discuss how to model the one-dimensional consolidation test in the finite element software (Abaqus or Plaxis). Your answer should include the assumption, boundary condition and initial condition used in modeling.

(10 marks)

(c) Construction of road embankment will use three different layers of material. Plan and describe the modeling procedure in the determination of factor of safety of the slope embankment using SLOPE/W software.

(10 marks)

-END OF QUESTION-

S1 (a) Apakah perbezaan antara keadaan terikan satah dan paksi simetri. (5 markah)

(b) Tanah silinder berdiameter 75 mm dan panjang 150 mm dikenakan tekanan paksi. Panjang sampel berkurang kepada 147 mm dan jejari sampel bertambah 0.3 mm. Kira:

(i) Terikan paksi dan jejari (2 markah)

(ii) Terikan isipadu (2 markah)

(iii) Nisbah Poisson's (1 markah)

(c) Ujikaji pengukuhan tak tersalir telah dijalankan ke atas tanah liat berkelodak yang dikukuhkan secara isotropik menggunakan tekanan sel 125 kN/m^2. Data berikut telah diperoleh:.

Beban paksi (kN/m^2)	Terikan paksi, ε_1 (%)	Δu (kN/m^2)
0	0	0
5.5	0.05	4.0
11.0	0.12	8.6
24.5	0.29	19.1
28.5	0.38	29.3
35.0	0.56	34.8
50.5	1.08	41.0
85.0	2.43	49.7
105.0	4.02	55.8
120.8	9.15	59.0

(i) Plot tekanan sisih melawan terikan paksi. (5 markah)

(ii) Tentukan kekuatan jumlah dan berkesan ricih tak tersalir. (5 markah)

(iii) Tentukan modulus Young, E semasa gagal. (5 markah)

S2 (a) Jelaskan secara ringkas kepentingan ilmu mekanik tanah tak tepu dalam keadaan berikut:

(i) Pembinaan dan pengoperasian empangan tanah.

(4 markah)

(ii) Cerun semulajadi yang terdedah kepada perubahan alam sekitar.

(4 markah)

(b) Data berikut telah diperolehi daripada ujikaji ricih terus yang diubahsuai untuk spesimen tanah baki tak tepu bersaiz 50 mm x 50 mm.

(u_a-u_w) (kN/m^2)	$(\sigma- u_a)$ (kN/m^2)	Tegasan ricih, 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 graf matrik sedutan melawan tegasan ricih dan tegasan bersih melawan tegasan ricih.

(6 markah)

(ii) Tentukan kekuatan ricih tanah jika matrik sedutan yang dikenakan dan tegasan bersih masing-masing adalah 500 kN/m^2 and 550 kN/m^2.

(4 markah)

(iii) Jika tanah menjadi tepu, berapakah nilai kekuatan ricih tanah apabila tegasan normal berkesan 500 kN/m^2. Komen jawapan anda.

(7 markah)

S3 (a) Terangkan secara ringkas bagaimana melakarkan permukaan alah dan tunjukkan dengan jelas keadaan elastik dan elastoplastik di dalam lakaran tersebut.

(5 markah)

(b) Data berikut telah diperolehi dari fasa pengukuhan dalam ujikaji piawai pengukuhan tak tersalir tigapaksi keatas tanah liat. Tentukan λ dan κ.

p'	25	50	200	400	800	1600	800	400	200
e	1.65	1.64	1.62	1.57	1.51	1.44	1.45	1.46	1.47

(6 markah)

(c) Sampel tanah tepu berdiamtere 38 mm dan tinggi 76 mm telah dikukuhkan secara isotropic kepada 200 kN/m^2 di dalam sel tiga paksi. Ianya telah diputuskan untuk menghentikan pengukuhan apabila lebihan tekanan air liang (Δu) menjadi 20 kN/m^2. Sampel itu dikenakan ujikaji tak tersalir piawai (σ_3 = 200 kN/m^2 yang tetap). Kegagalan (keadaan genting) telah direkodkan apabila q_f = 64 kN/m^2. Kandungan lembapan adalah 40%, λ = 0.16, dan κ = 0.03.
Tentukan:

(i) e_Γ
(ii) M
(iii) Δu_f

(14 markah)

S4 (a) Terangkan secara ringkas kepentingan pemodelan empar dalam bidang geoteknik.

(5 marks)

(b) Dimensi dalam model penuh boleh diskalakan secara linear di dalam model empar. Lakarkan dan terangkan bagaimana untuk menskalakan sampel tanah pada kedalaman 15 m dengan ketumpatan sebanyak 1800 kg/m^3 di dalam model empar. Apakah faktor skala yang perlu dikenakan dalam situasi ini?

(10 marks)

(c) Bincangkan secara kritis kesukaran menggunapakai model fizikal daam kejuruteraan geoteknik. Jawapan anda mestilah mengandungi analisis dimensi dan peraturan penskalaan.

(10 marks)

S5 (a) Terangkan secara ringkas **DUA (2)** kelebihan dan **DUA (2)** kekurangan dalam penyelesaian masalah menggunakan unsur tak terhingga dan pemodelan fizikal.

(5 markah)

(b) Dengan bantuan lakaran, bincangkan bagaimana untuk memodelkan ujikaji pengukuhan satu dimensi menggunakan perisian unsur tak terhingga (Abaqus atau Plaxis). Jawapan anda haruslah mengandungi anggapan, keadaan had dan keadaan awalan yang digunakan dalam pemodelan.

(10 markah)

(c) Pembinaan tambakan jalan akan menggunakan tiga jenis bahan lapisan yang berbeza. Rancang dan terangkan prosedur dalam menentukan faktor keselamatan cerun tambakan menggunakan perisian SLOPE/W.

(10 markah)

-SOALAN TAMAT-

FINAL EXAMINATION

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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

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

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

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

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

$$q_f = Mp'_f$$

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

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

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