UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	GEOTECHNICS 1
COURSE CODE	:	BFC 21702
PROGRAMME	:	2 BFF
EXAMINATION DATE	:	JUNE 2014
DURATION	:	2 HOURS AND 30 MINUTES
INSTRUCTION	:	ANSWER ANY **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **TWELVE (12)** PAGES

Q1. (a) Briefly explain (wherever possible with the aid of sketches/diagrams) or define the following terms:-

(i) Liquid limit (LL)
(ii) Plastic Limit (PL)
(iii) Plasticity index (PI)
(iv) Effective size (D_{10})
(v) Coefficient of uniformity (C_u)

(5 marks)

(b) Results of grain size analysis of a disturbed soil obtained from a construction site are shown in Table **Q1**.

(i) Plot a grain size distribution curve and determine D_{10}, D_{30}, and D_{60}

(8 marks)

(ii) Calculate the coefficient of uniformity (Cu) and the coefficient of gradation (Cc),

(4 marks)

(iii) Classify the soil using the American Association of State Highways and Transportation Officials (AASHTO) System, if the liquid limit of the soil is 42% and the plastic limit of the soil is 30%.

(5 marks)

(iv) Please comments on the suitability of the soil to be used for constructing road embankments.

(3 marks)

Q2 (a) Explain the terms:

(i) Bulk unit weight
(ii) Dry unit weight
(iii) Void ratio
(iv) Porosity
(v) Moisture content

(5 marks)

(b) The moist weight of 5.66×10^{-3} m^3 of a soil is 102.3×10^{-3} kN. The moisture content and the specific gravity of the soil solids are determined in the laboratory to be 11% and 2.7, respectively.

Calculate the following :

(i) Moist unit weight (kN/m^3)
(ii) Dry unit weight (kN/m^3)
(iii) Void ratio
(iv) Porosity
(v) Degree of saturation (%)
(vi) Volume occupied by water (m^3)

(15 marks)

(c) In construction project, the field moist unit weight was 19 kN/m^3 at the moisture content of 10%. If maximum and minimum dry unit weight determined in the laboratory were 17 kN/m^3 and 15 kN/m^3, respectively what was the relative density for the soil?

(5 marks)

Q3 (a) Which type of soil is most suitable to be compacted using sheepsfoot roller and vibratory rollers, respectively?

(4 marks)

(b) Briefly explain how soil type and compaction effort can affect the compaction with the aid of sketch.

(6 marks)

(c) A Site Investigation contractor was appointed to determine the quality of compaction at newly compacted soils. Sand replacement method was used and the data obtained were shown in Table **Q3**.

Determine the dry density (kg/m^3) of compaction in the field.

(7 marks)

(d) Based on the quality control test, the relative compaction of the soil in the field is reported as 95%. It was given that maximum dry unit weight of the soil is determined as 18 kN/m^3 and minimum dry unit weight is 15 kN/m^3 in laboratory.

(i) Determine the dry unit weight (kN/m^3) of soil in the field
(ii) Determine the relative density of compaction

(8 marks)

Q4 (a) The riser pipe has properties as shown in the Figure **Q4**.

(i) Determine the value of h, which will result in soil at point C to achieve quick condition. Given that the saturated unit weight of soil is 19 kN/m^3.

(ii) Calculate the overall critical hydraulic gradient over the and plug

(10 marks)

(b) The normally consolidated (NC) clay soil has the permeability condition as shown in Table **Q4**.

Calculate permeability at void ratio, e = 0.6.

(15 marks)

Q5. (a) Express the critical hydraulic gradient (i_c) in terms of the soil specific gravity (Gs) and the void ratio (e).

(6 marks)

(b) Figure **Q5 (a)** shows a cut made in stiff saturated clay that was underlain by a layer of sand. What should be the height of the water, h, in the cut so that the stability of the saturated clay is not lost?

(7 marks)

(c) A soil profile as shown in Figure **Q5 (b)** was obtained during a site investigation. Sketch graphs, showing the variations to a depth of 4.57 m of:

(i) the total vertical pressure,
(ii) the effective vertical pressure and
(iii) the pore water pressure.

Assume that the soil above the capillary zone is dry.

(12 marks)

Q6 (a) Explain Mohr's theory for failure of soils and state Coloumb's empirical law governing the strength of soils

(5 marks)

(b) A drained shear box test (60 mm x 60 mm) was carried out on a sandy clay and yielded the following as shown in Table **Q6.**

Determine the apparent cohesion, *c* and angle of friction, ϕ for the soil.

(10 marks)

(c) A consolidated-drained triaxial test was conducted on a normally consolidated clay with a chamber pressure, σ_3 = 180 kN/m^2. The deviator stress at failure, $(\Delta\sigma_d)_f$ = 230 kN/m^2.

Determine:

(i) The angle of friction, ϕ'

(ii) The angle, θ that the failure plane makes with the major principal plane

(iii) The normal stress σ'_f, and the shear stress τ_f, on the failure plane

(10 marks)

- END OF QUESTION -

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TABLE Q1

Sieve No.	Sieve size (mm)	Mass of soil retained (gm)
4	4.75	0
10	2.00	21.6
20	0.85	49.5
40	0.425	102.6
60	0.25	89.1
100	0.15	95.6
200	0.075	60.4
Pan		31.2

TABLE Q3

Details	Value
Mass of jar + cone + sand (before use)	7 kg
Mass of jar + cone + sand (after use)	3 kg
Mass of moist soil from hole	3.5 kg
Moisture content of moist soil	12.5 %
Calibrated dry density of Ottawa sand	1735 kg/m^3
Mass of Ottawa sand to fill the cone	0.120 kg

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TABLE Q4

Void ratio, e	Permeability (cm/s)
1.2	3×10^{-8}
0.8	1×10^{-8}

TABLE Q6: Shear box test

Normal load (N)	102	210	310	380	490	590
Shear load at failure (N)	170	240	270	330	380	410

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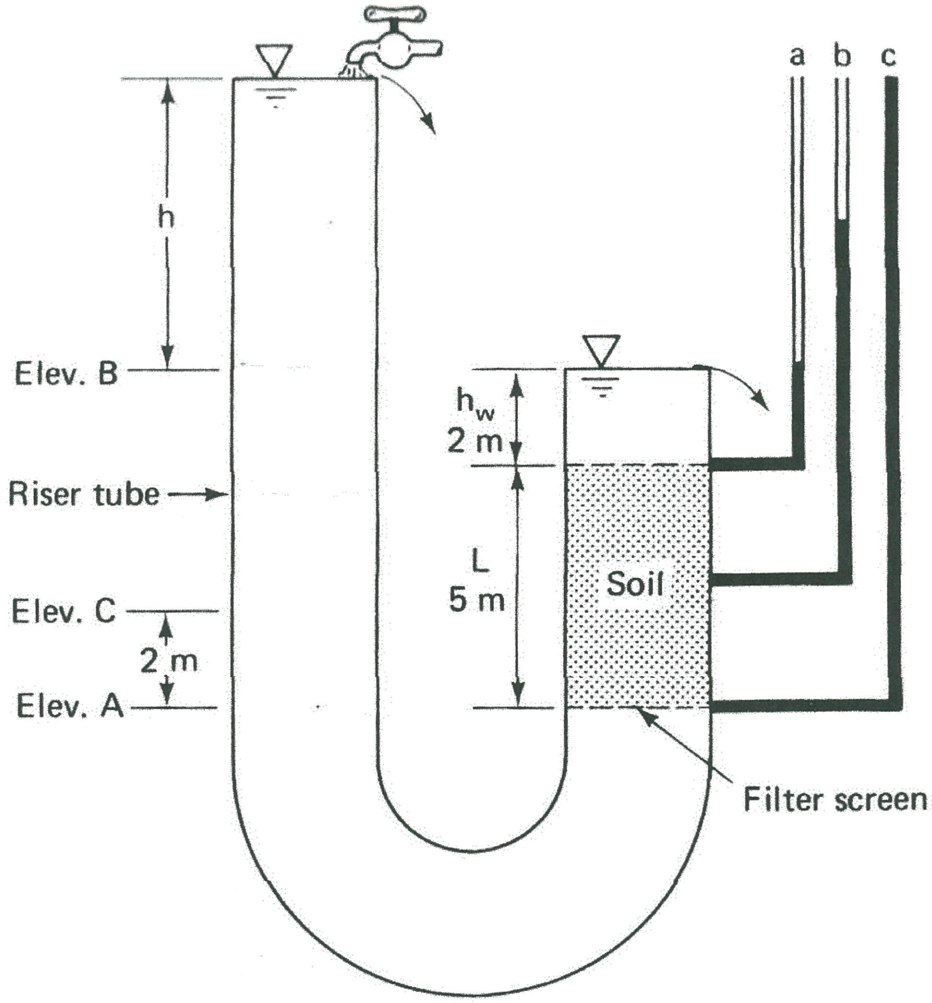

FIGURE Q4: Connected pipe riser

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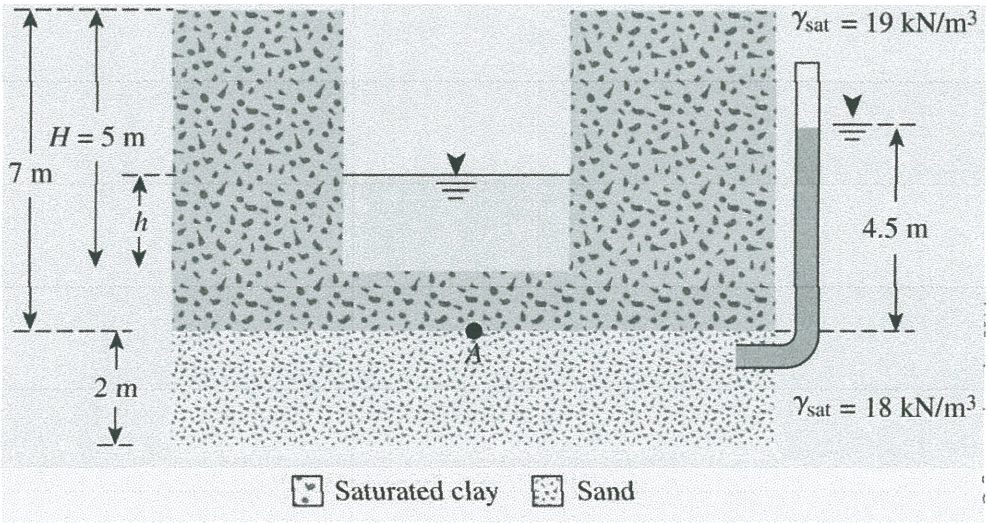

FIGURE Q5 (a)

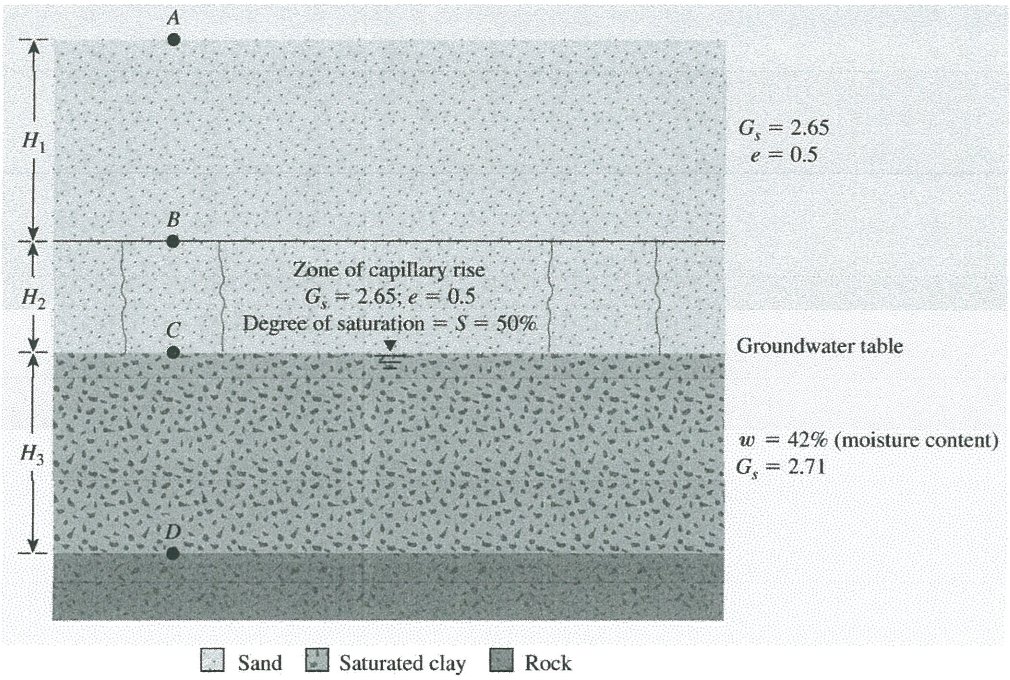

FIGURE Q5 (b)

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LIST OF FORMULA:

$$e = \frac{V_v}{V_s}$$

$$n = \frac{V_v}{V}$$

$$S_r = \frac{V_w}{V_v}$$

$$w = \frac{W_w}{W_s}$$

$$\gamma_d = \frac{W_s}{V}$$

$$\gamma_b = \frac{W}{V}$$

$$\rho = \frac{m}{V}$$

$$\rho_d = \frac{m_s}{V}$$

$$\gamma_{sat} = \frac{(G_s + e)\gamma_w}{1+e}$$

$$S_r e = wG_s$$

$$G_s = \frac{\gamma_s}{\gamma_w} @ \frac{\rho_s}{\rho_w}$$

$$C_u = \frac{D_{60}}{D_{10}}$$

$$C_c = \frac{D^2{}_{30}}{D_{60} \times D_{10}}$$

$$R = \frac{\gamma_{d(field)}}{\gamma_{d(max-lab)}}; \quad Dr = \left[\frac{\gamma_{d(field)} - \gamma_{d(\min)}}{\gamma_{d(\max)} - \gamma_{d(\min)}}\right]\left[\frac{\gamma_{d(\max)}}{\gamma_{d(field)}}\right]$$

$$k = C\left(\frac{e^n}{1+e}\right)$$

$$\sigma_n = \frac{\sigma_1 + \sigma_3}{2} + \frac{\sigma_1 - \sigma_3}{2}\cos 2\theta$$

$$\tau_n = \frac{\sigma_1 - \sigma_3}{2}\sin 2\theta$$

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TABLE: Classification of highway subgrade materials (AASHTO)

General classification	Granular materials (35% or less of total sample passing No. 200)						
	A-1			A-2			
Group classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7
Sieve analysis (percentage passing)							
No. 10	50 max.						
No. 40	30 max.	50 max.	51 min.				
No. 200	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.
Characteristics of fraction passing No. 40							
Liquid limit				40 max.	41 min.	40 max.	41 min.
Plasticity index	6 max.		NP	10 max.	10 max.	11 min.	11 min.
Usual types of significant constituent materials	Stone fragments, gravel, and sand		Fine sand	Silty or clayey gravel and sand			
General subgrade rating	Excellent to good						

General classification	Silt-clay materials (more than 35% of total sample passing No. 200)			
Group classification	A-4	A-5	A-6	A-7 A-7-5[a] A-7-6[b]
Sieve analysis (percentage passing)				
No. 10				
No. 40				
No. 200	36 min.	36 min.	36 min.	36 min.
Characteristics of fraction passing No. 40				
Liquid limit	40 max.	41 min.	40 max.	41 min.
Plasticity index	10 max.	10 max.	11 min.	11 min.
Usual types of significant constituent materials	Silty soils		Clayey soils	
General subgrade rating	Fair to poor			

[a]For A-7-5, $PI \leq LL - 30$
[b]For A-7-6, $PI > LL - 30$

$$GI = (F_{200} - 35)[0.2 + 0.005(LL - 40)] + 0.01(F_{200} - 15)(PI - 10)$$

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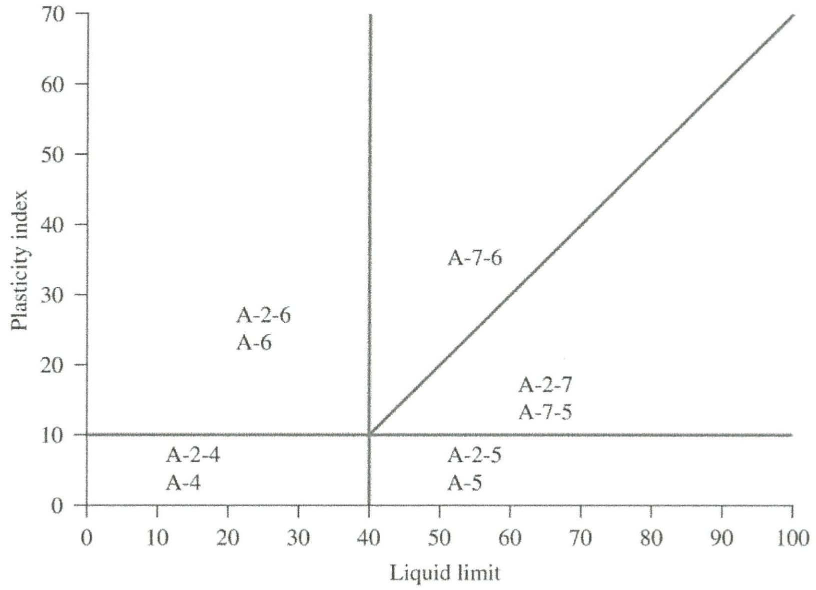

FIGURE: Range of liquid limit and plasticity index for soils in group A-2, A-4, A-5, A-6 and A-7 (AASHTO)

TABLE: Various forms of relationship for γ, γ_d and γ_{sat}

Moist unit weight (γ)		Dry unit weight (γ_d)		Saturated unit weight (γ_{sat})	
Given	**Relationship**	**Given**	**Relationship**	**Given**	**Relationship**
w, G_s, e	$\frac{(1+w)G_s\gamma_w}{1+e}$	γ, w	$\frac{\gamma}{1+w}$	G_s, e	$\frac{(G_s+e)\gamma_w}{1+e}$
S, G_s, e	$\frac{(G_s+Se)\gamma_w}{1+e}$	G_s, e	$\frac{G_s\gamma_w}{1+e}$	G_s, n	$[(1-n)G_s+n]\gamma_w$
w, G_s, S	$\frac{(1+w)G_s\gamma_w}{1+\frac{wG_s}{S}}$	G_s, n	$G_s\gamma_w(1-n)$	G_s, w_{sat}	$\left(\frac{1+w_{sat}}{1+w_{sat}G_s}\right)G_s\gamma_w$
w, G_s, n	$G_s\gamma_w(1-n)(1+w)$	G_s, w, S	$\frac{G_s\gamma_w}{1+\left(\frac{wG_s}{S}\right)}$	e, w_{sat}	$\left(\frac{e}{w_{sat}}\right)\left(\frac{1+w_{sat}}{1+e}\right)\gamma_w$
S, G_s, n	$G_s\gamma_w(1-n)+nS\gamma_w$	e, w, S	$\frac{eS\gamma_w}{(1+e)w}$	n, w_{sat}	$n\left(\frac{1+w_{sat}}{w_{sat}}\right)\gamma_w$
		γ_{sat}, e	$\gamma_{sat}-\frac{e\gamma_w}{1+e}$	γ_d, e	$\gamma_d+\left(\frac{e}{1+e}\right)\gamma_w$
		γ_{sat}, n	$\gamma_{sat}-n\gamma_w$	γ_d, n	$\gamma_d+n\gamma_w$
		γ_{sat}, G_s	$\frac{(\gamma_{sat}-\gamma_w)G_s}{(G_s-1)}$	γ_d, G_s	$\left(1-\frac{1}{G_s}\right)\gamma_d+\gamma_w$
				γ_d, w_{sat}	$\gamma_d(1+w_{sat})$