DTEMS PAST PAPERS
TECHNICAL

SIR ARTHUR LEWIS COMMUNITY COLLEGE
DIVISION OF TECHNICAL EDUCATION AND MANAGEMENT STUDIES

EXAMINATION SESSION	:	December 2007 Examination
TUTOR(S)	:	Mr. Damian Combie
PROGRAMME TITLE	:	Construction Engineering
PROGRAMME CODE	:	3BD-CON-AD
COURSE TITLE	:	Soil Mechanics
COURSE CODE	:	BSC106
CLASS	:	Year 2
DATE	:	December 7th 2007
TIME	:	9:00 a.m.
DURATION	:	3 hours
ROOM	:	SME R1
INVIGILATOR(S)	:	**Ms. R. Isaac,** Mr. N. Hyacinth

INSTRUCTIONS:

- Attempt not more than **five** questions
- Begin each question on a separate sheet
- Write your ID Number on *each* answer sheet
- Students must write legibly
- Students **must** show sufficient working steps to indicate the method of solution
- Any formulae used must first be stated
- Students must sign **IN** and **OUT** of examination class list

Question1

A sample of soil, $\frac{1}{1000}$ m^3, weighed in its natural state 1.82 kg, the degree of saturation being 67.5%. After oven drying at 105°C the sample weighed 1.53 kg. Find:

a) the specific gravity of the solids. (5 marks)

b) the natural water content. (1 mark)

c) the void ratio. (1 mark)

d) the bulk density, the dry density, the saturated density and the submerged density. (5 marks)

e) A borehole on a building site has the soil profile shown in **Figure 1**. Find the effective stress at the bottom of the clay. (8 marks)

Question 2:

The following results were obtained from a compaction test using the 2.5kg rammer.

Mass of mould and wet sand (g)	2798	3072	3239	3296	3265	3211
Water content (%)	8.1	9.9	12.0	14.3	16.1	18.2

The weight of the compaction mould less its collar and base was 1130g. The volume of the mould is 1000 cm^3, and the soil had a specific gravity of 2.7.

a) Plot the curve of dry density against moisture content and determine the optimum moisture content and maximum compaction. (10 marks)

b) Plot the five per cent air voids line. (4 marks)

c) Calculate the moisture content necessary for complete saturation at this maximum dry density. (2 marks)

d) What are the values of void ratio, porosity and degree of saturation at its condition of optimum moisture content? (4 marks)

Question 3:

a) In a laboratory a constant head permeability test was conducted on a silty sand. For the constant head the following data were obtained.

i) Quantity of water discharged during test = 250 cm^3.
ii) Length of specimen = 11.43cm
iii) Time required for a given quantity of water to be discharged = 65 secs.
iv) Head (difference between manometer levels) = 5.5cm.
v) Area of cross-section of sample 2000mm^3.
Determine the coefficient of permeability. (5 marks)

b) In a laboratory, a falling-head permeability test was conducted on a silty soil. For the falling-head apparatus the following data were obtained.

i) Length of specimen = 15.8cm
ii) Diameter of specimen = 10.16cm
iii) Cross-sectional area of burette = 1.83cm^2.

iv) Hydraulic head at beginning of test (h_1) = 120.0cm
v) Hydraulic head at end of test (h_2) = 110.0cm
vi) Time required for water in the burette to drop from h_1 to h_2 = 20.0 mins.
Determine the coefficient of permeability. (5 marks)

c) A well point lowering is carried out on a proposed construction site and after steady conditions have been obtained the readings in the observation wells are as shown in **Figure 2**. Determine the coefficient of permeability of the sandy soil. (5 marks)

d) A well point lowering is carried out on a proposed construction site and after steady conditions have been obtained the readings in the observation wells are as shown in **Figure 3**. Determine the coefficient of permeability of the sandy soil. (5 marks)

Question 4:

In an un-drained tri-axial test on three specimens of sandy clay taken from a depth of 3 m below ground level the following results were obtained:

Cell pressure (kN/m^2)	Deviator stress (kN/m^2)
200	221
400	365
600	505

a) Draw the Mohr diagram and determine the apparent cohesion and angle of shearing resistance of the soil. (12 marks)

b) Derive Coulomb's equation for this soil. (2 marks)

c) If a superimposed load of $60kN/m^2$ is applied to the top of the sandy clay layer, at ground level, find the permissible shear stress at a depth of 3m, assuming the Coulomb equation remains unchanged and $\Upsilon = 2000kg/m^3$. The water table is below the 3 m level. (6 marks)

Question 5:

Un-drained shear-box tests on samples of sandy clay gave the following results;

Normal pressure (kN/m^2)	50	125	250
Shearing resistance (kN/m^2)	61	83	119.5

a) Find the apparent cohesion and angle of shearing resistance. (10 marks)

b) Derive Coulomb's equation for this soil. (2 marks)

c) Find the value of apparent cohesion which would be expected from an unconfined compression test on a sample of the same soil. (4 marks)

d) If another specimen of this soil is subjected to an un-drained tri-axial test with lateral pressure 280 kN/m^2, find the total axial pressure at which failure would be expected. (4 marks)

7) **Figure 4** shows a retaining wall with a cohesive backfill.

i) Find the depth of tension cracks. (4 marks)

ii) Find for this slip plane, the thrust on the wall per lineal metre. (16 marks)

Question 6:

Figure 5 shows a retaining wall and silt backfill. If the unit weight of the silt is 17.66 kN/m^3, the cohesion 15 kN/m^2, the wall adhesion 12 kN/m^2, the angle of shearing resistance of the retained earth is 18°, and the angle of friction between the wall and the retained earth is 12°;

a) Find the depth of tension cracks z_0. (3 marks)

b) Find the maximum active thrust on the wall by the method of wedges using the trial slip plane shown. (17 marks)

Question 7:

Figure shows the backfill behind a smooth vertical retaining wall.

a) Determine the shear force in kN which must be mobilised beneath the base of the wall to prevent movement away from the backfill. (16 marks)

b) At what height above the base does the horizontal thrust act? (4 marks)

Question 8:

A vertical sheet pile wall is shown in **Figure 6**. The properties of the soil both behind and in front of the wall are $\gamma = 21 kN/m^3$, ϕ = 30°, and c = 0. Determine the minimum penetration depth of the pile to achieve free earth support conditions, using Rankine Theory. (Give answer to 2.d.p). (20 marks)

FORMULAS

SOIL DEFINITIONS:

i) $\gamma = \dfrac{W}{V}$ ii) $\gamma_d = \dfrac{W_s}{V}$ iii) $m = \dfrac{W_w}{W_s}$ iv) $V_s = \dfrac{W_s}{G_s \gamma_w}$

v) $\gamma_{sat} = \dfrac{W_s + W_w}{V}$ vi) $e = \dfrac{V_v}{V_s}$ viii) $n = \dfrac{V_v}{V}$ ix) $S_r = \dfrac{V_w}{V_v}$

COMPACTION:

i) $\gamma_d = \dfrac{\gamma}{1+m}$ ii) $\gamma_d = \dfrac{G_s \gamma_w (1 - V_a)}{1 + mG_s}$

PERMEABILITY:

i) $k = \dfrac{Q}{A} \times \dfrac{l}{t} \times \ln \dfrac{H_1}{H_2}$ ii) $k = \dfrac{Q}{A} \times \dfrac{l}{AH}$

iii) $k = \dfrac{\frac{Q}{t} \ln \frac{r_1}{r_2}}{\pi \left(z_2^2 - z_1^1\right)}$ iv) $k = \dfrac{\frac{Q}{t} \ln \frac{r_1}{r_2}}{2\pi d \left(z_2 - z_1\right)}$

1000 litres = 1m^3
1m^3 = 10^{9}mm^3

END OF EXAMINATION