Name_____ Index No._____

2307/304
SOIL MECHANICS AND HYDRAULICS
Oct/Nov 2014
Time: 3 hours

Candidate's Signature_____

Date _____

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN CIVIL ENGINEERING

SOIL MECHANICS AND HYDRAULICS

3 hours

INSTRUCTIONS TO CANDIDATES

Write your name and index number in the spaces provided above.
Sign and write the date of the examination in the spaces provided above.
You should have drawing instruments and a scientific calculator for this examination.
*This paper consists of **EIGHT** question in **TWO** Sections: **A** and **B**.*
*Answer **FIVE** questions: choosing at least **TWO** questions from each Section in the spaces provided in this question paper.*
***All** questions carry equal marks.*
Maximum marks for each part of a question are as shown.
*Do **NOT** remove any pages from this booklet.*
Candidates should answer the questions in English.

For Examiner's Use Only

Question	1	2	3	4	5	6	7	8	TOTAL SCORE
Candidate's Score									

This paper consists of 24 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

Turn over

SECTION A: SOIL MECHANICS

*Answer at least **TWO** questions from this Section.*

1. (a) (i) Differentiate between a residual soil and a transported soil;

(ii) Describe the following types of soils:

I sand;
II clay;
III silt;
IV peat. (8 marks)

(b) Prove that:

$$\gamma d = \frac{\gamma_b}{1 + m}$$

where the symbols have their usual meaning. (4 marks)

(c) An insitu test to determine the unit weight of a soil was carried out using the sand replacement method. A total of 4.62 kg of soil was extracted from a hole which was then refilled using 3.60 kg of loose, dry sand having a dry density of 1,570 kg/m^3. The following information was obtained:

Specific gravity determination:

mass of bottle and stopper = 25.00 g
mass of bottle, stopper and oven dried soil = 36.91 g
mass of bottle, soil and distilled water = 62.59 g
mass of bottle, stopper and distilled water = 55.21 g

Moisture content determination:

mass of tin and wet soil = 24.10 g
mass of tin and dry soil = 22.10 g
mass of tin = 12.30 g

Determine the:

(i) specific gravity of the particles;

(ii) moisture content;

(iii) bulk unit weight. (8 marks)

2. (a) (i) Define each of the following in ground water seepage:

I flow line;
II equipotential line;
III flow net.

(ii) Outline **five** factors observed while drawing a flow net. (8 marks)

(b) A stratum of soil 8.5 m thick is underlain by an impermeable stratum. A line of sheet piling is driven 6 m into the stratum, on one side of piling, the depth of water is 4.5 m, while on the other it is 0.50 m. The coefficient of permeability for the stratum is 2.5×10^{-6} m/s.

(i) Draw the flow net for the sheet piling arrangement;

(ii) Determine the quantity of seepage. (12 marks)

3. (a) Outline each of the following in the theory of consolidation:

(i) the coefficient of volume compressibility (Mv);

(ii) the compression index (Cc);

(iii) the degree of consolidation (Uv);

(iv) the coefficient of consolidation (Cv). (6 marks)

(b) The time to reach 60% consolidation is 33 seconds for a sample 10 mm thick, tested in the laboratory under conditions of double drainage. Determine how long a corresponding layer in the field will take to reach the same degree of consolidation if the layer is 10 m thick and drained on one side only. (4 marks)

(c) With the aid of a sketch, describe the direct sheer test. (10 marks)

4. (a) A square footing of size 1.5 m x 1.5 m rests on a sandy soil having the following properties:

unit weight, $\gamma = 17.3$ kN/m^3
angle of internal friction, $\phi = 35°$
cohesion, $c = O$ kN/m^2

Determine the gross ultimate bearing capacity of the footing if the footing:

(i) rests on the ground surface of the sandy soil;

(ii) is placed at a depth of 1 m below the ground surface of the sandy soil.

Use the chart shown in **figure 1**. (8 marks)

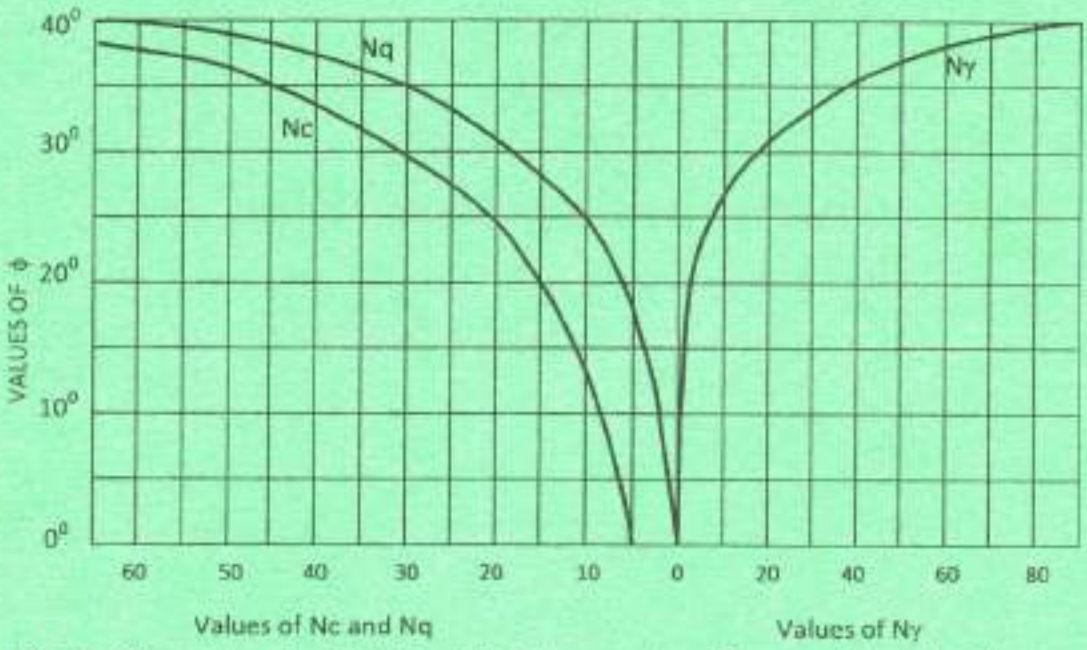

Fig. 1: Chart showing Relationship between ϕ and Bearing Capacity Factors

(b) The results in **table 1** were obtained from a standard proctor compaction test on a soil.

Table 1

Mass (g)	2010	2092	2114	2100	2055
Water content (%)	12.8	14.5	15.6	16.8	19.2

The volume of the mould used was 1000 cm^3. Plot the dry density against water content and determine the:

(i) optimum moisture content;

(ii) maximum dry density. (8 marks)

(c) Derive an expression for factor of safety against slip of surface BC as shown in **figure 2** in terms of C, r, θ, W and d, where C is the cohesion, r the radius, θ the angle of slip circle, W the weight of the wedge and d the distance of centre of gravity of wedge from point O. (4 marks)

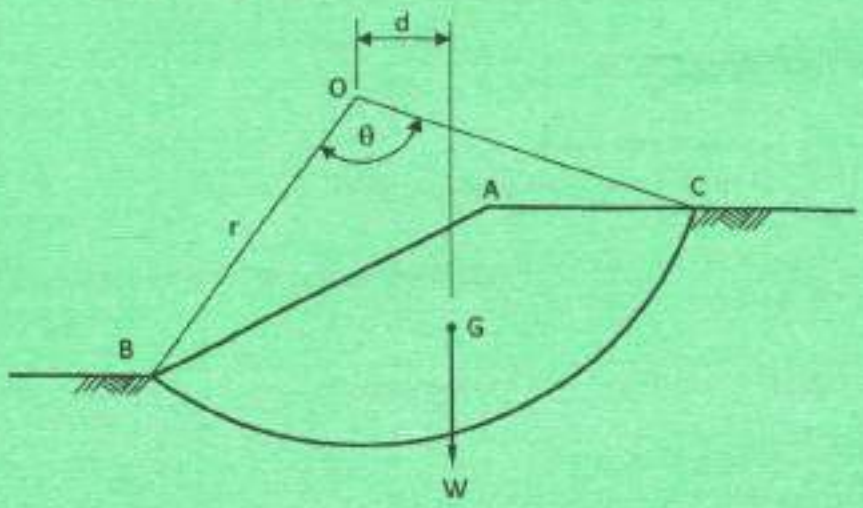

Fig. 2

SECTION B: HYDRAULICS

Answer at least TWO questions from this Section.

5. (a) State and prove Pascal's law. (6 marks)

(b) Determine the total pressure and depth of centre of pressure on one side of a plane surface submerged in water as shown in **figure 3**. (14 marks)

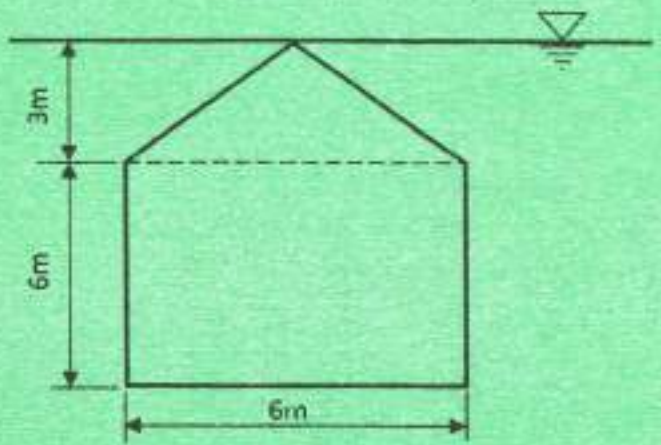

Fig. 3

6. (a) Derive the equation for discharge through a large orifice. (5 marks)

(b) A trapezoidal channel has side slopes of 3:4 (H:V) the slope of the bed being 1 in 2000. Determine the optimum dimensions of the channel if it is to convey water at 0.5 m^3/s. Take Chezy's constant C as 80 in SI units. (9 marks)

(c) (i) Differentiate between:

I a notch and a weir;
II a small orifice and a large orifice.

(ii) Determine the discharge over cippoletti weir of length 1.8 m when the head over the weir is 1.25 m. Take cd = 0.62. (6 marks)

7. (a) (i) Define the following types of pressure:

I absolute pressure;
II gauge pressure;
III atmospheric pressure;
IV vacuum pressure.

(ii) A U-tube differential manometer is connected to two pipes A and B as shown in **figure 4**.

I Derive an equation for pressure difference between pipes A and B;
II Determine the difference in mercury level in the differential manometer, given the following information:

pipe A contains liquid of sp. gr. 1.5 while pipe B contains a liquid of sp. gr. 09;
pressures at A and B are 98.1 kN/m^2 and 176.58 kN/m^2 respectively.
$h_1 = 3$ m and $h_2 = 2$ m. (8 marks)

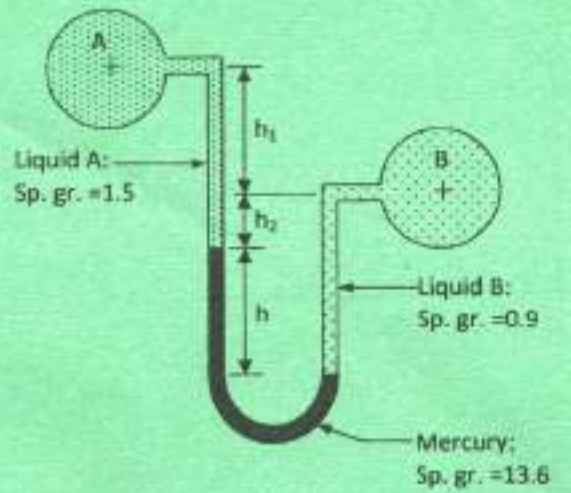

Fig. 4

(b) Two reservoirs A and B are connected by horizontal pipeline which is 150 m in diameter for the first 5 m and 250 mm in diameter for the remaining 15 m. The entrance and exit are sharp and change of section sudden. The water surface in the upper reservoir is 10 m above that in the lower reservoir. Determine the:

(i) losses of head which occur;

(ii) discharge.

Also, draw the H.G.L. and T.E.L. lines. *(Take $f = 0.01$ for both pipes).* (12 marks)

8. (a) With the aid of a sketch, explain the working principle of a single acting reciprocating pump. (9 marks)

(b) (i) With the aid of a sketch, explain the measurement of rainfall using a tipping bucket rain gauge.

(ii) **Figure 5** shows a catchment of area 200 km^2, with the rainfall amounts indicated at the respective gauge sites. Determine the:

I average depth of the rainfall based on the arithmetic mean method;
II volume of rainwater in m^3 received by the catchment. (11 marks)

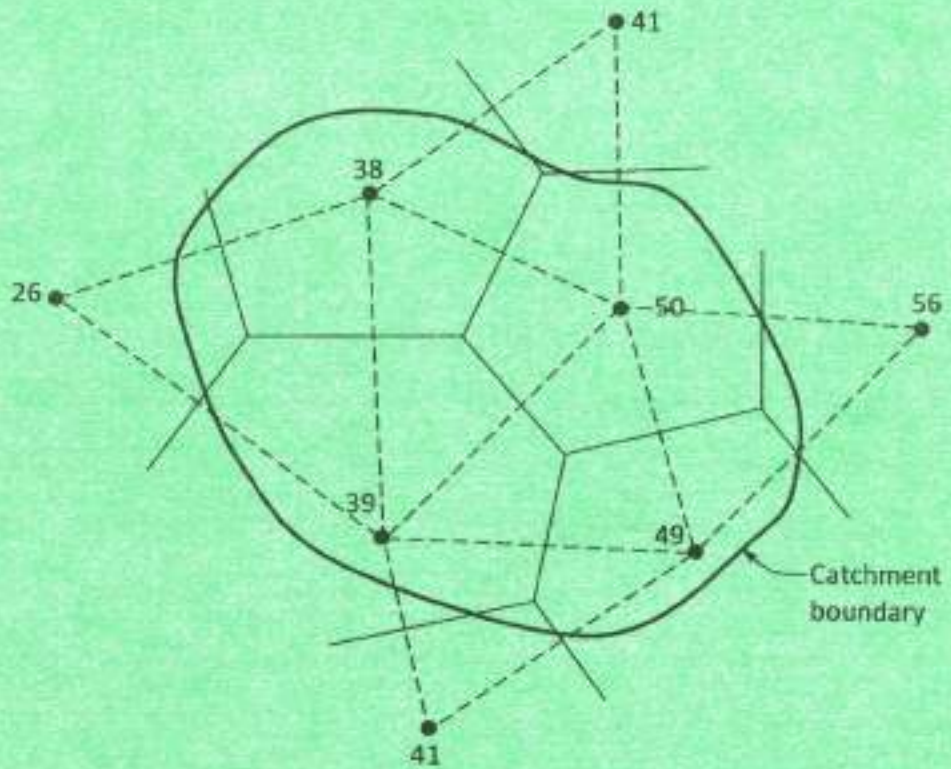

Fig. 5