2307/304
SOIL MECHANICS AND HYDRAULICS
Oct./Nov. 2010
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN CIVIL ENGINEERING

SOIL MECHANICS AND HYDRAULICS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:

Answer booklet;
Scientific calculator/Mathematical tables.

*This paper consists of **EIGHT** questions in **TWO** sections **A** and **B**.*
*Answer any **FIVE** questions, choosing at least **TWO** questions from each section.*
All questions carry equal marks.
Maximum marks for each part of a question are as indicated.

This paper consists of 7 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 any **TWO** questions from this section.*

1. (a) Describe each of the following field compaction equipments:

(i) tampers;
(ii) vibrating plate;
(iii) pneumatic-tired roller. (9 marks)

(b) The results of a compaction test are given in table 1. Plot the dry density - moisture content curve and determine the maximum dry density and optimum moisture content. (11 marks)

Table 1

Bulk density of (g/cm)	1.79	1.99	2.14	2.10	2.06	2.02
Moisture content (%)	7.7	11.5	14.6	17.5	19.7	21.2

2. (a) Define each of the following:

(i) effective stress;
(ii) neutral stress. (2 marks)

(b) A basement excavation is filled with water to a depth of 3m. Below the excavation is a sand layer 5m thick underlain by a clay deposit as shown in figure 1. The specific gravity and moisture contents of sand and clay are 2.64, 2.70, 25% and 20% respectively.

Determine the:

(i) total intergranular stress of A and B;
(ii) pore water pressure at A and B. (10 marks)

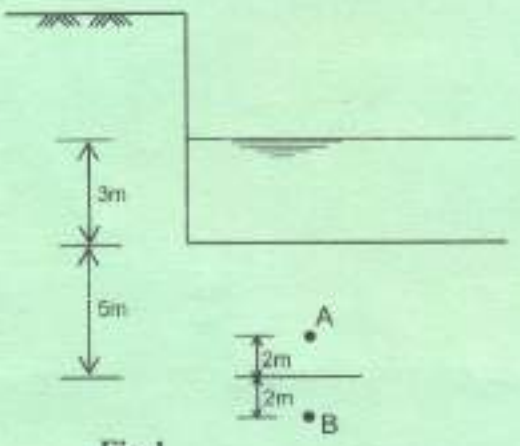

Fig 1

(c) With the aid of a diagram describe the field determination of coefficient of permeability by pumping test from an unconfined well. (8 marks)

3. (a) Outline each of the following:

(i) flow net;
(ii) flow line. (3 marks)

(b) (i) State **four** properties of flow nets.

(ii) Figure 2 shows a cross section of a dam where head water is 10m and down stream water head is 0m. If the coefficients of permeability of the material below the dam are 2×10^{-5} mm/s and 5×10^{-6} mm/s respectively, determine the rate of flow beneath the dam. (7½ marks)

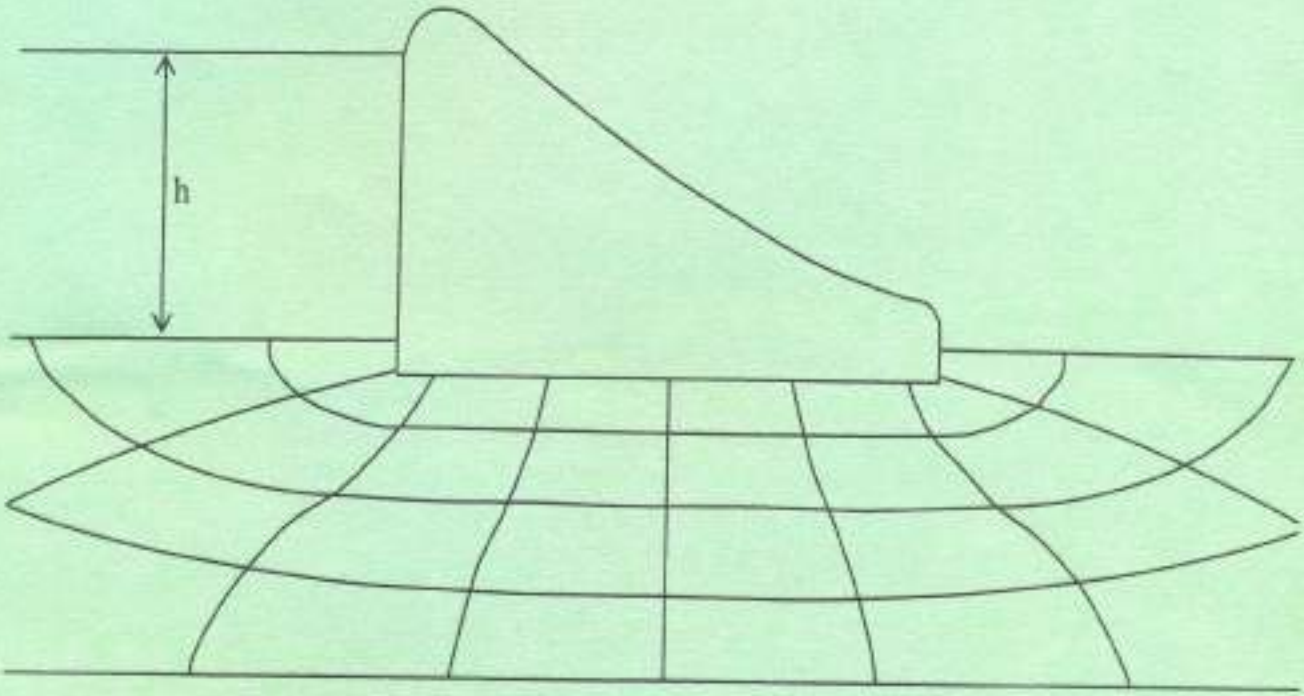

Fig 2

(c) A vertical wall with a smooth back retains sand backfill to a depth of 6m. The top of the backfill is horizontal and backfill soil properties are;

$C' = 0$, $\phi' = 28°$, $\gamma' = 16\ kN/m^3$,

$\gamma_{sat} = 20\ kN/m^3$.

Determine the following:

(i) magnitude of total active thrust against the wall when backfill is fully drained;

(ii) magnitude of the active thrust when the water level is at 3m depth with no drainage;

(iii) the point of application of the resultant for (ii). (9½ marks)

4. (a) Outline the following:

(i) ultimate bearing capacity;
(ii) net safe bearing capacity;
(iii) allowable bearing capacity. (4½ marks)

(b) (i) State the Terzaghi's equation for a strip footing and explain the terms.

(ii) Determine the ultimate bearing capacity for a square footing of size 2m x 2m sited on a sand of density $1800kg/m^3$. The angle of internal friction is 34°, and $N\gamma = 46$, $N_q = 42$ for condition of the footing at ground level and at 2m below ground level.

(iii) A strip footing 1.6m wide is sited at a depth of 1m below the ground level on dry sand stratum, where $\gamma d = 17\ kN/m^3$, $\phi' = 38^o$, $C' = 0$ and the groundwater table stands at 0.75m below ground level. If bearing capacity parameters Nq is 60 and $N\gamma$ is 75: determine the ultimate bearing capacity for the footing.

(15½ marks)

SECTION B: HYDRAULICS

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

5. (a) An orifice on the side of a tank has a cross sectional area of $650mm^2$. A jet from the orifice falls through a distance y=500mm and a horizontal distance x = 1500mm from the vena contrata. The head above the orifice is 1.2m and the volume rate of flow is $0.117m^3$/minute.

(i) Derive the expression for the actual velocity Va at vena contracta and the coefficient of velocity.

(ii) Determine the coefficient of:

I *velocity;*
II *discharge;*
III contraction.

(9 marks)

(b) An open channel has a trapezoidal cross-section, with a bottom width of 4000mm, side slope 1:1½ (V:H), bed slope 1 in 1800 and depth of flow 1200mm.

(i) Determine the volume rate of flow by both Chezy's and Manning's formulae.

Take n = 0.025, C = 38.8 in SI units.

(ii) comment on the two discharges. (11 marks)

6. (i) Discuss the Thiessen polygon method of computing areal rainfall.

(ii) A catchment area has eight rain gauge stations. The rainfall depth in mm and Thiessen Polygon areas within the catchment boundary for each station are as given in table 2.

Determine the average depth of rainfall. (14 marks)

Table 2

Station No.	Rainfall in mm	Thiessen polygon (km^2)
1	49	9.2
2	62	104
3	84	50.2
4	96	38.4
5	124	8.4
6	78	48.5
7	64	41.5
8	55	2.8

(b) A USWB Class B evaporation pan of diameter 1220mm was observed on two different occasions.

On day one, 4.75 litres of water were removed from the pan, while a nearby rain gauge station recorded 8.8 mm.

On day two, 10.8 litres of water were added to bring the water level to the required level while a nearly rain gauge station recorded 3.6 mm of rainfall.

Determine evaporation on day:

(i) one;
(ii) two.

(6 marks)

7. (a) Describe the following classification of water turbines:

(i) impulse;
(ii) reaction. (6 marks)

(b) With the aid of sketches, describe each of the following turbines:

(i) Pelton wheel;
(ii) Francis. (9 marks)

(c) Explain pumps installation in parallel and in series and show their performance curves. (5 marks)

8. (a) With the aid of sketches describe the following profiles for a weir:

(i) free nappe;
(ii) clinging nappe;
(iii) drowned nappe. (6 marks)

(b) (i) Explain the reasons for fitting air vessels on the suction and delivery pipes of a reciprocating pump.

(2 marks)

(ii) Two reservoirs having a difference in level of 16m are connected by a single pipeline of diameter 400mm and 300 m long feeding a junction from which two pipes, each 150 mm diameter and 300m long lead in parallel to the lower reservoir. If f = 0.01, determine the total discharge. (12 marks)