

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF CIVIL AND WATER ENGINEERING
FACULTY OF INDUSTRIAL TECHNOLOGY
BACHELOR OF ENGINEERING (HONOURS) DEGREE
PART II SECOND SEMESTER EXAMINATION : MAY 2014
SOIL MECHANICS – TCW 2201

INSTRUCTIONS

Answer any four questions

Time : 3hrs.

Total marks 100

QUESTION 1

(a) Define the following terms associated with soils : (i) void ratio , (ii) porosity ,
(iii) degree of saturation , (iv) water content and (v) percentage of voids (**1 mark each**).

(b) Explain the following terms ; (i) class and (ii) phase were soils are concerned .

(2 marks each)

© List five types of transported soils .

(5 marks)

(d) A soil sample with a mass of 30 kg and volume of $0,0183 \text{ m}^3$, when dried in an oven had its mass reduced to 27,2 kg. The specific gravity of solids was determined as 2,65.

Calculate :

(i) the bulk density.

(1 mark)

(ii) the dry density

(1 mark)

QUESTION 1 continued

- (iii) percentage moisture content. (2 marks)
- (iv) saturated density. (5 marks)
- (v) void ratio. (1 mark)
- (25 marks)

QUESTION 2

- (a) Derive the relationship between the porosity and void ratio of a soil. (7 marks)
- (b) A sand sample has a porosity of 28 % and the specific gravity of solids is 2,65.
Calculate
- (i) the dry unit weight of sand . (5 marks)
- (ii) the unit weight of sand if the degree of saturation $S_r = 0,56$ (3 marks)
- (iii) the unit weight of saturated sand (2 marks)
- (iv) the unit weight of submerged soil. (2 marks)
- © A moist sample of soil in a bottle had a mass of 25,24g and the bottle when empty , has a mass of 14,2 g. After drying in an oven for 24 hrs. the bottle and soil sample has a mass of 21,62 g. Calculate the water content of the soil. (3 marks)
- (d) A pycnometer having a mass of 620 g was used to determine the specific gravity of an oven dried sample of soil. If the mass of the soil sample was 980 g. and the mass of the pycnometer with the with the sample and filled up with water was 2112 g. The mass of the pycnometer when filled with water only was 1495 g. Calculate the specific gravity of the soil particles. (3 marks)
- (25 marks)

QUESTION 3

The following index properties were determined for two soils X and Y:

<u>Property</u>	<u>X</u>	<u>Y</u>
Liquid limit	0,62	0,34
Plastic limit	0,26	0,19
Water content	38%	25%
Specific gravity of solids	2,72	2,67
Degree of saturation	1,00	1,00

Which of these soils ?

- (a) contains more clay particles ? **(3 marks)**
 - (b) has a greater wet density ? **(15 marks)**
 - (c) has a greater dry density ? **(2 marks)**
 - (d) has a greater void ratio? **(5 marks)**
- (25 marks)**

QUESTION 4

(a) Briefly explain the following terms :

(i) permeability, (ii) homogeneous soil and (iii) isotropic soil **(2 marks each)**.

(b) List five factors that affect permeability . **(5 marks)**

(c) A horizontal stratified soil deposit consists of three layers , each uniform in itself.

The permeabilities of the layers are 8×10^{-4} , 50×10^{-4} and 15×10^{-4} cm/sec and their

QUESTION 4 CONTINUED

thicknesses are 6 , 3 and 12 m respectively. Calculate the effective average permeability of the deposit in horizontal and vertical directions . **(5 marks)**

(d) A 30 cm diameter well penetrates 25 m below a static watertable. After 24 hours of pumping at 5 400 litres/minute , the water level in the test well at 90 m is lowered by 0,53 and in a well 30 m away the drawdown is 1,110m. Calculate the transmissibility of the aquifer. **(4 marks)**

(e) Determine the drawdown in the main well in (d) above. **(5 marks)**
(25 marks)

QUESTION 5

A layer of sand 4,5 m deep overlies a thick bed of clay . The water table is 2m below the top of the sand. Above the water table , the sand has an average void ratio of 0,52 and an average degree of saturation of 0,37. The clay has a water content of 42% . The grain specific gravity is 2,65 for both sand and clay. Calculate the total effective and pore water pressures on a horizontal plane 9 m below the ground surface and draw pressure distribution diagrams down to this level. **(25 marks)**

QUESTION 6

Describe the electrical resistivity method of ground exploration. **(25 marks)**

LIST OF FORMULAE

$$Q = \frac{\pi K \cdot (h_2^2 - h_1^2)}{2.3 \log_{10} r_2/r_1}$$

$$\rho = (G_s + S_r \cdot e / 1 + e) \rho_w$$

$$K = K_1 d_1 + K_2 d_2 + K_3 d_3 + \dots / d_1 + d_2 + d_3 + \dots$$

$$K = \frac{d_1 + d_2 + d_3}{\frac{d_1}{K_1} + \frac{d_2}{K_2} + \frac{d_3}{K_3}}$$

$$n = e / 1 + e$$

$$e = V_v / V_s$$

$$Y_d = Y_w \times G_s / 1 + e$$

$$e = w \cdot G_s / S_r$$

$$Y = G_s \cdot Y_w (1 + w) / 1 + e$$