SOIL MECHANICS – I
(CIVL 2102)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) The quantity of water that will flow through a cylindrical soil (k = 0.01 mm/sec) sample of 8 cm in diameter and 12 cm in height in a day under a constant head of 65 cm is
(a) 23 lit. (b) 24 lit. (c) 23.5 lit. (d) 24.5 lit.

(ii) The path followed by a water particle during its course of seepage is called
(a) Flow line (b) Equipotential line
(c) Hydraulic line (d) All of the above.

(iii) The void ratio of a sand sample is 0.55. If the specific gravity of soil solids is 2.67, then the critical hydraulic gradient is
(a) 0.96 (b) 1.00 (c) 1.08 (d) 1.04.

(iv) A rectangular footing, 2 m × 3 m in size has to carry a uniformly distributed load of 100 kN/m^2. The vertical stress at a depth of 2 m below the base of footing by 2:1 dispersion method is
(a) 20 kN/m^2 (b) 25 kN/m^2 (c) 30 kN/m^2 (d) 40 kN/m^2

(v) A concentrated load of 40 kN is applied vertically on a horizontal ground surface. The vertical stress at a depth of 2 m below the point of application of load by Boussinesq's theory is
(a) 4.57 kN/m^2 (b) 4.77 kN/m^2 (c) 4.37 kN/m^2 (d) 4.97 kN/m^2

(vi) The limitation of sedimentation analysis is that Brownian movement takes place and particles size computed from Strokes' law gives erroneous results when particle size is
(a) < 0.0002 mm (b) < 0.002 mm
(c) > 0.0002 mm (d) > 0.002 mm.

(vii) Based on grain size distribution analysis, D_{10}, D_{30} and D_{60} values of a given soil are 0.23mm, 0.3mm and 0.41mm, respectively. The C_u and C_c are given by
(a) 1.78 & 0.96 (b) 1.8 & 0.95 (c) 1.78 & 0.95 (d) 1.81 & 0.96

(viii) In Recumbent fold the axial surface is
(a) Curve (b) Vertical (c) Inclined (d) Horizontal

(ix) The hardest silicate mineral in the Moh's scale of hardness is
(a) Corundum (b) Topaz (c) Feldspar (d) Quartz

(x) Metallic lustre is found in
(a) Diamond (b) Magnetite (c) Muscovite (d) Galena

Group – B

2. (a) What is hardness of a mineral? How is it measured? What is Moh's scale of hardness?

(b) What are intrusive and extrusive igneous rocks? Describe their salient features.

(c) What is the difference between weathering and erosion?

4 + (6 + 2) = 12

3. (a) Define a fault. Draw a diagram to show the hanging wall, footwall, heave and through of a fault. Classify the fault on the basis of net slip directions with diagrams.

(b) Classify folds on the basis of inclination of axial surface of folds.

6 + 6 = 12

Group – C

4. (a) By three phase soil system, show that the degree of saturation 'S' (as ratio) in terms of mass unit weight 'γ', water content 'w' (as ratio), specific gravity of soil grains 'G', and unit weight of water 'γ_w', is given by the expression

$$S = \frac{w}{\frac{\gamma_w}{\gamma}(1+w)-\frac{1}{G}}$$

(b) A 500 gm of dry soil was used for combined sieve and hydrometer analysis. The soil mass passing through 75μ sieve = 120 gm. Hydrometer analysis was carried out on a mass of 40 gm that passed through 75μ sieve. The average temp recorded during the test was 31°C.
Given: G = 2.65, C_m = 0.5, C_d = 0.6, C_t = 0.915, μ = 8.15× 10^{-3} poise,
H_{e1} = 22.0 cm for R_h = 0, H_{e2} = 10.0 cm for R_h = 30, Aj = 30 cm^2 and V_h = 40 cm^3.
The hydrometer reading R_h = 15.00 after a lapse of time of 120 min after the start of the test. Determine the particle size 'D' and percentage finer N%?
H_{e1} = 22.0 cm for R_h = 0, H_{e2} = 10.0 cm for R_h = 30, Aj = 30 cm^2 and V_h = 40 cm^3.
The hydrometer reading R_h = 15.00 after a lapse of time of 120 min after the start of the test. Determine the particle size 'D' and percentage finer N%?

4 + 8 = 12

5. (a) The results of laboratory tests conducted on two soils A and B are as follows:

	Soil A	Soil B
% passing 0.075 mm sieve	14	75
% passing 4.75 mm sieve	92	100
(D_{10}) mm	0.14	-
(D_{30}) mm	0.33	-
(D_{60}) mm	1.00	-
Liquid limit	16	58
Plastic limit	8	14

Classify the two soils as per the Indian Standard Classification.

(b) Liquid limit tests were carried out two given samples of clay. The test data are as given below.

Test No.	1	2	3	4
Sample No.1	120	114	98	86
Water Content %				
Number of blows, N	7	10	30	40
Sample No.2	96	74	45	30
Water Content %				
Number of blows, N	9	15	32	46

The plastic limit of sample No. 1 is 40 % and that of sample No. 2 is 32 %. Determine (i) The flow index of the two samples, (ii) The toughness index of the samples. Also comment on the type of the soils on the basis the toughness index values.

6 + 6 = 12

Group – D

6. (a) At a particular site lies a layer of fine sand 8 m thick below the ground surface and having a void ratio of 0.65. The GWT is at a depth of 4 m below ground surface. The average degree of saturation of the sand above the capillary fringe is 70%. The soil is saturated due to capillary action to a height of 1.5m above the GWT level. Considering the effect of porosity, calculate the effective pressures at (i) Fringe level, (ii) GWT level, (iii) at depths of 3 m and 6 m below the ground level. [Given: G = 2.65]

(b) Two soils A and B with coefficients of permeability as 0.004 m/s and 0.0004 m/s, respectively are arranged in the manners shown in Fig.1. Determine (i) The total head at El. 0.0 m and El. +3.0 m in each case and (ii) Quantity of flow in each case. Take El. 0.0 m as datum.

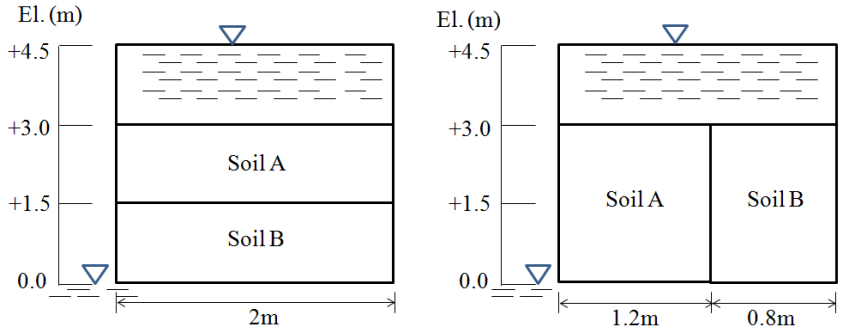

Fig.1

(c) The dam with the flownet is shown in Fig. 2. The dam is 120 m long and has two nos. 10 m long sheet piles driven partially into the granular soil layer. Datum is at the tailwater elevation. Determine (i) the quantity of seepage loss under the dam when $k = 3 \times 10^{-3}$ cm/sec, (ii) the uplift pressures at B and D, (iv) Factor of safety with respect to piping, if critical hydraulic gradient is 0.6.

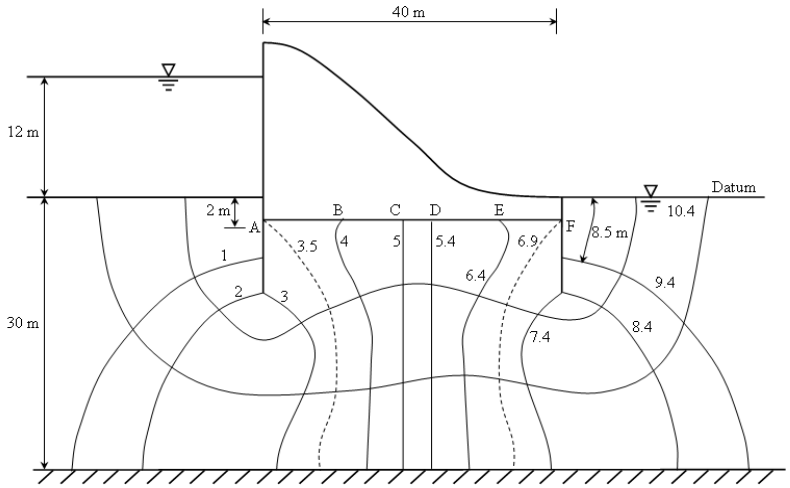

Fig.2

4 + 4 + 4 = 12

7. (a) At a particular site there are three layers of soil (Fig. 3). The ground water table is at a depth of 5 m below ground surface. The average degree of saturation of the sand above the capillary fringe is 40%. The soil is saturated due to capillary action to a height of 3.0 m above the ground water table level. Considering the effect of porosity, calculate the effective pressures at 3m, 6m, 9m and 13m below ground level.

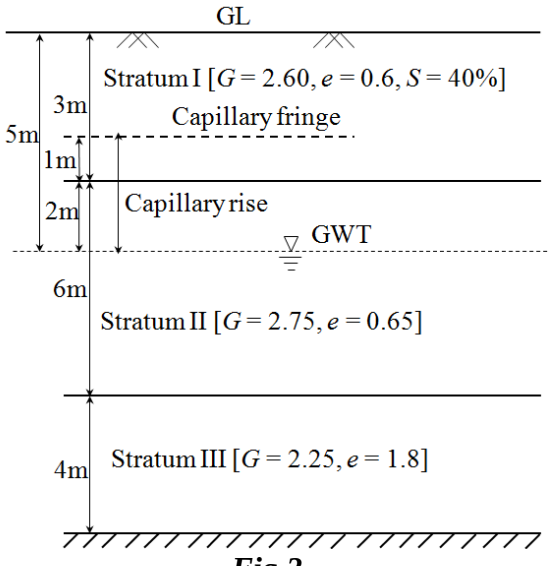

Fig.3

(b) A falling head permeability test was carried out on a 25 cm long sample of silty clay. The diameter of the sample and the stand-pipe were 9.8 cm and 0.80 cm, respectively. The water level in the stand-pipe was observed to fall from 60 cm to 45 cm in 20 mins. Determine (i) the co-efficient of permeability of the soil in m/day, (ii) height of water level in the stand-pipe after another 30 mins., (iii) time required for the water level to drop to 10 cm.

(c) The dam with the flownet is shown in Fig. 4. Determine the height of water that would rise, if a piezometer is placed at A, B, D and G.

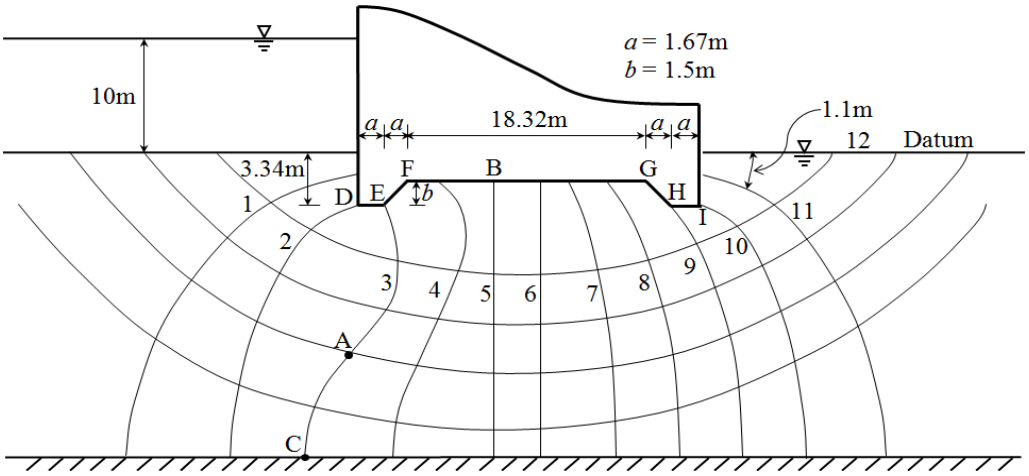

Fig.4

4 + 4 + 4 = 12

Group – E

8. (a) A rectangular raft of size 30 m × 18 m founded at a depth of 2.5 m below the ground surface is subjected to a uniform pressure of 200 kPa. Assume the centre of the area is the origin of the coordinates (0,0) and the corners have the coordinates (9,15). Calculate the stresses at a depth of 10 m below the foundation level by the methods of (i) Boussinesq, and (ii) Westergaard at coordinates of (9,0), (9,15) and (12,25). Neglect the effect of foundation depth on stresses.

(b) A 2.5 m wide strip footing is located on the ground surface with a pressure of 80 kN/m^2. Determine the vertical stress at a depth of 2 m below centerline of the footing, edge of the footing and at a distance of 1.5 m from the edge of the footing.

6 + 6 = 12

9. (a) A rectangular foundation, 2 m × 4 m (Fig. 5) transmits a uniform pressure of 450 kN/m^2 to the underlying soil. Determine the vertical stress at a depth of 1 metre below the foundation at a point within the loaded area, 1 metre away from a short edge and 0.5 metre away from a long edge. Use Boussinesq's theory.

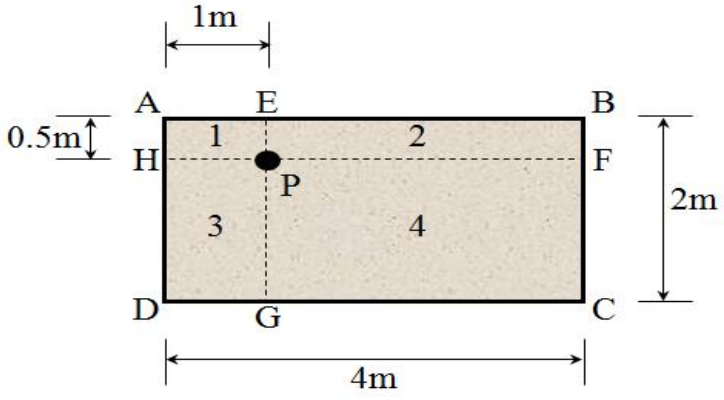

Fig.5

(b) A ring foundation is of 3.60 m external diameter and 2.40 m internal diameter. It transmits a uniform pressure of 135 kN/m^2. Calculate the vertical stress at depths of 2 m and 6 m directly beneath the centre of the loaded area. Use Boussinesq's theory.

8 + 4 = 12

Department & Section	Submission Link
CE A	https://classroom.google.com/w/MTIyOTQxNDQxNDA4/t/all
CE B	https://classroom.google.com/c/MTIyNjQxMDE0OTY4/a/MjcxNDcxMjM0Mjc0/details