(vi) In the consolidated undrained triaxial test on a saturated soil sample, the pore water pressure is zero
(a) during shearing stage only
(b) at the end of consolidation stage only.
(c) both at the end of consolidation and during shearing stages
(d) under none of the above conditions.

(vii) Consider the following statements related to the pore pressure parameters, A and B
P. A always lies between 0 and 1.0.
Q. A can be less than 0 or greater than 1.0.
R. B always lies between 0 and 1.0.
S. B can be less than 0 or greater than 1.0.
For these statements, which one of the following options is correct?
(a) P and R (b) P and S (c) Q and R (d) Q and S.

(viii) When water flows through a soil mass in upward direction, the effective stress at any depth within the soil mass
(a) increases
(b) decreases
(c) remains unchanged
(d) may increase or remain constant depending on the quantity of water.

(ix) Seepage velocity (vs) and discharge velocity(v) are related as
(a) vs < v (b) vs = v (c) vs > v (d) all of the above.

(x) Boussinesq's theory was developed on the basis of which the following assumptions?
(a) Uniformly distributed load acting on the ground surface
(b) Point load acting on the ground surface
(c) Trapezoidal load acting on the ground surface
(d) Point load acting at a certain depth below the ground surface.

Group – B

2. (a) The following results were obtained from the sieve analysis carried out on a dry soil sample weighing 300 g.

I.S Sieve size	4.75 mm	2.40 mm	1.20 mm	600μ	425μ	300μ	150μ	75μ	Pan
Wt. of soil retained (gm)	11.02	30.45	46.26	48.73	50.27	45.49	40.21	20.33	7.24

(b) At a particular site there are three layers of soil (Figure 3). The ground water table (GWT) is at a depth of 5 m below ground level (GL). The average degree of saturation of the sand above the capillary fringe is 40%. The soil is saturated due to capillary action upto a height of 3.5 m above the GWT level. Considering the effect of porosity, calculate the effective stresses at 3 m, 6 m, 9 m and 11 m below GL.

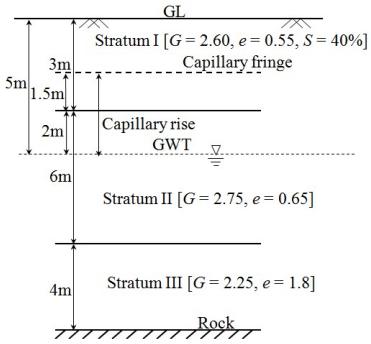

Figure 3

(b) What are flow lines and equipotential lines?

(c) A sheet pile wall was driven across a river to a depth of 6 m below the river bed (silty sand extending upto a depth of 12 m) retaining a head, 12 m of water. The average uplift pressure head at the bottom of the pile is 3.5m. The saturated unit weight of the soil, N_f and N_d are 19.5 kN/m^3, 6 and 12, respectively. Determine (i) seepage loss per meter length of pile per day and (ii) factor of safety against heave on the downstream side of the pile. The coefficient of permeability of the soil is 8×10^{-5} m/min.

4 + 4 + 2 + 2 = 12

Group – D

6.(a) A concentrated load of 2000 kN is applied at the ground surface. Compute the vertical stresses at (i) a depth of 4 m below the load and (ii) a distance of 3 m at the same depth using Boussinesq's and Westergaard's equations.

(b) A ring footing of external diameter 8 m and internal diameter 4 m rests at a depth of 2 m below ground surface. It carries a load intensity of 250 kN/m^2. Using Table1, determine the vertical stress at depths of 2 m, 4 m, 8 m and 16 m along the axis of the footing below the footing base. Neglect the effect of excavation on the stress.

Table 1: Values of R/z for different values of σ_z/q

σ_z/q	R/z	σ_z/q	R/z
0.00	0.000	0.80	1.387
0.10	0.270	0.90	1.908
0.20	0.401	0.92	2.094
0.30	0.518	0.94	2.351
0.40	0.637	0.96	2.748
0.50	0.766	0.98	3.546
0.60	0.917	1.00	∞
0.70	1.110	–	–

(c) Describe isobar and significant depth with the help of a neat sketch.

4 + 4 + 4 = 12

7. (a) A rectangular footing of size 2 m × 3 m has to carry a uniformly distributed load of 100 kN/m^2. Plot the distribution of vertical stress intensity on a horizontal plane at a depth of 2 m below the base of footing by (i) Boussinesq's method, (ii) 2:1 dispersion method.

(b) Two long boundary walls of small width run parallel to each other at a distance of 3 m apart. The self-weights of the walls are 25 and 15 kN/m. Plot the distribution of vertical stress intensity due to the walls on a horizontal plane 3 m below the ground level. [Choose the point of application of 25 kN/m linear load as the origin].

6 + 6= 12

Group – E

8. (a) Explain the Mohr - Coulomb strength envelop.

(b) Shear box test on sandy clay yielded the following data:

Normal load (N)	100	200	300
Shear load at failure (N)	99.5	156.3	210.7

The size of the shear box was 60 mm × 60 mm. Draw the failure envelop and determine the strength parameters of the soil. If a triaxial test was conducted on the soil specimen at a cell pressure of 40 kN/m^2, what would be the major principal stress at failure?

(c) A shear vane of 7.5 cm diameter and 11 cm length was used to measure the shear strength of soft clay. If torque of 600 kg-cm was required to shear the soil calculate the shear strength. The vane was then rotated rapidly to cause remoulding of the soil. The torque required in the remoulded state was 200 kg-cm. Determine the sensitivity of the soil and comment on the type of soil.

3 + 5 + 4 = 12

9.(a) Cylindrical specimen of dry sand was tested in a triaxial test. Failure occurred under a cell pressure of 1.2 kg/cm^2 and deviator stress of 4 kg/cm^2. Determine

(i) angle of shearing resistance of the soil.
(ii) normal and shear stresses on the failure plane.
(iii) angle which the failure plane makes with the minor principal plane.
(iv) maximum shear stress on any plane in the specimen at the instant of failure
(v) angle which the failure plane makes with the major principal plane.

(b) Write short notes on the following (any one):
(i) Stress - strain relationship for dense and loose sand with sketches.
(ii) Different types of Triaxial test (based on drainage conditions)

8 + 4 = 12

SOIL MECHANICS I
(CIVL 2202)

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) Falling head permeability test is best suited for
(a) coarse-grainedsoil (b) fine-grained soil
(c) rock (d) all of the above.

(ii) In fluid flow through soil, the total head is given by
(a) pressure head - elevation head
(b) velocity head + pressure head + elevation head
(c) pressure head
(d) pressure head + elevation head.

(iii) Piping ratio is given by
(a) $\frac{D_{15(filter)}}{D_{15(soil)}}$ (b) $\frac{D_{85(filter)}}{D_{15(soil)}}$ (c) $\frac{D_{15(soil)}}{D_{85(filter)}}$ (d) $\frac{D_{15(filter)}}{D_{85(soil)}}$.

(iv) One of the approximate methods for determining vertical stress within a soil mass is
(a) 2.5:1 method (b) 2:1 method
(c) 1:2 method (d) 3:1 method.

(v) If the soil is dried beyond its shrinkage limit, it will show
(a) high volume change (b) low volume change
(c) moderate volume change (d) no volume change.

Draw the particle size distribution curve of the soil and compute the following:

i) percentage of gravel, coarse sand, medium sand, fine sand and finer fraction as per IS system (IS: 1498-1970).

ii) uniformity co-efficient and the co-efficient of curvature.

(d) The volume and mass of a saturated clay sample are 22.5 cc and 35.94 gm respectively. On drying in an oven, its mass is reduced to 21.42 gm. The volume of the dry soil pat was found to be 11.78cc. Determine the shrinkage limit, specific gravity and shrinkage ratio of the soil.

9 + 3 = 12

3. (a) Laboratory tests on a soil sample obtained from a foundation site reveal the following data:

Total mass of soil sieved = 200 gm.
Cumulative mass retained on 4 mm sieve = 30 gm
Cumulative mass retained on 75 micron sieve = 150 gm
D_{10}= 0.07 mm, D_{30} = 0.12 mm, D_{60} = 1.95 mm
Liquid limit = 38%, Plastic limit = 28%
Classify the soil according to USCS.

(b) A sample of wet silty clay soil has a mass of 126 kg. The following data were obtained from laboratory tests on the sample. Wet density = 2.1 gm/cc, G = 2.7, water content = 15%. Determine (i) dry density, (ii) porosity, (iii) void ratio and (iv) degree of saturation.

(c) Two soil samples tested in a soil mechanics laboratory gave the following results:

	Sample 1	Sample 2
Liquid limit, w_l	50%	40%
Plastic limit, w_p	30%	20%
Flow indices, I_f	27	17

Determine the toughness index and comment on the types of soils.

4 + 4 + 4 = 12

Group – C

4 .(a) A layer of silty soil of thickness 6 m lies below the ground level (GL) and below the silt layer lies a clay stratum. The ground water table (GWT) is at a depth of 5 m below the ground surface. The following data are available for both the silt and clay layers of soil; Silt layer: D_{10} = 0.018 mm, e = 0.7 and G = 2.65 and Clay layer: e = 0.8 and G = 2.75. Considering the effect of porosity, determine the effective stresses at (i) GL, (ii) GWT level, (iii) 3 m below GL and (iv) 9 m below GL. [Assume C = 0.4 cm^2]

(b) The average coefficient of permeability of a 24 m thick sand layer was determined by pumping test. The ground water table was located at a depth of 3 m below the ground level. A steady state was reached when the discharge from the well was 26 lit/sec. At this stage, the drawdown in the test well was 3.2 m, while the drawdowns in two observation wells situated at 8 m and 20 m from the test well were found to be 1.86m and 1.37m, respectively. Determine (i) coefficient of permeability of the sand layer in m/day, (ii) radius of influence of the test well in m, (iii) effective size of the sand particle i.e. D_{10} in mm. [Assume C = 120 cm^{-1}sec^{-1}]

(c) Determine the quantity of seepage under the dam (Figure 1) and calculate the uplift pressures at points 1, 3 and 5 on the base of the dam. The coefficient of permeability of foundation soil is 2.5×10^{-5} m/sec. The points 6, 7 and 8 are lying at 3.07m, 5.20m and 6.0m below datum.

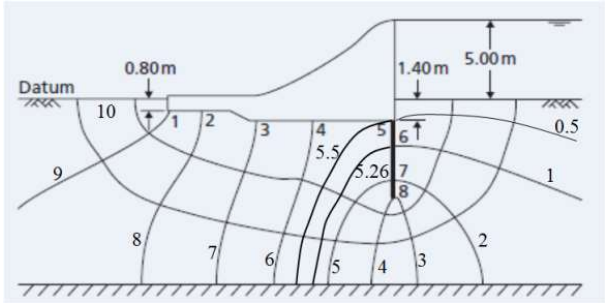

Figure 1

4 + 4 + 4 = 12

5.(a) A stratified soil deposit (Figure 2) has an average hydraulic gradient of 0.3 in both horizontal and vertical directions. Determine (i) the ratio of equivalent permeability in horizontal and vertical directions, (ii) discharge quantity in each layer and (iii) discharge velocity in each layer for horizontal flow.

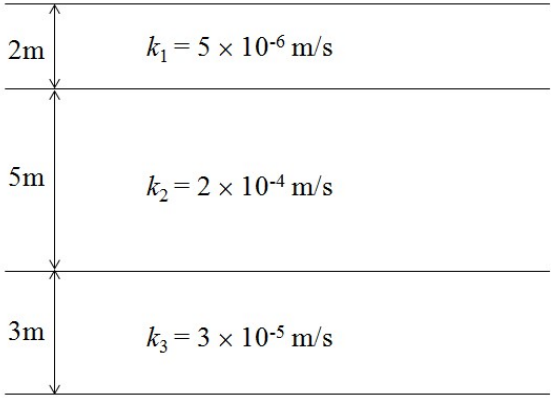

Figure 2

Draw the particle size distribution curve of the soil and compute the following:

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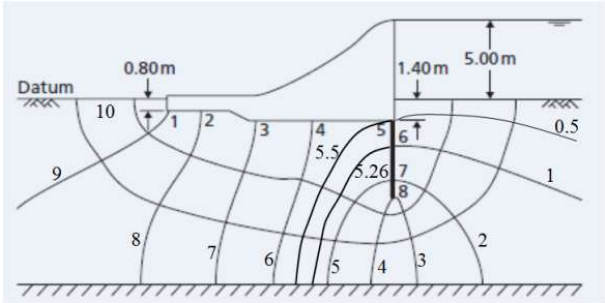

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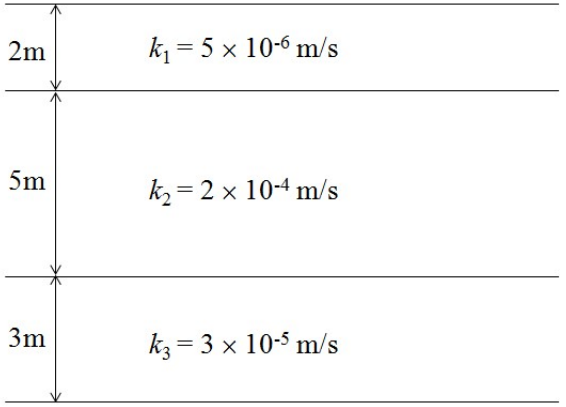

Figure 2