(vi) A clay deposit suffers a total settlement of 15 cm with one-way drainage. With two-way drainage, total settlement will be
(a) 30 cm (b) 15 cm (c) 7.5 cm (d) 5 cm.

(vii) The shape factors for square footing, s_c, s_q, s_γ are respectively (IS code)
(a) 1.3, 1.2, 0.8 (b) 1.2, 1.2, 0.8
(c) 1.3, 1.2, 0.6 (d) 1.2, 1.3, 0.6.

(viii) The weight of rammer used in IS light compaction test is
(a) 2.3 kgf (b) 2.6 kgf
(c) 2.5 kgf (d) 2.7 kgf.

(ix) A 6 m thick double draining clay layer settles by 30 mm in 3 years under the influence of certain loads. Its final consolidation settlement was estimated to be 120 mm. If a thin layer of sand having negligible thickness is introduced at a depth 1.5 m below the top surface, the final consolidation settlement of clay layer will be
(a) 60 mm. (b) 120 mm.
(c) 240 mm. (d) 30 mm.

(x) In a consolidation test, void ratio decreased from 0.80 to 0.70 when the load was changed from 40 to 80 kN/m^2. What is the compression index?
(a) 0.14 (b) 0.16 (c) 0.33 (d) 0.66.

Group – B

2. (a) A stratum of clay 6 m deep, has w_l = 45 %. The surface of clay is at 10 m below the present ground level, w = 40 % and G = 2.76 for clay. Between ground surface and clay, the subsoil consists of fine sand. The ground water level is 4.5 m below ground level. The average submerged unit weight of sand is 10.6 kN/m^3 and the unit weight of sand above the ground water level is 17.2 kN/m^3 . The clay is normally consolidated. The weight of structure coming on top of the sand above the clay increases the overburden pressure on clay by 45 kN/m^2. Estimate the consolidation settlement of the building.

(b) Following are the results of a compaction test:

Weight of the mould + wet soil (N)	29.25	30.95	31.5	31.25	30.70
Water content (%)	10.0	12.0	14.3	16.1	18.2

Volume of the mould = 1000 cm^3, weight of the mould = 10 N, specific gravity of solids = 2.70. Plot (i) the compaction curve showing the optimum moisture content and maximum dry density and (ii) zero air voids line. Also determine the degree of saturation at the maximum dry density.

7. (a) A 2.5 m wide strip footing carries a load intensity of 450 kN/m^2 at a depth of 1.5 m in sand. The saturated unit weight of sand is 19.2 kN/m^3 and unit weight above water table is 16.6 kN/m^3. The shear strength parameters are c = 0, ϕ = 35°. For ϕ = 35°, N_c = 41.44, N_q = 57.75 and N_γ = 42.4. Determine the factor of safety with respect to shear failure using Terzaghi's equations for the following cases of location of water table:
(i) Water table is 4.0 m below G.L.
(ii) Water table is 1.5 m below G.L.
(iii) Water table is 2.2 m below G.L.
(iv) Water table is 1.0 m below G.L.

(b) A square footing 2.5 m × 2.5 m is built in a homogeneous bed of loose sand of unit weight 16 kN/m^3 and angle of shearing resistance is 25°. The depth of the base of footing is 1.5 m below the ground surface. What will be the maximum safe load that can be carried by a footing with a factor safety of 3.0 against complete local shear failure? For ϕ = 25°, N_q' = 5.6 and N_γ' = 3.2.

8 + 4 = 12

Group – E

8. (a) It is proposed to construct an overhead tank at a site on a rigid raft foundation of size 6 m × 10 m with the footing at a depth of 2 m below ground level. The soil upto a depth of 20 m is normally consolidated clay with the water table 2 m below ground level. The average value of undrained cohesion (c_u) was found to be 25 kN/m^2 and the average saturated unit weight of the soil is 18 kN/m^3. Calculate the values of D_f/B, H/B, L/B and $D_f/\sqrt{BL}$, where the symbols have their usual meanings. Determine the immediate settlement of the foundation. The contact pressure is 100 kN/m^2. [Given: $E_s = 500c_u$, μ_0 = 0.95, μ_1 = 0.6 and depth factor = 0.94].

(b) Derive the expression for critical height of an embankment by Culmann's method. Determine by Culmann's method the allowable height of an embankment having a slope angle of 40° and the constructed soil having c' = 25 kN/m^2, ϕ' = 20°, and effective unit weight = 17 kN/m^3. [Given: $F_c = F_\phi$ = 1.25].

(c) What will be the factors of safety w.r.t. (i) average shearing strength (ii) cohesion and (iii) internal friction of a soil, for which the strength parameters obtained from the laboratory tests are c' = 28 kN/m^2, ϕ' = 20°; the expected parameters of mobilized shearing resistance are c'_m = 24 kN/m^2 and ϕ'_m = 15° and the average effective pressure on the

failure surface is 130 kN/m^2. For the same value of the mobilized shearing resistance determine the following: (iv) FOS w.r.t. height (v) FOS w.r.t. friction when FOS w.r.t. cohesion is unity.

3 + (3 + 1) + 5 = 12

9. (a) A slope has to be made from a granular soil [γ_{sat} = 19 kN/m^3, ϕ' = 33°, e = 0.70, G = 2.65]. If a FOS of 1.4 is needed against slope failure, determine the safe angle of the slope when (i) the slope is dry or submerged without seepage and (ii) the seepage occurs at and parallel to the surface of the slope. If seepage occurs parallel to the slope with WT at a depth of 1.6 m, what is the FOS available on a slip plane parallel to the ground surface at a depth of 4.5 m assuming the slope angle as that obtained in case (i). What will be the FOS under case (ii) when the slope angle is kept as that obtained in case (i) The degree of saturation above water table is 20%.

(b) A cutting is made in a soil mass having c = 19 kN/m^2, ϕ = 15° and γ = 18 kN/m^3 with side slopes of 30° to the horizontal upto a depth of 14 m below ground level. Determine the FOS of the slope w.r.t cohesion. Also determine the FOS of the slope against shear failure assuming friction and cohesion are mobilized to the same proportion of their ultimate values. [Given: for β = 30°, ϕ = 15°; S_n = 0.046 & for β = 30°, ϕ = 10°; S_n = 0.075].

(c) For the problem (Figure 3) compute the consolidation settlement by Skempton - Bjerrum method. The compressible layer of depth 24m is divided into four layers. The net pressure (q_n) transmitted by the foundation is 150 kN/m^2. [Given: β = 0.7]

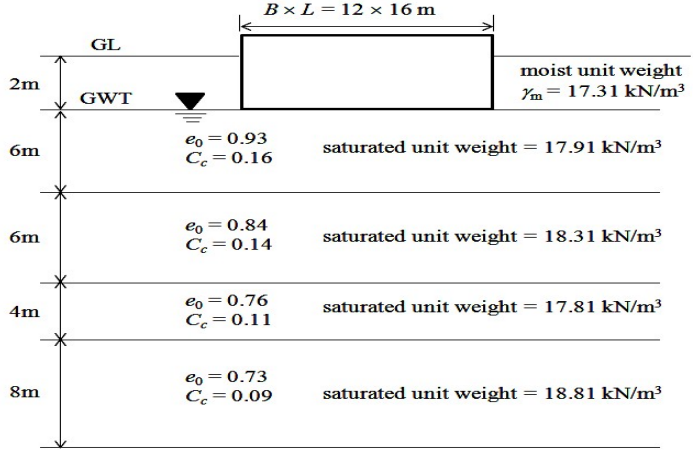

Figure 3

(2 + 2) + 4 + 4 = 12

SOIL MECHANICS - II
(CIVL 3102)

Time Allotted : 3 hrs **Full Mark**

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 practica

Group – A
(Multiple Choice Type Questions)

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

(i) The FOS of a slope of infinite extent having a slope angle of 3(made of cohesionless soil (friction angle = 36°) is given by
(a) 1.258 (b) 1.315 (c) 0.945 (d)

(ii) An excavation was made in saturated soft clay (unit wei 18 kN/m^3) with its sides more or less vertical. If the depth of te crack is 6m, what was the approximate value of cohesion of the s(
(a) 50 kN/m^2 (b) 54 kN/m^2
(c) 58 kN/m^2 (d) 48 kN/m^2.

(iii) Taylor's stability number is given by
(a) $N_S = \dfrac{c_u H_c}{\gamma}$ (b) $N_S = \dfrac{\gamma H_c}{c_u}$
(c) $N_S = \left(\dfrac{c_u}{\gamma H_c}\right)^2$ (d) $N_S = \dfrac{c_u}{\gamma H_c}$.

(iv) Active earth pressure coefficient for a soil with friction angle 30°
(a) 2/3 (b) 4/3 (c) 1/3 (d

(v) Rankine's earth pressure theory is based on which of the foll assumption(s)?
(a) Backfill material is cohesionless
(b) Backfill surface is horizontal
(c) There is no friction between wall surface and backfill soil
(d) All of the above.

(c) Write short notes on factors affecting consolidation.

5 + 5 + 2 = 12

3. (a) The following observations refer to a standard laboratory consolidation test on an undistrurbed sample of clay:

Pressure (KN/m²)	0	10	20	50	100	200	400	800	0
Final dial gauge reading (× 10^{-2} mm)	80	104	152	260	424	578	730	851	707

The sample was 75 mm in diameter and had an initial thickness of 25 mm. The moisture content at the end of the test was 45.5%; the specific gravity 2.68. Compute the void ratio at the end of each loading increament. Determine the value of C_c.

(b) Write short notes on the following:
(i) Determination of pre-consolidation pressure.
(ii) Factors affecting compaction.

7 + (2.5 + 2.5) = 12

Group – C

4. (a) A retaining wall has to retain a sand backfill (ϕ = 28°, e = 0.82, G = 2.65) upto a height of 5.5 m. A uniform surcharge of 60 kN/m² is placed over the backfill. The water table is at 2.5 m below ground surface. The soil above the water table has a degree of saturation of 10%. Determine the magnitude and point of application of the resultant active thrust on the wall.

(b) For the retaining wall (Figure 1), determine the magnitude and point of application of the resultant active thrust on the wall.

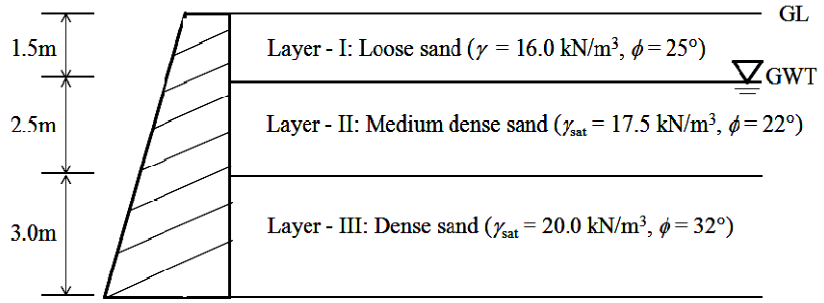

Figure 1

4 + 8 = 12

5. (a) With the help of Mohr circle, derive the expression for coeffici active earth pressure as per Rankine's theory, when the b surface is inclined at an angle β with the horizontal. The friction and unit weight of the backfill soil are ϕ and γ, respectively.

(b) For the cantilever wall (Figure 2), check the stability of the wal respect to (i) overturning, (ii) sliding and (iii) bearing capacity adhesion factor as 0.55. Assume angle of friction between base wall and the foundation soil as $(2/3)\phi_f$, where, ϕ_f is the angle of fr of the foundation soil. The ultimate bearing capacity of the foun soil is 550 kN/m².

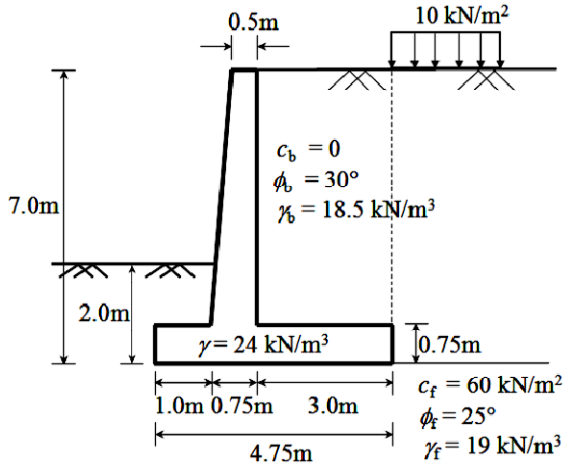

Figure 2

4 + (3 + 2 + 3

Group – D

6. (a) A rectangular footing of 1.8 m × 3.0 m size is to be constructed at below G.L. in a c - ϕ soil having the following properties: n = 40%, G = w = 15%, ϕ = 32.5° c = 8 t/m². Calculate the safe load which the footi carry at a factor of safety of 3 against shear failure as per IS code. N_c = N_q = 25.85 and N_γ = 35.21.
$s_c = s_q = 1 + 0.2\ (B/L)$ $s_\gamma = 1 - 0.4\ (B/L)$ and
$d_c = 1 + 0.2 \times \sqrt{N_\phi} \times (D_f/B)$, $d_q = d_\gamma = 1 + 0.1 \times \sqrt{N_\phi} \times (D_f/B)$ where $N_\phi = \tan^2(450 + \phi/2)$ and inclination factor, $i_q = (1-\alpha/90)^2$ and $i_\gamma = (1-$

(b) Write short notes on effect of water table in shallow foundation sketch.

8 +