Civil Engineering

SOIL MECHANICS

PART – A

1. Theoretically, if the shrinkage limit of a soil is 0%, find its volume at dry state in terms of volume of its solids.
2. Draw the typical grain size distribution curves of well graded and gap graded soils.
3. State the conditions for quick sand phenomenon to occur.
4. In a flow net, the number of flow channels and the number of equipotential lines are respectively 4 and 12. If the coefficient of permeability and loss of head are 1 x 10-8 m/s and 4 m respectively, find the discharge per meter run.
5. Boussinesq's vertical stress due to a point load at a point which is at a depth of 'z' and at a radial distance of 'r' from the line of action of the load is 'cz', when the modulus of elasticity of the medium is 'E'. Find the vertical stress at the same point when the modulus of elasticity of the medium is doubled.
6. A point in a clayey layer is subjected to a stress of 80 kPa at present. The consolidation test results conducted on a sample of the clay show a preconsolidation pressure of 120 kPa. Say whether the clay is normally consolidated or overconsolidated. Justify your answer.
7. The unconfined compressive strength of an undisturbed specimen of a clay is 160 kPa. If the unconfined compressive strength of the clay remoulded at the same moisture content is 10 kPa, find the sensitivity.
8. Can saturated sand exhibit 0 = 0? If so, under what circumstances?
9. Why is stability analysis of an infinite slope simpler than that of a finite slope?
10. Find the available factor of safety of an infinite slope made of c-0 soil when slope angle is equal to angle of internal friction.

PART - B

11. a) i) The results of grain size distribution analysis on a soil yielded the following results.

Size, mm	4.75	2.0	0.425	0.075	0.002
Percentage Finer	100	98	80	65	40

The liquid limit and plastic limit of the soil are 60% and 28% respectively. Find the percentage of gravel, coarse sand, medium sand, fine sand. Also find its activity and classify the soil as per IS 1498.

ii) State the specifications of light and heavy compaction tests and hence calculate the ratio of compactive energy imparted in heavy compaction test to that imparted in light compaction test.

b) i) An oven dried soil sample of volume 163 cc has a mass of 310 g. Determine its void ratio and shrinkage limit, if the specific gravity of solids is 2.67. If the sample is allowed to swell and get fully saturated on contact with water, what will be the water content that will fully saturate the sample and also cause an increase in volume equal to 18% of the original dry volume?

ii) Discuss the influence of particle size of a soil on its Optimum Moisture Content.

12. a) i) A soil in a location consists of sand upto a depth of 5 m from the ground level underlain by clay. The water table is at 2m below the ground level and there is a capillary rise for 1 m from the water table. The sand above the capillary fringe has a degree of saturation of 30%. The saturated unit weights of sand and clay are respectively 19.33 kN/m3 and 19.12 kN/m3 and the dry unit weight of sand is 15.29 kN/m3. Determine the effective stress at a depth of 1 m and 7 m below the ground level.

ii) Discuss the influence of void ratio and temperature on coefficient of permeability of a soil.

b) i) A soil sample of diameter 100 mm and length 127.3 mm was subjected to falling head permeability test. In a time, interval of one hour, the head dropped from 600 mm to 400 mm. The diameter the standpipe was 20 mm. After the test was over, the soil was oven-dried and the oven-dried mass was 1.823 kg. Compute the coefficient of permeability of the sample at a porosity of 40%. Take specific gravity of solids as 2.68.

ii) The discharge velocity through a soil of submerged unit weight of8.338 kN/m3 and specific gravity of solids of 2.7 is 1 x 10-5 cm/s. Find the seepage velocity.

13. a) i) Distinguish between consolidation and compaction.

ii) In a consolidation test, the following results were obtained:

Pressure, kPa	0	10	20	40	80	160	320
Dial reading	2000	1979	1942	1874	1643	1328	949

Obtain the values of void ratio for the pressures of 0, 10 kPa, 20 kPa, 40 kPa, 160 kPa and 320 kPa. The other relevant data are:

Initial thickness of the soil sample: 20 mm

Diameter of the consolidation ring: 60 mm

Specific gravity of solids: 2.65

Weight of the dry soil : 0.772 N

Least count of the dial gauge: 0.002 mm

b) i) A Newmark's chart has 10 radial lines and is prepared with z = 5 cm, influence factor = 0.005. If the innermost circle is completely loaded with a pressure of 100 kPa, find the additional vertical stress at the center at depth of 5 cm.

ii) A building undergoes a settlement of 25 mm in 2 years and the ultimate settlement of the building is estimated to be 100 mm. Another building has a compressible layer underneath it similar to the other building except that it is 30% thicker. Assuming that the average pressure increase in both the cases is alike, find the ultimate settlement of the second building. Also, compute settlement of the second building in 8 years.

14. a) i) An undisturbed soil sample 38 mm in diameter and 80 mm high was tested in a triaxial test apparatus under undrained condition. Under a cell pressure of 300 kPa, the sample failed at an additional axial load of 400 N with a vertical deformation of 8 mm. The failure plane was inclined at 50° to the horizontal. Determine the total stress parameters.

ii) Discuss the limitations of direct shear test.

b) i) A laboratory vane shear test is conducted on a soft, saturated clay sample in such a way that

the top of the vane is at the top surface of the clay. The diameter and height of the vane are 12 mm and 24 mm respectively. Find the shear strength of the sample, if it fails under a torque of 140 N.mm. Derive the equation used, if any.

ii) Taking angle of internal friction as zero, draw the Mohr circle and strength envelope corresponding to incipient failure condition for unconfined compression test and derive the relation between unconfined compressive strength and cohesion.

15. a) An embankment is to be made from a soil with cohesion of 20 kPa, angle of internal friction of 15°, void ratio of 0.7 and specific gravity of solids of 2.65 and moisture content of 26%. If a factor of safety of 1.5 is required with respect to height, find the limiting height of the slope for a slope angle of 45°. Also find the steepest angle of the slope if the height of the embankment is to be kept as 15 m. The table of Taylor's stability number is given below.

i	0°	5°	10°	15°	20°	25°
90°	0.261	0.239	0.218	0.199	0.182	0.166
75°	0.219	0.195	0.173	0.152	0.134	0.117
60°	0.191	0.162	0.138	0.116	0.097	0.079
45°	0.170	0.136	0.108	0.083	0.062	0.044
C O O	0.156	0.110	0.075	0.046	0.025	0.009
15°	0.145	0.068	0.023	-	-	-

b) Explain the stability analysis of a finite slope made of c-9 soil by method slices. Also, derive the equation for factor of safety against sliding for a particular trial.

16. a) The weight of specimen of a fine-grained soil collected in a core cutter of internal diameter 100 mm and length 130 mm is 20.42 N. Assuming that the specimen occupies the entire volume of the core cutter and is saturated, find the void ratio water content, porosity, dry unit weight, submerged unit weight. Take specific gravity of solids as 2.65. If the soil is in plastic state between moisture contents of 38% and 20%, find its relative consistency.

b) Following are the results of Unconsolidated Undrained triaxial test conducted on two

specimens of the same soil. Find the shear strength parameters of the soil. If another specimen of the same soil were subjected to unconfined compression test, find the expected unconfined compressive strength and the angle made by failure plane with respect to major principal plane. Also, find the magnitude of maximum shear stress and locate the plane of maximum shear stress with respect to major principal plane in the sample subjected to unconfined compression test.

Cell pressure, kPa	100	200
Deviator stress at failure, kPa	280	322