GEOTECHNICAL AND FOUNDATION ENGINEERING

Time : Three hours

Maximum Marks : 100

Answer FIVE *questions, taking* ANY TWO *from* **Group A,** ANY TWO *from* **Group B** *and* ALL *from* **Group C.**

All parts of a question (a,b,etc.) should be answered at one place.

Answer should be brief and to-the-point and be supplemented with neat sketches. Unnecessary long answers may result in loss of marks.

Any missing or wrong data may be assumed suitably giving proper justification.

Figures on the right-hand side margin indicate full marks.

Group A

1. (*a*) Derive from fundamentals : $es = Gw$, where 's' represents degree of saturation, 'e' represents void ratio, 'w' represents water content, and 'G' represents grain specific gravity. 6

(*b*) A soil sample has a liquid limit of 20% and plastic limit of 12%. The following data are also available from sieve analysis :

Sieve size, mm	2·0	0·425	0·075
% passing	100	85	38

Classify the soil approximately according to Indian Standard classification. 6

(*c*) The porosity of a soil sample is 35% and the specific gravity of its particles is 2.7. Calculate its void ratio, dry unit weight, saturated unit weight and submerged unit weight. Also, calculate the bulk unit weight of soil, if its degree of saturation is 50%. 8

2. (*a*) How is the coefficient of consolidation of soil estimated ? Explain *any one* method. Discuss the use of coefficient of consolidation in soil engineering. 8

(*b*) A sample in a variable head permeameter is 80 mm in diameter and 100 mm high. The permeability of the sample estimated to be 10×10^{-3} mm/s, if it is desired that the head in the stand pipe should fall from 240 mm to 120 mm in 180 sec. Determine the size of the stand pipe which should be used. 6

(*c*) Write a note on 'effective stress' and 'quick sand condition'. 6

3. (*a*) What are the various parameters that affect the permeability of soil in the field ? Discuss critically. 8

(*b*) There is a bed of compressible clay of 4 m thickness with pervious sand on top and impervious rock at the bottom. Consolidation test conducted on an undisturbed specimen of clay of 20 mm thick obtained from the same deposit showed that 90% settlement has reached in 4 hr. Estimate the time (in year) for the building founded over this deposit to reach 90% of its final settlement. 6

(*c*) A cylindrical specimen of a saturated soil fails under an axial stress of 150 kPa in an unconfined compression test. The failure plane makes an angle of 52° with the horizontal. Calculate the cohesion and angle of internal friction of the soil. 6

4. (*a*) Define overconsolidation pressure and write *any two* examples. Discuss how the overconsolidation pressure is estimated using Casagrande's graphical method. 6

(*b*) An earth dam of 60 m wide is built on an impervious foundation with a horizontal filter at the base near the toe. The permeability of the soil in the horizontal and vertical directions is 4×10^{-2} mm/s and 1×10^{-2} mm/s, respectively. The full reservoir level is 30 m above the filter. A flow net, constructed for the transformed section of the dam, consists of four flow channels and 16 head drops. Estimate the seepage loss for the entire length of dam. 8

(*c*) Discuss critically the 'stress strain behavior of sands' and 'critical void ratio'. 6

Group B

5. (*a*) What are the various steps considered in the planning of sub-surface exploration programme ? Describe the Standard Penetration Test and write its use in foundation design. 8

(*b*) What is the ultimate bearing capacity of a circular footing of 1 m diameter resting on the surface of a saturated clay of unconfined compression strength of 100 kN/m^2 ? What is the safe bearing capacity, if the factor of safety is 3 ? 6

(*c*) What do you mean by 'floating foundation' ? Discuss its concept. 6

6. (*a*) A retaining wall, 7·5 m high, retains a cohesionless backfill. The top 3 m of the fill has a unit weight of 18 kN/m^3 and $\phi = 30^\circ$ and the rest has unit weight of 24 kN/m^3 and $\phi = 20^\circ$. Draw the active earth pressure distribution diagram. Also, find the total active earth thrust and its location from the bottom of the wall. 8

(*b*) Discuss various factors that affect the bearing capacity of shallow footings. 6

(*c*) Explain the terms 'area ratio', 'inside clearance', and 'outside clearance' as applied to a sampler. Why are they required ? 6

7. (*a*) What are the design criteria to be satisfied for the stability of a gravity retaining wall ? Indicate briefly how you will ensure the same. 6

(*b*) A soft normally consolidated clay layer is 18 m thick. The natural water content is 45%. The saturated unit weight of clay is 18 kN/m^3; the grain specific gravity is 2·7and the liquid limit is 63%.The vertical stress increment at the centre of the clay layer due to the foundation load is 9 kN/m^2. The ground water-table is at the surface of the clay layer. Determine the consolidation settlement of the foundation. 8

(*c*) What are the expansive soils ? How do you confirm expansive soils from the differential-free swell index ? 6

8. (*a*) A vane shear test, conducted on a deposit of soft alluvial clay, showed a torque of 73·5 N-m at the time of shear failure. The vane dimensions are : Diameter, $D = 100$ mm and height, $H = 200$ mm. Determine the undrained shear strength of clay for a fully embedded vane condition and estimate the sensitivity of clay, if the undrained strength of clay in remoulded state is 5 kPa. 8

(*b*) Describe the basic principles involved in the process of soil stabilization using 'cement' as additive. 6

(*c*) What do you understand about 'general shear' and 'local shear' failure ? Write soil parameters which influence the type of failure. 6

Group C

9. Answer the following in brief : 10 × 2

(*i*) Write the formula for coefficient of permeability in the falling head method and explain various terms in the formula.

(*ii*) Write limitations of the Rankine's theory.

(*iii*) Discuss shear parameters in unconfined compression test with the help of Mohr's circle.

(*iv*) A soil has a unit weight equal to 20 kN/m^3 and angle of internal friction equal to 35°. If foundation load intensity on the soil is 200 kPa, determine the minimum depth of foundation using Rankine's formula.

(*v*) Distinguish 'quick sand' and 'liquefaction' conditions in soil.

(*vi*) A square footing is resting on the surface of clay strata having cohesion, $c = 50$ kPa. Determine the ultimate bearing capacity.

(*vii*) A sampler of 45 cm long is pushed into the soil for collection of soil sample. If 40 cm of soil sample is recovered in the sampler, determine the sample recovery ratio.

(*viii*) Write *any three* differences between compaction and consolidation.

(*ix*) At a site, the water-table is located at the ground surface and the submerged unit weight of soil is 10 kN/m^3. If water-table rises 2 m above the ground surface, determine the change in effective stress at 5 m below the ground surface.

(*x*) An annular circular raft has outer and inner diameters as 20 m and 15 m, respectively. If the load intensity on the raft is 200 kPa, estimate the increase in vertical stress at a depth of 5 m from the ground surface and exactly below the centre of the raft.