Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 40306

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Fourth/Fifth Semester

Civil Engineering

CE 8491 — SOIL MECHANICS

(Common to Environmental Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. List the three most common clay minerals. Which one is usually more problematic for civil engineers?

2. Define the following : (a) flow index (b) Toughness index.

3. To what height would water rise in a glass capillary tube of 0.01 mm diameter? Assume $T_s = 73 \times 10^{-6}$ N/mm .

4. Write the relationship between seepage velocity and discharge velocity.

5. List the assumptions made in Boussinesq theory.

6. Draw the typical e-log p relationship for NC clay and OC clay.

7. Draw typical sketches of failure envelopes of saturated clay as obtained from undrained and drained shear tests.

8. Write the equation for shear strength according to Mohr-Coulomb failure theory.

9. Differentiate the modes of failure of infinite slope and finite slope.

10. List various slope protection measures.

PART B — (5 × 13 = 65 marks)

11. (a) (i) A soil has bulk unit weight of 20.1 kN/m^3 and water content of 15%. Calculate the water content if the soil partially dries to a unit weight of 19.4 kN/m^3 and the void ratio remains unchanged. (5)

(ii) Discuss briefly the factors influencing compaction. (8)

Or

(b) A soil sample has a liquid limit of 20% and plastic limit of 12%. The following data are also available from sieve analysis : (13)

Sieve size	% passing
2.032 mm	100
0.422 mm	85
0.075 mm	38

Classify the soil according to Unified Classification and IS Classification.

12. (a) (i) Explain the laboratory determination of coefficient of permeability using falling head method and derive the expression to calculate coefficient of permeability. (7)

(ii) Find the total stress, effective stress and pore water pressure at a depth of 6 m below ground level, given the following data. The water table is 2 m below ground level. The dry unit weight of the soil is 17.66 kN/m^3 and saturated unit weight of the soil is 20.81 kN/m^3. (6)

Or

(b) (i) For a homogeneous earth dam 32 m high and 2 m free board, a flow net was constructed with four flow channels. The number of potential drops was 20. The dam has a horizontal filter at the base near the toe. The coefficient of permeability of the soil was 9×10^{-2} mm/s. Determine the anticipated seepage, if the length of the dam is 100 m. (7)

(ii) Calculate the coefficient of permeability of a soil sample, 6 cm in height and 50 cm^2 in cross sectional area, if a quantity of water equal to 430 ml passed down in 10 minutes, under an effective constant head of 40 cm. (6)

13. (a) (i) A line load of 100 kN/metre run extends to a long distance. Determine the intensity of vertical stress at a point, 2 m below the surface and (1) directly under the line load, and (2) at a distance of 2 m perpendicular to the line. Use Boussinesq's theory. (6)

(ii) Explain log "t" method for the determination of coefficient of consolidation. (7)

Or

(b) (i) A sand fill compacted to a bulk density of 18.84 kN/m^3 is to be placed on a compressible saturated marsh deposit 3.5 m thick. The height of the sand fill is to be 3 m. If the volume compressibility m_v of the deposit is 7×10^4 m^2/kN, estimate the final settlement of the fill. (6)

(ii) Explain the procedure to use Newmarks influence chart to find the stress below the loaded soil mass. (7)

14. (a) (i) Two samples of a soil were subjected to shear tests. The results were as follows :

Test No.	σ_3 (kN/m^2)	σ_1 (kN/m^2)
1	100	240
2	300	630

Find the shear strength parameters. If a further sample of the same soil was tested under a minor principal stress of 200 kN/m^2, what value of major principal stress can be expected at failure? (8)

(ii) Explain vane shear test and derive the equation to get the shear strength. (5)

Or

(b) (i) A series of undrained shear box tests (area of box = 3600 mm^2) were carried out on a soil with the following results :

Normal load (N)	280	560	1080
Shear force at failure (N)	240	320	460

Determine the cohesion and angle of friction of the soil with respect to total stresses. (8)

(ii) Prove that the unit cohesion of a saturated clay sample is half its unconfined compressive strength. (5)

15. (a) Find the factor of safety of a slope of infinite extent having a slope angle = 25°. The depth of failure surface is 6 m. The slope is made of clay having $c' = 20$ kN/m^2, $\phi' = 20°$, $\gamma_b = 17.24$ kN/m^3 and $\gamma_{sat} = 19.14$ kN/m^3 under the following conditions: (i) when the soil is dry, (ii) when water seeps parallel to the surface of the slope, and (iii) when the slope is submerged. (13)

Or

(b) Explain with neat sketch friction circle method of slope stability analysis. (13)

PART C — (1 × 15 = 15 marks)

16. (a) The soil profile at a building site consists of dense sand up to 2 m depth, normally loaded soft clay from 2 m to 6 m depth, and stiff impervious rock below 6 m depth. The ground-water table is at 0.40 m depth below ground level. The sand has a density of 18.5 kN/m^3 above water table and 19 kN/m^3 below it. For the clay, natural water content is 50%, liquid limit is 65% and grain specific gravity is 2.65. Calculate the probable ultimate settlement resulting from a uniformly distributed surface load of 40 kN/m^2 applied over an extensive area of the site. (15)

Or

(b) A soil in the borrow pit is at a dry density of 17 kN/m^3 with a moisture content of 10%. The soil is excavated from this pit and compacted in an embankment to a dry density of 18 kN/m^3 with a moisture content of 15%. Compute the quantity of soil to be excavated from the borrow pit and the amount of water to be added for 100 m^3 of compacted soil in the embankment. (15)

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