SOIL MECHANICS - I
(CIVL 2102)

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)   If the height of capillary rise in a soil is 2 m, then the capillary pressure is
          (a) -19.62 kN/m²   (b) -9.81 kN/m²
          (c) -4.905 kN/m²   (d) -24.525 kN/m²

    (ii) When water flows through a soil mass in downward direction, the effective stress at any depth within the soil mass
          (a) Increases
          (b) Decreases
          (c) Remains unchanged
          (d) May increase or decrease depending on the quantity of flow.

    (iii) If D_{10} = 0.005 cm, then the coefficient of permeability as per Allen Hazen's empirical relationship (C = 100 cm⁻¹sec⁻¹) is
          (a) 0.25 cm/sec   (b) 0.025 cm/sec
          (c) 0.0025 cm/sec   (d) 2.5 cm/sec.

    (iv) A load of 2000 kN is uniformly distributed over an area of 3 m × 2 m. The average vertical stress at a depth of 2 m using 2 : 1 distribution method is
          (a) 120 kN/m²   (b) 100 kN/m²
          (c) 80 kN/m²   (d) 140 kN/m²

    (v)   The maximum contact pressure on a rigid footing in a cohesionless soil occurs at the
          (a) Outside edge of the footing   (b) Edge of the footing
          (c) Between centre and edge of the footing   (d) Centre of the footing.

    (vi) For a soil, if the plasticity index and percent finer than 0.002 mm are 29% and 18%, respectively, then the activity number is
          (a) 1.608   (b) 1.614   (c) 1.611   (d) 1.617

(vii)   The size of silt particle is
(a) 2 microns to 75 microns   (b) less than 2 microns
(c) greater than 75 microns   (d) 75 microns to 4.75 mm

(viii)   The three directions of cleavage at 90° angle are found in
(a) Gypsum   (b) Fluorite   (c) Feldspar   (d) Galena.

(ix)   Streak of a mineral is
(a) Its tendency to split along certain direction yielding smooth surfaces
(b) Its appearance on a broken surface of a mineral
(c) Colour of its powder
(d) Colour of the mineral itself.

(x)   Metallic lustre is found in
(a) Diamond   (b) Magnetite   (c) Muscovite   (d) Galena

Group – B

2. (a)   What is mineral? How mineral deposits are classified?
[(CO1) (Understand/LOCQ)]
(b)   Write short note on any one of the followings
(i)   Moh's Scale of hardness
(ii) Fractured mineral. [(CO1) (Understand/LOCQ)]
(c)   Classify sedimentary rocks on the basis of their textures?
[(CO1) (Understand/LOCQ)]

(2 + 3) + 3 + 4 = 12

3. (a)   What are the different parts of a fault? Draw diagrams to show at least four parts.   [(CO1) (Understand/(LOCQ)]
(b)   What are joints and how are they formed? Describe the types of joints with neat sketches.   [(CO1) (Understand/(LOCQ)]

5 + 7 = 12

Group – C

4. (a)   The weight of 1 m³ of wet soil is 2039 kg. Its dry weight is 1835 kg. Specific gravity of soil solids is 2.67. Determine the water content, void ratio, porosity and degree of saturation.   [(CO2) (Evaluate/HOCQ)]
(b)   A partially saturated soil sample from a borrow pit has a natural moisture content of 15% and bulk density of 1.9 gm/cc. The specific gravity of soil solids is 2.70. Determine the degree of saturation, void ratio, dry density and saturated density.   [(CO2) (Evaluate/HOCQ)]
(c)   50 gm of oven-dried soil sample is taken for sedimentation analysis. The hydrometer reading in a 1000 mL soil suspension after 30 mins. from the commencement of sedimentation is 24.5. The effective depth for R_h = 25, found from the calibration curve is 10.7 cm. The meniscus correction is found to be +0.5 and the composite correction as -2.50 at the test temperature of 30°C. Determine the smallest particle size which would have settled during this

interval of 30 mins. and the percentage of particles finer than this size. Assume $G = 2.75$ and $\mu = 8 \times 10^{-7}$ kN-s/m². [(CO2) (Evaluate/HOCQ)]

4 + 4 + 4 = 12

5. (a) Two soils were tested for their consistency limits in the laboratory. The following data were obtained:

Soil A: Soil B:

Liquid limit = 38%, Plastic limit = 25%, Liquid limit = 60%, Plastic limit = 30%,

Natural moisture content = 40% Natural moisture content = 50%

Which soil has greater plasticity? Which soil would be a greater foundation material for remoulding? [(CO2) (Evaluate/HOCQ)]

(b) An oven-dried soil sample of volume 250 cc weighs 430 gm. If the specific gravity of soil solids is 2.70, then determine the water content when the soil becomes fully saturated without any change in volume. Also calculate the water content which will fully saturate the sample and also cause an increase in volume equal to 10% of the original dry volume. [(CO2) (Evaluate/HOCQ)]

(c) The volume and weight of a partially saturated clay sample are 185 cc and 362 gm, respectively. After oven drying for 24 hrs., its weight reduced to 326 gm. If the natural void ratio was 0.54, determine the moisture content, dry density, bulk density, degree of saturation and specific gravity of soil solids.

[(CO2) (Evaluate/HOCQ)]

3 + 4 + 5 = 12

Group – D

6. (a) A granular soil deposit is 7 m deep and lies over an impermeable layer. The ground water table is 4 m below the ground surface. The deposit has a zone of capillary rise of 1.2 m with a saturation of 50%. Determine the effective stresses at ground level, at the level of capillary rise, at ground water table level and at the bottom of the granular deposit. Assume $e = 0.6$ and $G = 2.65$.

[(CO3) (Evaluate/HOCQ)]

(b) The horizontal cylinder of soil is shown in Fig. 1. Determine (i) head loss in soil - I and II and (ii) pressure heads at A and E. [(CO4) (Evaluate/HOCQ)]
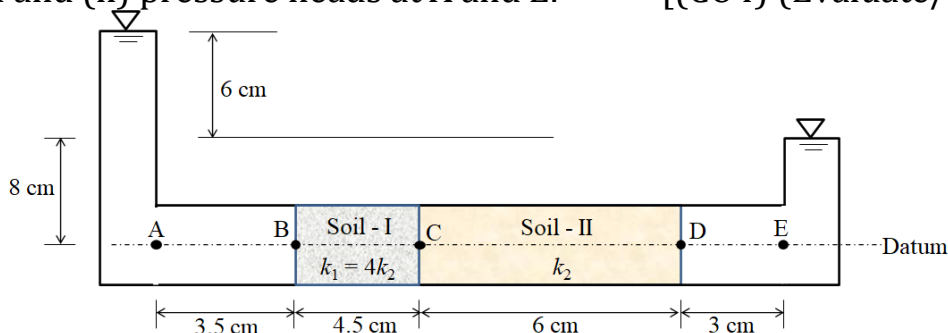

Figure 1

(c) A single row of sheet piles (shown in Fig. 2) is driven upto a depth of 6 m in a bed of clean sand having a co-efficient of permeability of 0.004 cm/sec. An impermeable layer of very stiff clay exists at a depth of 14 m below the GL. The sheet pile wall has to retain water upto 5 m above GL. The height of water level on the downstream side is 0.5 m. The length of the last element is 1.3 m. Determine (i) the quantity of seepage loss considering unit width of the sheet

piles, (ii) the piezometric heads at points B and C, (iii) the exit gradient, (iv) Factor of safety against piping. [Given: $G = 2.67$, $e = 0.75$]. (CO5) (Evaluate/HOCQ)]
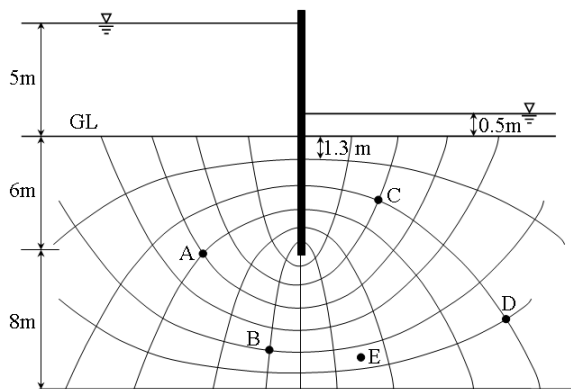

Figure 2

4 + 4 + 4 = 12

7. (a) A 10 m thick bed of sand is underlain by a layer of clay of 6 m thickness. The water table which was originally at the ground surface is lowered by drainage to a depth of 4 m, whereupon the degree of saturation above the water table reduces to 20%. Determine the increase in the magnitude of vertical effective pressure at the middle of the clay layer due to lowering of water table. The saturated unit weights of sand and clay are 20.6 kN/m³ and 17.6 kN/m³, and the dry unit weight of sand is 16.7 kN/m³. [(CO3) (Evaluate/HOCQ)]

(b) A sand sample of 35 cm² cross-sectional area and 20 cm long was tested in a constant head permeameter. Under a head of 60 cm, the discharge was 180 ml in 10 min. The dry weight of sand used for the test was 1200 gm. Determine the discharge and seepage velocities. Assume $G = 2.68$. [(CO4) (Evaluate/HOCQ)]

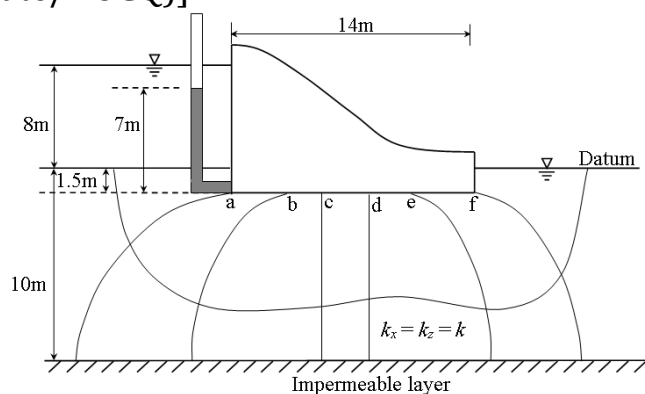(c) Determine the uplift pressures at the points a and c at the base of the dam (Fig. 3). (CO5) (Evaluate/HOCQ)]

Figure 3

4 + 4 + 4 = 12

Group – E

8. (a) A 3 m × 3 m square footing (Fig.4) carries a uniform pressure of 150 kPa. Determine the vertical stresses at points E and I at depth of 2 m below the plane of loaded area. [Given, $a = 1.0$ m]. [(CO6) (Evaluate/HOCQ)]
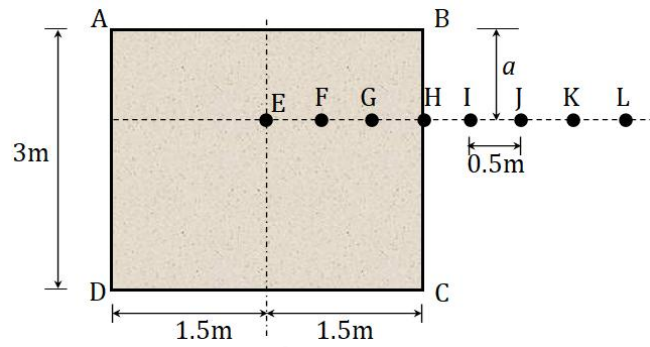
Figure 4

(b)   A 3 m wide strip footing (Fig. 5) is located on the ground surface with a pressure of 100 kN/m². Determine the vertical stresses at a depth of 1.5 m at A (below centreline of the footing), B (edge of the footing) and C (at a distance of 2 m from the edge of the footing).   [(CO6) (Evaluate/HOCQ)]
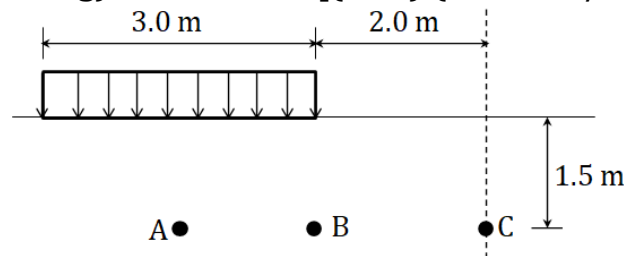

Figure 5

6 + 6 = 12

9.   (a)   Three footings A, B and C (Fig. 6) are placed at locations forming an equilateral triangle of 5 m sides and carrying vertical loads of 300, 650 and 1200 kN, respectively. Determine the vertical stresses by means of Westergaard's equations at a depth of 3 m vertically below the centre of footings A and B. [(CO6)(Evaluate/HOCQ)]
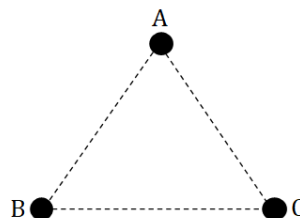

Figure 6

(b)   Three parallel strip footings (Fig.7) 3 m wide each and 5 m apart centre to centre transmit contact loads of 250, 150 and 200 kN/m, respectively. Calculate the vertical stress due to the combined loads at points A and C located at a depth of 2 m below the centre of the respective footings. Use Boussinesq's equation for line loads.   (CO6) (Evaluate/HOCQ)]
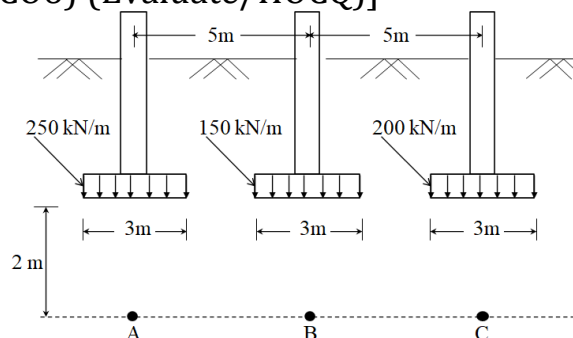

Figure 7

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	30%	43.33%	26.67%

Course Outcome (CO):

After the completion of the course students will be able to

CO1 Identify the properties of rocks and which one is suitable for construction purpose.

CO2 Classify soil as per grain size distribution curve and understand the index properties of soil.

CO3 Apply the concept of total stress, effective stress and pore water pressure for solving geotechnical problems.

CO4 Assess the permeability of different types of soil and solve flow problems.

CO5 Estimate the seepage loss, factor of safety against piping failure using flow net related to any hydraulic structure.

CO6 Determine vertical stress on a horizontal plane within a soil mass subjected to different types of loading on the ground surface and also the maximum stressed zone or isobar below a loaded area.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	Submission Link
CE & SEC A	https://classroom.google.com/w/NDA1MTUxNDA2NDU4/t/all
	classroom joining code: pmctaby classroom joining link: tps://classroom.google.com/c/NDA1MTUxNDA2NDU4?cjc=pmctaby
CE & SEC B	https://classroom.google.com/w/NDA1MTUxNDA2NTIz/t/all
	Classroom joining code: muhkvqs Classroom joining link: ttps://classroom.google.com/c/NDA1MTUxNDA2NTIz?cjc=muhkvqs
Backlog	https://classroom.google.com/w/NDA1MTUxNDA2NTIz/t/all
	Classroom joining code: muhkvqs Classroom joining link: https://classroom.google.com/c/NDA1MTUxNDA2NTIz?cjc=muhkvqs