Ref. No.: Ex/CE/5/T/506B/2023

BACHELOR OF ENGINEERING (CIVIL ENGINEERING) FIFTH YEAR SECOND SEMESTER EXAMINATION 2023

ADVANCED SOIL MECHANICS

Time : Three hours | Full Marks : 100

(50 Marks for each Part)

Use separate answer script for each Part

PART I (50 Marks)

Answer all the questions

Assume any data if needed, reasonably

1. (a) State of stress at a point is characterized by the following matrix **(10)**

$$\sigma = \begin{bmatrix} 18 & 0 & 24 \\ 0 & -50 & 0 \\ 24 & 0 & 32 \end{bmatrix} \text{kPa}$$

find stress invariants, characteristic equation, principal stresses and the principal plane associated with the maximum principal stress.

(b) Differentiate plane stress and plane strain problems with suitable examples **(5)**

(c) Describe octahedral shear stress theory. **(4)**

(d) Write down the strain – displacement relation in Cartesian coordinate system. **(3)**

(e) Explain the term: 'compatibility condition'. **(3)**

2. (a) Focusing on design guidelines, write a short note on vertical sand drains. **(5)**

(b) From Terzaghi's one dimensional consolidation equation prove that the excess pore water pressure (u) can be expressed as: **(15)**

$$u = \sum_{n=1}^{n=\infty} \left(\frac{1}{H} \int_0^{2H} u_i \sin \frac{n\pi z}{2H} dz \right) \sin \frac{n\pi z}{2H} \exp\left(\frac{-n^2 \pi^2 T_v}{4} \right)$$

(c) Differentiate between free strain case and equal strain case. **(2)**

(d) The average degree of consolidation calculated on the assumption that only vertical drainage exists is 23% and the average degree of consolidation calculated on the assumption that only radial drainage exists is 26%. Calculate the average degree of consolidation for simultaneous vertical and radial drainage. **(3)**

[Turn over

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SUBJECT: ADVANCED SOIL MECHANICS

PART - II

(50 Marks)

Answer any TWO from the following.

No. of Questions		Marks
Q.1.a)	State and explain the different triaxial tests giving explanatory figures and graphs wherever necessary.	15
Q.1.b)	An embankment is being built of a soil whose effective stress shear strength parameters are: $c' = 100$ kN/m^2 and $\varphi' = 20^0$; unit weight is equal to 17 kN/m^3. The pore pressure parameters A and B as determined by the triaxial shear tests are 0.6 and 0.8 respectively. The height of the embankment has just been raised from 4m to 9m. Determine the shear strength of the soil at the base of the embankment. It can be assumed that the dissipation of pore pressure during this stage of the construction is negligible and the lateral pressure at any point is one-half of the vertical pressure.	10
2.(a)	What do you mean by stress point and stress path? Explain K_0 and K_f lines giving neat sketches wherever necessary.	10
2.(b)	Show in a tabular form the basic condition, types of deformations, stress path and uses for the four cases of tests, viz., isotropic compression, confined compression, triaxial compression and direct shear.	10
2.(c)	Draw the stress paths for consolidated undrained test on normally consolidated clay.	5
3.(a)	What is anchored bulk head? Explain any one of the method of design of anchored sheet pile wall with a neat sketch.	10

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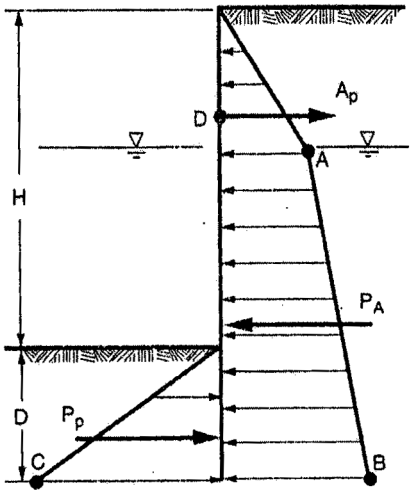
PART - II

(50 Marks)

Answer any TWO from the following.

No. of Questions		Marks
3.(b)	While designing a sheet pile wall as shown below in Fig., it was found that the soil behind and in front of the sheet pile wall was uniform sand with a friction angle $\varphi' = 33^0$, buoyant unit weight $\gamma_b = 10.25$ kN/m^3 and above the ground water table, the total unit weight $\gamma_t = 19.2$ kN/m^3. The sheet pile wall had H = 9.0 m and D = 6 m. The water level in front of the wall was at the same elevation as the groundwater table which was located 1.5 m below the ground surface and the tieback anchor was located 1.2 m below the ground surface. Calculate the factor of safety for toe kick-out and the tie back anchor force. In the analysis, neglect wall friction. 	15