M. E. CIVIL ENGINEERING FIRST YEAR FIRST SEMESTER EXAM – 2024
ADVANCED THEORY OF SOIL MECHANICS

TIME: Three Hours   FULL MARKS: 100

Answer all the questions
Assume any data if needed, reasonably

1.	(a)	What are the conditions that need to be fulfilled for plane stress and plane strain cases? Write the stress-strain relationship for plane strain case.	(8)
	(b)	What is octahedral stress? Show that the octahedral shear stress can be expressed in terms of stress invariants only.	(10)
	(c)	(d) Determine the principal stresses, and principal axes for the following stress matrix $$[\sigma_{ij}] = \begin{bmatrix} 18 & 0 & 24 \\ 0 & -50 & 0 \\ 24 & 0 & 32 \end{bmatrix} \text{kPa}$$	(10)
	(d)	If the displacement field is given by: $$u = [(x^2 + y^2 + 2)\, e_1 + (3x + 4y^2)\, e_2 + (2x^3 + 4z)\, e_3]10^{-4}$$ what is the strain at (1,2,3) in the direction $n_x = n_y = n_z = 1/\sqrt{3}$?	(7)
2.	(a)	Explain the significance of hydrostatic stress and deviatoric stress in the theory of failure.	(4)
	(c)	"If the stress vectors acting on three mutually perpendicular planes passing through a point are known, we can determine the stress vector acting on any other arbitrary plane at that point" : prove this statement.	(10)
	(d)	'In the stress-strain relationship, for an isotropic linear elastic material the unknowns of the stiffness tensor can be reduced from 81 to 2'. Write down the steps only to justify the above statement.	(6)
3.	(a)	From Terzaghi's one dimensional consolidation equation prove that the excess pore water pressure (u) at depth z can be expressed as: $$u = \sum_{n=1}^{n=\infty} \left(\frac{1}{H} \int_0^{2H} u_i \sin\frac{n\pi z}{2H} dz \right) \sin\frac{n\pi z}{2H} \exp\left(\frac{-n^2\pi^2 T_v}{4} \right)$$ where, u_i is initial pore water pressure and total depth of the layer is $2H$. Assume double drainage condition.	(20)
4.	(a)	Explain the relevance of CD test with real life examples.	(3)
	(b)	(i)What is stress path? (ii)Write down the names of different types of stress paths. (iii)Draw the stress path diagram for CU test on NC and OC clay.	(6)
	(c)	Prove that the pore water pressure in a triaxial test can be expressed as: $$\Delta u = B[\Delta\sigma_3 + A(\Delta\sigma_1 - \Delta\sigma_3)]$$	(8)
	(d)	What is the significance of Hvorslev parameters? Explain the method to obtain Hvorslev parameters.	(8)

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