Ref. No.: Ex/PG/CE/T/112C/2025

M. E. CIVIL ENGINEERING FIRST YEAR FIRST SEMESTER EXAM – 2025

ADVANCED THEORY OF SOIL MECHANICS

TIME: Three Hours **FULL MARKS: 100**

Answer all the questions

Assume any data if needed, reasonably

1.	**(a)**	Draw the Mohr's Circles for three dimensional state of stress.	**(2)**
	(b)	What is octahedral stress? Show that the octahedral shear stress can be expressed in terms of stress invariants only.	**(10)**
	(c)	The state of stress at a point is characterised by the components: σ_{xx}= 100 MPa, σ_{yy}= = – 40 MPa, σ_{zz}= = 80 MPa, τ_{xy}= = τ_{xz} = τ_{yz} = 0 Determine the principal stresses and the associated planes, maximum shear stresses and their associated normal stresses, the octahedral shear stress and its associated normal stress.	**(13)**
2.	**(a)**	How does the projection of the yield surface in deviatoric plane looks like for octahedral shear stress theory? Prove it.	**(10)**
	(b)	Prove that the traction vector {T} can be expressed as: {T} = [σ]{n} where, [σ] is stress tensor and {n} is unit normal vector to the surface at the point of interest.	**(10)**
	(c)	'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.	**(5)**
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)**
	(b)	Write down a short note on sand drain.	**(5)**
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)	In a triaxial test, a soil sample was consolidated under a cell pressure of 700 kN/m^2 and a back pressure of 350 kN/m^2. Thereafter, with no drainage condition, the cell pressure was raised to 800 kN/m^2 resulting in increased pore water pressure of 445 kN/m^2. The axial load was then increased to give a deviator stress of 575 kN/m^2 and a pore pressure reading of 640 kN/m^2. Calculate Skempton's pore water pressure parameters B and A.	**(8)**

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