

**M. E. CIVIL ENGINEERING FIRST YEAR FIRST SEMESTER EXAM – 2025**  
**ADVANCED GEOTECHNICAL ENGINEERING**

TIME: Three Hours

(Part – I) ( 60 Marks)

FULL MARKS: 100 (60+40)

*Answer all the questions**Assume any data if needed, reasonably*

1.	(a)	Prove that the traction vector $\{T\}$ can be expressed as: $\{T\} = [\sigma]\{n\}$ where, $[\sigma]$ is stress tensor and $\{n\}$ is unit normal vector to the surface at the point of interest.	(10)
	(b)	What is stress invariants? $[\sigma] = \begin{bmatrix} 200 & 200 & 200 \\ 200 & -100 & 200 \\ 200 & 200 & -100 \end{bmatrix}$ kPa Divide the above state of stress in hydrostatic and deviatoric part. Find the stress invariants for both hydrostatic and deviatoric cases.	(10)
	(c)	$\begin{bmatrix} \sigma_{xx} & \tau_{xy} & \tau_{xz} \\ \tau_{yx} & \sigma_{yy} & \tau_{yz} \\ \tau_{zx} & \tau_{zy} & \sigma_{zz} \end{bmatrix}$ Out of these 9 components show that only 6 components are independent.	(15)
2.	(a)	Write a short note on Compatibility Condition.	(5)
	(b)	Derive the stress-strain relationship for both plane strain and plane stress cases.	(10)
	(c)	Draw the projection of the yield surface in deviatoric plane for maximum shear stress theory. 'The shape of the projection may be different for different material' – Is this statement true? Justify your answer.	(4)
	(d)	If the displacement field is given by: $\mathbf{u} = [(x^2 + y^2 + 2) \mathbf{e}_1 + (3x + 4y^2) \mathbf{e}_2 + (2x^3 + 4z) \mathbf{e}_3]10^{-4}$ what is the strain at (1,2,3) in the direction $n_x = n_y = n_z = 1/\sqrt{3}$ ?	(6)

[ Turn over

Ref. No. : Ex/PG/CIV/PC/T/111B/2025

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**SUBJECT: ADVANCED GEOTECHNICAL ENGINEERING**

**(PART II - MARKS 40)**

**Time: 3 HOURS Full Marks: 100**

**Assume reasonable values of data not supplied**

**USE RELEVANT VALUES OF DATA NOT SUPPLIED**

1. Derive the relation between undrained shear strength and effective overburden pressure of a clayey deposit. Using this relation also give the normalised value of undrained shear strength of normally consolidated deposit using typical values soil parameters. 10+5=15
2. A 15m thick soft clay deposit underlain by a hard clay layer is required to be consolidated under a superimposed load of 100 kPa using band drain of size 100mm x 5mm placed at a spacing of 2m c/c. Determine the time required to reach 90% degree of consolidation. Assume only radial drainage with  $C_{vr} = 0.08 \text{ m}^2/\text{day}$  and corresponding  $T_r = 0.64$  for equal vertical strain condition. What will be the change in degree of consolidation if vertical drainage ( $C_v = 0.04 \text{ m}^2/\text{day}$  - only upward) is also allowed? Also estimate the total settlement of the layer for the properties:  $\gamma_{sat} = 16.5 \text{ kN/m}^3$ ,  $C_c / (1 + e_0) = 0.15$ . 10+5=15
3. Draw stress-path diagram for one-dimensional consolidation test, UU tri-axial and CU tri-axial tests. 10