BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: MTECH/PRE-PHD **SEMESTER : I**
BRANCH: CEE **SESSION : MO/2025**

SUBJECT: CE501 ADVANCED SOLID MECHANICS

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	The state of stress at a point in MPa is $\sigma_x = 12.31$, $\sigma_y = 8.96$, $\sigma_z = 4.34$, $\tau_{xy} = 4.20$, $\tau_{yz} = 5.27$, $\tau_{xz} = 0.84$ Determine the three principal stresses.	[5]	1	K2, K3
Q.1(b)	The stress tensor at a point is $$\sigma = \begin{bmatrix} 5 & 2 & 1 \\ 2 & 3 & 4 \\ 1 & 4 & 2 \end{bmatrix} MPa$$ Find the normal and shear stresses on a plane whose direction cosines are $$(a_{Nx}, a_{Ny}, a_{Nz}) = \left(\frac{1}{\sqrt{3}}, \sqrt{\frac{2}{3}}, 0\right)$$ and determine the direction of shear stress on that plane.	[5]	1	K2, K3
Q.2(a)	The displacement field for a body is $$\boldsymbol{u}(x, y, z) = (x^2 + y)\boldsymbol{i} + (3 + z)\boldsymbol{j} + (x^2 + 2y)\boldsymbol{k}$$ Find the deformed position of a point that was originally at $(x, y, z) = (3, 1, -2)$	[5]	1	K2, K3
Q.2(b)	For Q.2(a), determine the principal strains and the direction of the minimum principal strain.	[5]	1	K2, K3
Q.3(a)	What properties ensures the symmetry of stress and strain matrix and how does those symmetry reduce the numbers of independent components in constitutive matrix (81 to 36)? What are the numerical limits of Poisson's ratio? Can it be negative?	[3+2]	2	K1, K2, K3
Q.3(b)	What is plane of symmetry? How does plane of symmetry reduces 21 independent coefficients of constitutive matrix to 2 independent coefficients (Mention the steps only)? Write down the isotropic compliance tensor/matrix in term of elastic modulus (E, υ).	[3+2]	2	K1, K2, K3
Q.4(a)	What is plane stress condition? How does this condition impact the stress, strain and compliance tensor/matrix for isotropic material?	[2+3]	3	K1, K2, K3
Q.4(b)	Derive the fourth order differential equation to solve elasticity problem using Airy's stress function for plane stress condition of isotropic material. Mention the assumptions and steps clearly.	[5]	3	K1, K2
Q.5(a)	Derive the following equation of torsion for circular shaft: $T/I_p = \tau/r = G\theta^*/L$	[5]	4	K1, K2
Q.5(b)	What is warping? Derive the stress components developed in a solid non-circular isotropic prismatic bar under uniform twist T following Saint-Venant Approach.	[1+4]	4	K1, K2

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