APL 104: Minor 1

Full Marks: 45 Duration: 1 hrs Date: 30^{th} Aug 2016

1. All questions are compulsory.
2. Problems 1-4 are objective type and has only one correct option each. You only need to provide the correct options to these questions on the first page of your answer sheet only.

Problem 1: Stress tensor can become unsymmetric if
(a) the body has non-zero angular acceleration (b) is always symmetric (c) body force acts (d)none of these (3)

Problem 2: Shear traction can act in a fluid media if
(a) fluid is static (b) fluid is viscous but static (c) fluid is ideal but moving (d) fluid is viscous and moving (3)

Problem 3: Principal planes can have non-zero shear traction if
(a) the body is accelerating (b) is always shear-free (c) always has shear (d) None of these (3)

Problem 4: The plane on which maximum shear traction acts
(a) has no normal traction (b) does not exist (c) has zero normal traction if two of principal stresses are equal and opposite (d) none of these (3)

Problem 5: Deduce the radial, theta and axial component of divergence of stress tensor $\underline{\underline{\sigma}}$. You may use the following definition for divergence in cylinderical coordinate system: (10)

$$\underline{\nabla} \cdot () = \frac{\partial}{\partial r}() \cdot \underline{e}_r + \frac{1}{r}\frac{\partial}{\partial \theta}() \cdot \underline{e}_\theta + \frac{\partial}{\partial z}() \cdot \underline{e}_z$$

Problem 6: The stress tensor at a point is denoted by the following matrix in cartesian co-ordinate system:

$$\underline{\underline{\sigma}} = \begin{bmatrix} 4 & 4 & 0 \\ 4 & -4 & 0 \\ 0 & 0 & 3 \end{bmatrix}$$

(a) Draw Mohr's circle corresponding to this state for tractions in (x-y) plane. What are the principal stresses and their directions? What is the maximum shear traction and on what plane does it act? (8)
(b) Using Mohr's circle idea, find out the normal and shear tractions on a plane whose normal lies in $x - y$ plane and makes an angle of 7.5 degrees from x-axis in clockwise direction. (4)
(c) Find out the octahedral stress components corresponding to this state of stress. (2)
(d) Decompose the given stress matrix into hydrostatic and deviatoric part. (2)

Problem 7: A body having arbitrary shape is acted upon by atmospheric pressure (p_{atm}) on its boundary surface. Think of a point on the surface and a co-ordinate system such that its origin passes through that point and one of the axis lies along the outward surface normal. Can you write down the stress matrix at this point in the given coordinate system? Show all the unknown components of this stress matrix as '×' sign. (7)