No. of Pages: 2

B

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2017

Branch: **Civil Engineering**

Stream: Structural Engineering

01CE6103 Theory of Elasticity

Answer *any two full* questions from *each* part

Limit answers to the required points.

Max. Marks: 60 Duration: 3 hours

PART A

1. a. Define stress ellipsoid and stress director surface 2

   b. Explain the state of pure shear with an example 2

   c. For the given state of stress, determine the principal stresses and their directions $[\sigma_{ij}]=\begin{bmatrix}0 & 1 & 1\\ 1 & 0 & 1\\ 1 & 1 & 0\end{bmatrix} MPa$ 5

2. a. Explain Strain deviator and strain invariants. 3

   b. The strain tensor at a point in a body is given by $\in_{ij=}\begin{bmatrix}1 & 2 & 5\\ 2 & 3 & 4\\ 5 & 4 & 5\end{bmatrix}\times 10^{-4}$ 6

   Determine (a) octahedral normal and shearing strains. (b) Deviator and Spherical strain tensors.

3. Write notes on 3x3

   (i) Traction boundary conditions
   (ii) Significance of compatibility equations
   (iii) Mohr's circle for three - dimensional state of stress

PART B

4. a. Differentiate between plane stress and plane strain problems 4

b. Show that the function $\phi = A\left(xy^3 - \frac{3}{4}xyh^2\right)$ is an Airy's stress function and hence show that it represents the stress distribution in a cantilever beam loaded at the free end with a load P. The width of beam is 'b' and depth is 'h'. Assume $\tau_{xy} = 0 \; at \; y = \pm\frac{h}{2}$ 5

5. a. State and prove uniqueness theorem in theory of elasticity 3

b. State generalized Hooke's law with clear explanation to the reduction in elastic constants for different cases. Hence write down the stress-strain relations for a three - dimensional orthotropic and transversely isotropic body. 6

6. a. Derive Betrami-Michell's equations for a three - dimensional stress state 7

b. State and explain Saint Venant's principle 2

PART C

7. Show that the stress concentration around a hole in a plate of infinite dimension under uni-axial tension is 3. Plot the variation of stresses around the hole. 12

8. a. Derive the compatibility equation in polar co-ordinate system for two-dimensional stress state 8

b. Show that by making a small hole at the centre in a solid rotating disc with radius 'b', the circumferential stress will increase twice. 4

9. a. Discuss Prandtl's membrane analogy on torsion 6

b. Determine the maximum torque that can be applied on the section shown in the figure below if the allowable shear stress is 300 N/mm^2 . What is the angle of twist per unit length of the shaft under the above torque. Determine the shear stress in various parts of the section. The wall thickness is uniform and has a value of 15mm. The modulus of rigidity G =2 x 10^4 N/mm^2 6