B **B4B142**

Reg. No._____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MAY 2017

Course Code: **ME202**

Course Name: **ADVANCED MECHANICS OF SOLIDS (ME)**

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any three questions.

1. The stress tensor at a point is given by the following matrix

$$\begin{bmatrix} 50 & -20 & 40 \\ -20 & 20 & 10 \\ 40 & 10 & 30 \end{bmatrix} \text{ kPa.}$$

Determine the stress on a plane whose unit normal has direction cosines $\frac{1}{\sqrt{2}}, \frac{1}{2}$ and $\frac{1}{2}$. (10)

2. Displacement field for a 2D plane strain case is given as,

$$u = [(x^2 + xy)\hat{\imath} + (y^2 + xy)\hat{\jmath}] \times 10^{-2}$$

a) Find components of strain at point (2,4) (3)

b) Write strain compatibility equations for a general 3D problem (2)

c) Simplify the compatibility equations, for 2D plane strain problem, with proper justification, and check compatibility of the given displacement field. (5)

3. a) State and explain Saint Venant's principle for end effects with a suitable example. (5)

b) State and prove uniqueness theorem in theory of elasticity. (5)

4. Stress components at a point P in a plane stress problem are,

$\sigma_{xx} = 150\ MPa,\quad \sigma_{yy} = -100\ MPa\ \&\tau_{xy} = 50\ MPa$.

Find values of all principal strains and it directions at point P. Take the value for

$E = 210GPa\ \&\ \upsilon = 0.25$ (10)

PART B

Answer any three questions.

5. Derive equations of equilibrium for an axisymmetric problem. (10)

6. Consider a thin large rectangular plate, with a small hole at the centre, subjected to uniform tensile stress from its two ends. Find the variations of stress components around the hole by Airy's stress function method. (10)

7. Determine the maximum stress in the section A-A as shown in the figure1. Also mark the region in section A-A where the absolute value of stress is more than 8000 N/cm^2. (10)

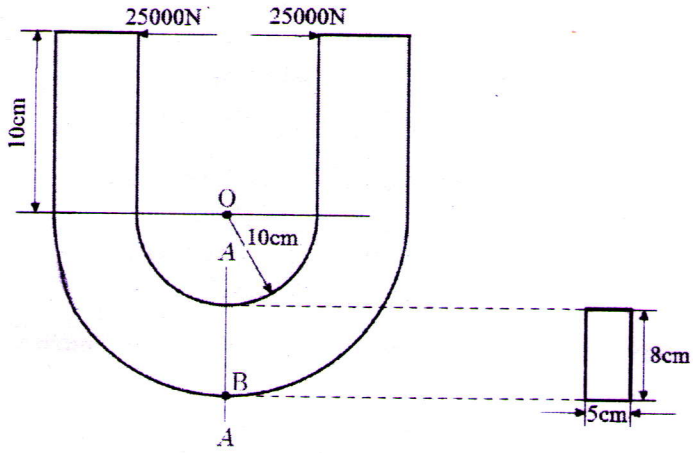

Figure 1

8. State and prove reciprocal relation in energy methods, and explain its application with an example. (10)

PART C

Answer any four questions.

9. Check whether the function, $\psi = constant$, is a possible warping function for solving torsion problem of prismatic bar using Saint Venant's method. If so, find
   (a) shape of the cross section corresponding to the above function, (3)
   (b) torsional rigidity of the prismatic bar, (3)
   (c) angle of twist per unit length on applying a torque T and (1)
   (d) stress components and resultant stress. (3)

10. Explain the principle of virtual work in energy methods, and its application in finding load and displacement at a point. (10)

11. (a) Explain the application of membrane analogy in solving torsion problem, of prismatic bar of any cross section, for finding twisting moment and shear stress acting on the cross section. (6)

(b) State and prove Maxwell's reciprocal theorem. (4)

12. Find the angle of twist per unit length when the two cell tubular section, as shown in figure 2 is subjected to a torque of 30,000 Nm. Take value of $G = 160 \times 10^9\ N/m^2$ (10)

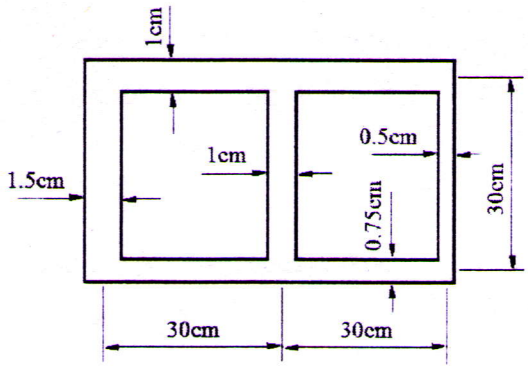

Figure 2

13. Use Prandtl's method to derive equations for the components of stress, the maximum value of resultant stress and torsional rigidity of a prismatic bar with elliptic cross section. (10)

14. Derive an equation for angle of twist per unit length for a thin walled tube subjected to a torque, T. (10)

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