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**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
**FOURTH SEMESTER B.TECH DEGREE EXAMINATION, JULY 2017**

**Course Code: ME202****Course Name: ADVANCED MECHANICS OF SOLIDS (ME)**

Max. Marks: 100

Duration: 3 Hours

*(Data handbooks not permitted)***PART A***Answer any three questions. Each question carries 10 marks.*

- 1 a) What is meant by the state of stress at a point? (3)
- b) The state of stress at a point is characterised by  $\sigma_x=18$ ,  $\sigma_y=-50$ ,  $\sigma_z=32$ ,  $\tau_{xy}=0$ ,  $\tau_{xz}=24$ ,  $\tau_{yz}=0$  (All stress values are in kPa); Calculate the principal stresses and the direction of largest tensile principal stress? (7)
- 2 a) Explain the plane stress and strain with ONE example each? (4)
- b) A displacement field  $u=2xyi+3zk$  where  $i$  and  $k$  are unit vectors along  $x$  and  $z$  directions is acting at  $(1, 1, 0)$ . Find the rectangular components of strain and obtain the state of strain matrix? (6)
- 3 a) Describe the Airy's stress function with the help of second degree polynomial? (4)
- b) Obtain the bending stress on the cross section of a cantilever beam carrying point load at the free end using polynomial stress function method? (6)
- 4 a) Write the generalized Hook's law for an isotropic material. (5)
- b) State and prove uniqueness theorem. (5)

**PART B***Answer any three questions. Each question carries 10 marks*

- 5 a) Obtain the stress distribution in a rotating solid disc of radius 'b' with no external forces at the outer surface. (7)
- b) Sketch the circumferential stress distribution for a thick cylinder subjected to internal pressure only. (3)
- 6 a) Draw the stress distribution around a small hole (diameter 'b'), on a thin plate having large width ('a') where  $b \ll a$ , subjected to uniform tensile forces at the two edges. (4)

- b) What are the assumptions involved in axisymmetric problems. Write the governing equilibrium equations for the axisymmetric problem with sketch indicating stress components. (6)
- 7 a) Find the value of load  $P$  in Fig.1, so that the maximum bending stress allowed is 15MPa for the case of beam shown below, subjected to unsymmetrical bending. (8)

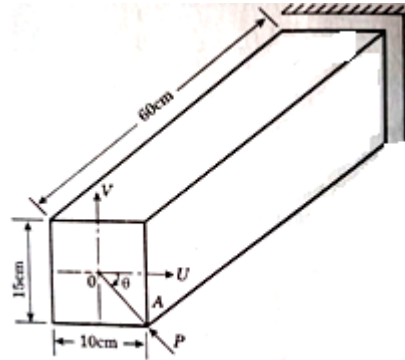


Fig.1

- b) What is meant by shear centre? (2)
- 8 a) Obtain the expression for strain energy in a bar subjected to:- (6)
- i) axial force      ii) bending moment      iii) twisting moment
- b) State and prove reciprocal relation in strain energy. (4)

### PART C

*Answer any four questions. Each question carries 10 marks.*

- 9 a) Explain the principle of virtual work? (3)
- b) State and prove Castiglianos's first theorem. (7)
- 10 a) Write the general expression for twisting moment for shafts of non-circular cross section incorporating warping function  $\Psi(x,y)$ . (3)
- b) What is meant by warping of non-circular shafts? Prove that St.Venants warping function is harmonic? (7)
- 11 a) Explain the minimum potential energy theorem? (2)
- b) Find the support reaction  $R$  in Fig.2 at the end of the cantilever beam using strain energy method. (Load acting is  $P$  at a distance of ' $b$ ' from the roller support). (8)

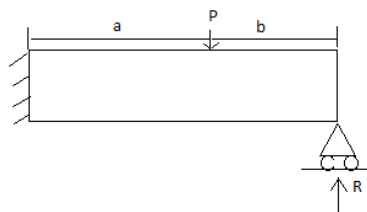


Fig.2

- 12 a) Discuss the Maxwell reciprocal theorem. (2)
- b) A shaft of square section as shown in Fig. 3 below is subjected to a twisting moment such that the maximum shear stress is limited to  $250 \text{ N/mm}^2$ . Obtain the torque and angular twist, if shaft is 1.6m long (Take  $G = 70000 \text{ N/mm}^2$ ). (8)

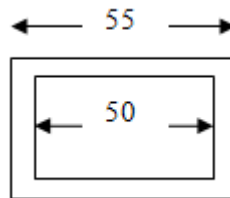


Fig.3

- 13 a) Why closed sections are having better torsional rigidity than open sections, briefly explain? (4)
- b) Find an expression for the maximum shear stress induced in an elliptical bar under torsion? (6)
- 14 a) A thin walled box section  $2a \times a \times t$  is to be compared with a solid circular section having diameter 'a' shown below in Fig.4. Find the thickness 't' so that both sections have: - (8)
- Same shear stress for same torque
  - Same stiffness.

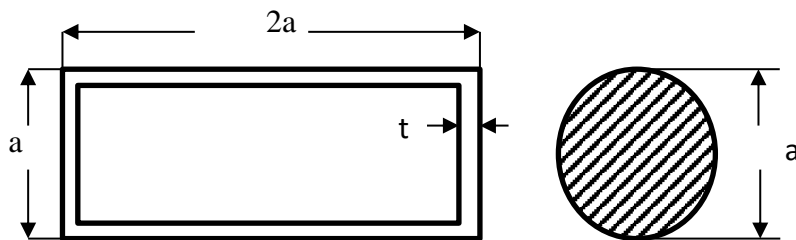


Fig. 4

- b) Define the term shear flow in a thin walled tube? (2)

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