

**B.E DEGREE EXAMINATIONS: APRIL/MAY 2014**

(Regulation 2009)

Sixth Semester

**AERONAUTICAL ENGINEERING**

AER127:Theory of Elasticity

**Time: Three Hours**

**Maximum Marks: 100**

**Answer all the Questions:-**

**PART A (10 x 1 = 10 Marks)**

1. Number of Independent Elastic Constants for an elastic material is
  - a) 2
  - b) 3
  - c) 4
  - d) 6
2. On a Principal strain plane, Normal strain is
  - a) Zero
  - b) Maximum
  - c) Minimum
  - d) Maximum or Minimum
3. Young's modulus E, Shear modulus G and Poisson's ratio  $\mu$  are related as
  - a)  $G = E / 2 (1 + \mu)$
  - b)  $G = E / (1 + \mu)$
  - c)  $G = 2E / (1 + \mu)$
  - d)  $G = E / 2(1 - \mu)$
4. Strain compatibility conditions ensure the continuity of
  - a) Displacements
  - b) Slopes
  - c) Curvatures
  - d) Displacements, Slopes and Curvatures
5. Derivatives of Airy's stress function yield
  - a) Displacements
  - b) Slopes
  - c) Curvatures
  - d) Stresses
6. In plane problems in (x,y) plane, thickness in z-direction is
  - a) Constant
  - b) Varies
  - c) Constant but small
  - d) Constant but large
7. In axi-symmetric problems \_\_\_\_\_ are symmetric about the axis
  - a) Geometry
  - b) Boundary Conditions
  - c) Loads
  - d) Geometry, Boundary conditions and Loads
8. Problem of line load on a semi-infinite body is \_\_\_\_\_ problem.
  - a) Kirch
  - b) Michell
  - c) Boussinesque
  - d) Lamé
9. Prandtl's theory of torsion can be readily applied to torsion of \_\_\_\_\_ shafts.

- a) Solid Elliptical
  - b) Hollow Elliptical
  - c) Hollow Triangular
  - d) Hollow Circular
10. Shear stress in an equilateral shaft under torsion is maximum at
- a) Corner points
  - b) Middle of the sides
  - c) Centre of gravity
  - d) Centre of twist

**PART B (10 x 2 = 20 Marks)**

11. Define Elastic material.
12. Write the equations of static equilibrium in 2D.
13. Write down strain displacement equations in 2D Cartesian coordinates.
14. Explain Saint-Venant's principle.
15. State the conditions for plane stress problems.
16. What is symmetric bending?
17. Write the strain compatibility condition in 2D axi-symmetric problems.
18. Write the stress equilibrium equation in 2D polar coordinates with body forces.
19. Write the assumptions of Saint-Venant theory of torsion.
20. Bring out the differences between direct and semi-inverse method of solutions of elasticity problems.

**PART C (5 x 14 = 70 Marks)**

21. a) i) Derive stress equilibrium equations in 2D Cartesian problems with body forces. (8)
  - ii) Explain the sign conventions for stresses and indicate the stresses  $\sigma_x = 1000$  pa,  $\sigma_y = -600$  pa,  $\tau_{xy} = -200$  pa on a typical element. (6)
- (OR)**
- b) i) Derive stress equilibrium equation at a point on the boundary of an element. (7)
  - ii) If  $\sigma_x = 1000$  pa,  $\sigma_y = -700$  pa,  $\tau_{xy} = 300$  pa, find the normal and shear stresses (7) on a plane whose normal is at  $30^\circ$  to x-axis.
22. a) i) Write down Hooke's law for 2D orthotropic material and state the number of independent elastic constants. (6)
  - ii) Derive the expression for Lamé's constants in 2D problems. (8)
- (OR)**
- b) i) Relate Bulk modulus with Shear modulus, Young's modulus and Poisson's ratio. (6)
  - ii) Clearly explain the construction of Moh's circle and indicate its applications. (8)

23. a) i) Clearly bring out the differences between plane stress and plane strain problems (6) with examples.

ii) If Airy's stress function  $\Phi = 20(x^3 - 3xy^2)$ , plot the stresses  $\sigma_x$ ,  $\sigma_y$  and  $\tau_{xy}$  on a (8) typical element.

**(OR)**

b) Derive expressions for the stresses in a cantilever beam with a tip load.

24. a) Derive stresses in a curved cantilever beam with transverse shear load at its free end.

**(OR)**

b) Derive the expression for stresses of a Bousinesque problem.

25. a) Derive expression for the ratio of maximum shear stresses under torsion of same torque and same cross-sectional area of circular solid and hollow shafts.

**(OR)**

b) Derive expressions for the stresses on the boundary and at the ends of major and minor axis of an elliptical shaft under torque T.

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