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B.E. DEGREE EXAMINATIONS: APRIL/MAY 2011

Sixth Semester

AERONAUTICAL ENGINEERING

U07ARE01: Theory of Elasticity

Time: Three Hours **Maximum Marks: 100**

Answer ALL Questions:-

PART A (10 x 1 = 10 Marks)

1. General anisotropic material has _____ independent constants.

   a) 36 b) 21 c) 13 d) 9

2. The deformation of the twisted shaft consist of

   a) Rotation of cross- section or Warping of the cross-section

   b) Rotation of cross- section and Warping of the cross-section

   c) Rotation of cross- section

   d) Warping of the cross-section

3. Design of gas turbines is an application of theory of elasticity on.

   a) Rotating discs problems b) Axi-symmetry problems

   c) Michell's problems d) Boussinesque problems

4. Thick tubes subjected to internal and external uniformly distributed pressures is

   a) Boussinesque problem b) Michell's problem c) Lame's problem d) Kirsch problem

5. Saint Venant's method is also called as

   a) Inverse method b) Semi-inverse method c) General method d) Mohr's circle method

6. The maximum value of poisson's ratio is

   a) 0 b) 1 c) 0.5 d) -1

7. Youngs modulus for brass is

   a) 100 GPa b) 210 GPa c) 70 GPa d) 290 GPa

8. Lame's constant λ is given by

   a) $\frac{2E\nu}{(1-\nu)(1+2\nu)}$ b) $\frac{E\nu}{(1-\nu)(1+2\nu)}$ c) $\frac{2E\nu}{(1+\nu)(1-2\nu)}$ d) $\frac{E\nu}{(1+\nu)(1-2\nu)}$

9. The compatibility condition in theory of elasticity ensures that

   a) There is compatibility between various direct and shear stresses

   b) Displacements are single – valued and continuous

   c) Relationship between stresses and strains are consistent with constitutive relations

   d) Stresses satisfy bi –harmonic equation

10. For Axi- symmetric problems Ø =

a) $A \log r + B \log r^2 + C \log r^3 + D \log r^4$ b) $Ar^3 \log r + B r^2 \log r + Cr + D$

c) $A \log r + B r^2 \log r^2 + C r^3 \mathit{log}\, r^3 + D \mathit{log}\, r^4$ d) $A \log r + B r^2 \log r + C r^3 + D$

PART B (10 x 2 = 20 Marks)

11. What are the body forces acting on a body? Explain
12. Draw a small element and mark the stress components in Cartesian co-ordinate system.
13. Define the principal planes and principal stresses.
14. State St. Venant's principle.
15. Differentiate Mechanics of materials approach and theory of elasticity approach.
16. Write down the Bi-harmonic equation in Cartesian coordinates.
17. Differentiate plane stress and plane strain problems.
18. What is meant by warping.
19. Define the maximum shear stress theory.
20. Define stress concentration factor.

PART C (5 x 14 = 70 Marks)

21. a) Derive the equilibrium equations in Cartesian coordinates for a general three dimensional state of stress and explain the significance of these equations.

(OR)

b) The stress components at a point P (4, 2, 6) are given by, $\boldsymbol{\sigma_{xx} = 4 + 2y^2}$, $\boldsymbol{\sigma_{yy} = 4x + 2z^3}$, $\boldsymbol{\sigma_{zz} = 2x^2 + 2y^2}$, $\boldsymbol{\tau_{xy} = 2z}$, $\boldsymbol{\tau_{yz} = 2x^3}$, $\boldsymbol{\tau_{zx} = 2y^3}$.

Assuming E = 210 GPa and ν = 0.29, determine the state of strain at the point, the body force distribution required for equilibrium.

22. a) Derive the 2D compatibility equation for plain strain assumption.

(OR)

b) Derive the 2D-strain displacement relation in Cartesian coordinates.

23. a) A cantilever beam of length L and of rectangular cross section, depth 2c and unit width is subjected to load P at free end. Obtain the expression for the deflection curve using elasticity approach.

(OR)

b) (i) Derive the equilibrium equations in polar coordinates.

(ii) Derive the strain displacement relations in polar coordinates for 2-D problems.

24. a) The general solution of an axi-symmetric problem is given as $\varphi = A \log r + B\, r^2 \log r + Cr^2 + D$ Where 'φ' is the stress function A, B, C, and D are arbitrary constants and 'r' is radius at any point. Use the above expression to obtain stresses in a thick cylinder subjected internal pressure. Sketch the variation through the thickness.

(OR)

b) Derive the expressions for stresses at any point in a plate of infinite dimension with a small central circular hole under uni-axial tension.

25. a) Determine the maximum shear stress and angle of twist per unit length for the following sections due to twisting moment of 10 Nm. Assume G = 40 kN/mm^2.

(i) A circular section of diameter 200 mm.

(ii) An elliptical section of dimension 200 mm x 100 mm.

(iii) A triangular section of base 200 mm

(iv) A rectangular section of dimension 200 mm x 20 mm.

(OR)

b) A bar of elliptical cross section with 'a' as its semi major axis and 'b' as its semi minor axis is subjected to torque T. Using the Prandtl's theory of torsion obtain the expression for shear stresses and twist.

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