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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Eighth Semester, B.E. - Civil Engineering

Semester End Examination; July - 2021

Theory of Elasticity

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer any **FIVE** full questions.*

1 a. Obtain the expressions for equilibrium equations in 3D Cartesian coordinate system. 10

b. At a point in strained material, the intensity of resultant stress on a certain plane is 800 kN/m^2 tensile inclined at 30° to the normal of the plane. The normal stress on a plane perpendicular to this plane is 600 kN/m^2 compressive. Find the resultant stress on the second plane, principal planes, principal stresses, maximum shear stress and its plane. 10

2 a. Derive the differential equations of equilibrium for plane stress problems in polar form. 10

b. The state of stress at a point is characterized by the components σ_{ij}, find the stress invariants and principal stress. 10

$$\sigma_{ij} = \begin{bmatrix} 12.31 & 4.20 & 0.84 \\ 4.20 & 8.96 & 5.27 \\ 0.84 & 5.27 & 4.34 \end{bmatrix} MPa.$$

3 a. Obtain the expression for strain displacement relationship in Cartesian coordinate system. 10

b. Given, $u = 3x^4 + 2x^2y^2 + x + y + 8, \quad v = 3xy + y^3 + 3$. Determine the strain components. Are they compatible? 10

4. Derive the expressions for strain components in polar coordinate system. 20

5 a. Explain state of plane stress and state of plane strain with examples and write the expressions. 10

b. Derive the compatibility equation for the plane stress problem in cartesian coordinate system when the body force components are absent. 10

6 a. Show that $\frac{-P}{2\pi} r^2 \left\{ \theta - \frac{\sin 2\theta}{2} \right\}$ represents a stress function. 8

b. Using a stress function in the form of a polynomial of the fourth degree, plot the stress diagram on a rectangular plate of size 2C×L. 12

7 a. Show that $\sigma_x = \frac{-P_{xy}}{I}, \sigma_y = 0, \tau_{xy} = \frac{-P}{2I}(c^2 - y^2)$ are the expression for the stress components in solving a problem for a narrow cantilever of span length '*L*' and rectangular cross section under an end load *P*. 12

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b. Plot the variation of σ_θ along x-axis and along y-axis showing the effect of circular holes on stress distribution in plates subjected to uni-axial tension. 8

8 a. What is axi-symmetric stress distribution? Mention its advantages. 6

b. Derive the expression for the stress components in a thick cylinder subjected to internal and external fluid pressure. 14

9. Explain perfectly elastic, rigid-perfectly plastic, linear work-hardening and elastic perfectly plastic materials with neat stress-strain diagrams. 20

10. Write a short note on;

a) Failure theories

b) Tresca criteria of yielding 20

c) Von-Mises criteria of yielding

d) Westergard stress space

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