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Question Paper Code: U1602

M.E. DEGREE EXAMINATION, DEC 2025

First Semester

Structural Engineering

21PSE102 – THEORY OF ELASTICITY AND PLASTICITY

(Regulations 2021)

Duration: Three hours

Maximum: 100 Marks

Answer ALL Questions

PART - A (5 x 20 = 100 Marks)

1. (a) Develop the stress–strain relationship for a linearly elastic, homogeneous, and isotropic material in three dimensions. **CO1-App** (20)
- (b) Determine the strain components at a point given the stress components in a 2D state using Hooke's law. **CO1-App** (20)
2. (a) Determine the Airy's stress function for a thin rectangular plate under uniform tension. **CO1-App** (20)
- Or
- (b) Derive the compatibility condition in polar coordinates and discuss its engineering importance. **CO1-App** (20)
3. (a) Using the principle of least work, determine the redundant reaction in a statically indeterminate beam. **CO3-Ana** (20)
- Or
- (b) Develop the Rayleigh–Ritz formulation for a fixed–fixed beam subjected to a central point load. **CO3-Ana** (20)
4. (a) A thin-walled circular tube has thickness $t = 2$ mm and mean diameter 120 mm. It carries torque $T = 500$ Nm. Calculate shear flow and maximum shear stress. **CO4-Ana** (20)
- Or
- (b) A shaft is subjected to torsional shear $\tau = 200$ MPa. Using Von-Mises and Tresca criteria, determine the equivalent (failure) stress and comment on whether yielding occurs (take an appropriate yield strength or state symbolically). **CO3-Ana** (20)

5. (a) Considering a strain-hardening rule, analyze how the hardening exponent affects ductility and ultimate strength of steel. Support with a stress-strain sketch. CO3-Ana (20)

Or

- (b) Analyze the physical assumptions of plasticity theory (isotropy, incompressibility, gradual yielding). Compare these assumptions with actual metal behavior in engineering practice CO3-Ana (20)