

*This question paper contains 3 printed pages.*

3054

Your Roll No. ....

MEC

J

Paper— CE.551

THEORY OF ELASTICITY AND PLASTICITY

Time : 3 hours

Maximum Marks : 100

*(Write your Roll No. on the top immediately  
on receipt of this question paper.)*

*Answer any five questions.*

*Assume suitable data, missing, if any.*

1. (a) Derive equations of equilibrium for 3-D cartesian system of coordinates. 8
- (b) Derive strain-displacement relationships for 3-D cartesian system of coordinates. 12
2. Derive the expressions for finding out radial stress, tangential stress and shear stress on a large plate with a small hole when subjected to direct tensile stress,  $s$  (uniaxial). 20
3. Stress tensor at a point is given by:

$$\tau_{ij} = \begin{pmatrix} 10 & 15 & 20 \\ 15 & 25 & 15 \\ 20 & 15 & 30 \end{pmatrix}.$$

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Find out:

- (i) Principal stresses and their directions. 10
- (ii) Maximum and minimum shear stresses alongwith their planes. 10
4. Find out stresses in a cantilever beam by Airy's stress function approach when it is subjected to a point load at the free end. The width of the beam is  $h$  and depth of the beam is  $d$ . 20
5. A rectangular beam 8 cm wide and 10 cm deep is 2 m long and is simply supported at the ends. The yield strength of the material is 250 MPa. Determine the value of the concentrated load applied at the midspan of the beam if (a) the outermost fibres of the beam just start yielding, (b) the outer shell upto 3 cm depth yielded, and (c) whole of the beam yielded. Assume the material is linearly elastic and perfectly plastic. 20
6. A solid circular shaft of 10 cm radius is subjected to a twisting couple so that the outer 5 cm deep shell yields plastically. If the yield strength in shear for the shaft material is 175 MPa, determine the twisting couple applied and the associated angle of twist.  $G=0.84 \times 10^5$  N/mm<sup>2</sup>. 20
7. A thick cylinder of internal radius 15 cm and external radius 25 cm is subjected to an internal pressure  $p$

MPa. If the yield strength of the cylinder material is  $240 \text{ N/mm}^2$ , determine (a) pressure at which the cylinder will start yielding just at inner radius, (b) the stresses when the cylinder has a plastic front of radius 20 cm, and (c) stresses when whole of the cylinder has yielded.

Assume Tresca yield criterion and plane strain condition. 20

8. A thin circular disc of uniform thickness is of 50 cm outer diameter and 20 cm inner diameter. Determine (a) speed of rotation so that the disc just starts yielding plastically at the inner radius, (b) stresses in the disc when disc has yielded upto 15 cm radius and (c) the speed for full yielding. Given:  $\rho=7850 \text{ kg/m}^3$ ,  $\sigma_y=250 \text{ N/mm}^2$  and  $\nu=0.30$ . 20