

**M. E. (Mech.) First Semester Examination, 2011**  
**Solid Mechanics for Mechanical Design**  
**(ME – 909)**

Time : 3 hours

Full Marks : 70

Answer FIVE questions.  
(taking TWO from Group – A & Group – B respectively and  
Group – C is compulsory to answer)  
The questions are of equal value.

**GROUP - A**

1. (a) Deduce the expressions for radial and transverse stresses in a thick cylinder when it is subjected to internal pressure,  $p_i$  .  
  
(b) A thick-walled tube with an internal radius of 14 cm is subjected to an internal pressure of 180 MPa. Determine the external radius if the shear stress developed is limited to 300 MPa. Calculate also the maximum transverse stress,  $\sigma_r$ . Take  $E = 210$  GPa and  $\mu = 0.3$ .
  
2. (a) Deduce the expression for shrink fit pressure,  $p_c$  .  
  
(b) A steel shaft of 12 cm diameter is shrunk inside a bronze cylinder of 26 cm outside diameter. The shrink allowance is 0.008 cm difference between the radii. Find the shrink fit pressure.  
Given that  $E_s = 210$  GPa,  $E_b = 107$  GPa and Poisson's ratio,  $\mu = 0.3$  for both materials.
  
3. (a) Find out the expression for the radial stress,  $\sigma_r$  in a rotating disc of uniform thickness, which is not subjected to external forces on the edges.  
  
(b) Prove that this radial stress is maximum at the radial distance,  $r = \sqrt{r_o r_i}$  .  
Where,  $r_i$  and  $r_o$  are the inner and outer radii of disc.

**GROUP – B**

4. (a) An infinitely long beam supported by a continuous elastic foundation is subjected to a concentrated load,  $P$ . Find the deflection equation.  
  
(b) If the above beam is subjected to an external moment,  $M_o$  only at the origin of the coordinate system, instead of the above concentrated load,  $P$ , find the deflection and slope equations.

5. (a) Deduce the expressions for bending stress,  $\sigma_x$  at any fibre in a curved beam subjected to a bending moment,  $M$ .
- (b) Define the geometric characteristics of a curved beam having a cross-sectional profile.  
Deduce the expression for the geometrical characteristics,  $z$  for a curved beam having rectangular cross-section.
6. (a) Find out the expression for the creep shear stress on the outer fibre of a machine member having a circular cross-section.  
What is the expression for the creep shear stress at any fibre?
- (b) Deduce the expression for the creep angle of twist per unit length of a machine member. Show the creep shear strain variation diagram across the cross-section.

### GROUP – C

7. (a) Deduce the expression for creep stress in bending. What are the basic assumptions for deducing it?
- (b) Establish the expression for creep bending deflection of a beam of circular cross-section.