Exam. Code: 0940
Sub. Code: 33856

2056
B.E. (Mechanical Engineering)
Fourth Semester
MEC-402: Mechanics of Solids

Time allowed: 3 Hours **Max. Marks: 50**

NOTE: ***Attempt five questions in all, including Question No. I which is compulsory and selecting two questions from each Part. Use usual notations and symbols for derivations. Assume suitably missing data if any. All questions carry 10 marks.***

x-x-x

Question 1 Answer the following, *show* your work.

a) A steel sample with $\sigma_Y = 700$ MPa is to be used. Determine τ_Y and $\tau_{\text{allowable}}$ given FOS $= 4$.

b) Determine the *Lame's* constants λ and μ given $E = 210$ GPa and $\nu = 0.3$.

c) Show that P_{cr} for the 2^{nd} buckling mode for a *pin-pin* column of length L is the same as the P_{cr} for the 1^{st} buckling mode for a *fixed-free* column of length $\frac{L}{4}$.

d) A thick cylinder with inner radius a and outer radius $2a$ is subjected to an internal fluid pressure p. Find the hoop stress at the outer surface.

e) What is the *stress-optic* law? Give the equation. Also state the value of the *stress-optical coefficient* for polycarbonate.

Part A

Question 2 A 250 kg drum with a 750 mm diameter is supported by the bar AB and cable BC as shown. Determine forces on each element.

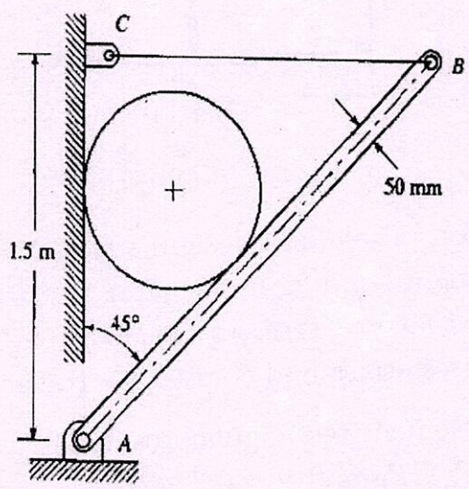

Figure 1: Question 2.

Question 3 The state of stress at a point relative to an xyz coordinate system is given by

Contd.....P/2

$$[\sigma] = \begin{bmatrix} 3 & 0 & -2 \\ 0 & 1 & 2 \\ -2 & 2 & -1 \end{bmatrix} 10^3 \text{lbf/in}^2.$$

Determine the normal and shear stresses and their directional cosines on a surface intersecting the point and parallel to the plane given by the equation $x + 2y - 2z = -4$.

Question 4 Two thick walled cylinders are mated with no gap or interference. Initially the inner cylinder has an inner radius a and outer radius b, whereas the outer cylinder has an inner radius b and outer radius c.The inner cylinder is of a material with a modulus of elasticity E_i and Poissons's ratio ν_i, whereas the outer cylinder is of a material of modulus of Elasticity E_o and a Poisson's ratio ν_o. The inside of the inner cylinder is then subjected to a pressure p_i. Determine the equation for the resulting interface pressure p at $r = b$.

Part B

Question 5 For the wire form shown use Castigliano's method to determine the vertical deflection of point A. Consider bending only and let the bending rigidity of the cross section be EI.

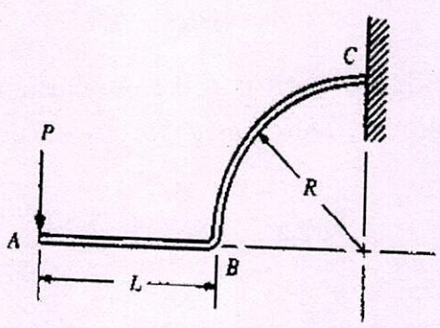

Figure 2: Question 5.

Question 6 A common problem in design is that of a solid circular shaft of diameter d transmitting a bending moment M and torsional moment T simultaneously. Prove that the Tresca stress is given by $\tau_{\max} = \frac{16}{\pi d^3}\sqrt{M^2 + T^2}$. Determine the von Mises stress and compare it to the Tresca stress.

Question 7 A three element rectangular rosette strain gage is mounted on a specimen with $E = 105$ GPa and $\nu = 0.324$. For a particular state of loading of the structure the strain gage readings are $\varepsilon_A = -400\mu$, $\varepsilon_B = -400\mu$, and $\varepsilon_C = 200\mu$. Determine the values and orientation of the principal stresses and the value of the maximum shear stress at that point.

x-x-x