INDIAN INSTITUTE OF TECHNOLOGY

Date: .11.2012 (day F/N) **Autumn Semester** **Time:** 3 hrs **Full Marks:** 50

Subject Name: Mechanics of Solids **Subject No.:** ME21103

No of students: 80 (approx) **2nd Year B. Tech +DD (OENA) +Breadth+Addl**

Question paper has 1 page

All questions carry equal marks. Answer all 5 questions. Any assumptions made in solving the questions should be justified with reasons.

1. The uniform brass bar *AB* has a rectangular cross section and is supported by pins and brackets as shown. Each end of the bar can rotate freely about a horizontal axis through the pin, but rotation about a vertical axis is prevented by the brackets. (a) Determine the ratio *b/d* for which the factor of safety with regard to buckling is the same whether the bar buckles in either of the two possible directions of buckling. (b) Determine the factor of safety if P = 8 kN, L = 2m, d = 38 mm, and E = 105 GPa.

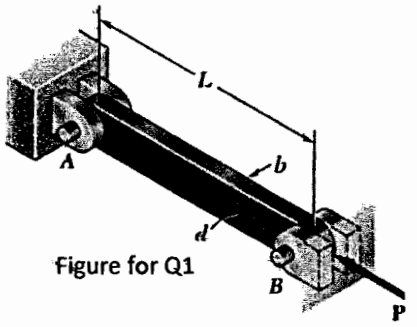

Figure for Q1

2. The stress array for the torsion problem of a circular cross section bar of radius *a*, and with longitudinal axis coincident with the z axis of rectangular Cartesian axes (*x*, *y*, z) is $\begin{bmatrix} 0 & 0 & -G\gamma\beta \\ 0 & 0 & G\alpha\beta \\ -G\gamma\beta & G\alpha\beta & 0 \end{bmatrix}$ where G and b are constants. Determine the principal stresses and their directions at a point $x = y$ on the lateral surface of the bar. What is the ratio of the octahedral shear stress and the maximum shear stress at that point?

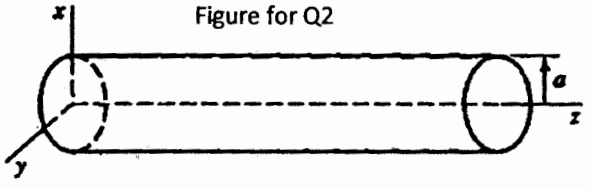

Figure for Q2

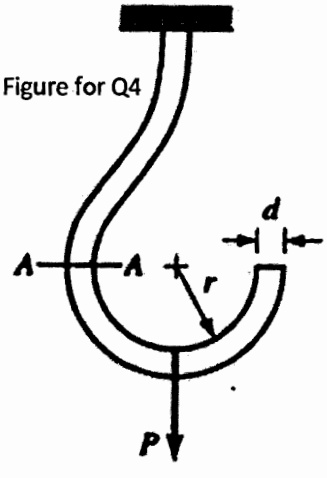

Figure for Q4

3. If the displacement field is given by **u**= axy **i** + axy **j** + 2a(x+y)z **k**, write down the strain matrix. Find the strain along a line equally oriented with all three coordinate axes. Check if the strain matrix satisfies compatibility conditions and state your conclusion.

4. A curved steel bar of square cross section is used as a crane hook. The radius of curvature to the inner edge of the bar is r and the bar has diameter d. Determine the maximum tensile and compressive stresses at section A-A in terms of P, r, and d.

5. A composite disc is formed by interference fitting of a hollow disc of outer radius *a* and inner radius *b* over a solid disc of radius *b*+d (assume plane stress) where d is very small as compared to either *a* or *b*. What is the radial stress at the interface? What are the tangential stresses at the interface? If the composite disc is now rotated, at what speed will the interference d decrease by 50%? The material of the discs has modulus of elasticity E and Poisson's ratio n.