Exam.Code:0940
Sub. Code: 6712

2014
B.E. (Mechanical Engineering)
Fourth Semester
MEC-402: Mechanics of Solids

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

NOTE: Attempt <u>five</u> 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 equal marks.

x-x-x

Q.1 Provide *brief* and *clear* answers to the following:

a. How do brittle and ductile materials fail? What are the failure theories used for them?
b. What is Cauchy's stress theorem?
c. What is virtual work principle? Explain.
d. What is Castigliano's first theorem used for?
e. What Soderberg's criteria?

Part A

Q.2 The state of stress at a point in a member relative to a x, y, and z coordinate system is

$$[\sigma] = \begin{matrix} 20 & 10 & 10 \\ 10 & 30 & 0 \\ -10 & 0 & 50 \end{matrix} \text{ MPa.}$$

Determine the normal stress σ and shearing stress τ on the surface intersecting the point and parallel to the plane $2x + y - 3z = 9$.

Q.3 If the stress field given by

$$\sigma_x = pyx^3 - 2c_1xy + c_2y$$

$$\sigma_y = pxy^3 - 2px^3y$$

$$\tau_{xy} = \frac{3}{2}px^2y^2 + c_1y^2 + \frac{1}{2}px^4 + c_3$$

acts in the thin plate shown and p is a known constant, determine the c's so that the edges $x = \pm a$ are free of shearing stress and no normal stress acts on the edge $x = a$.

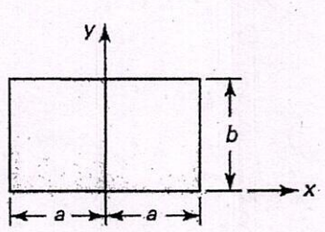

Figure: Q.3

Q.4 A square prismatic bar of sides 0.05m is subjected to an axial tensile force $F_m = 90$kN. The fatigue strength for completely reversed stress at 10^6 cycles is $S_E = 210$MPa, and the static tensile yield strength is $S_Y = 280$MPa. Apply the *Soderberg* criterion to determine the limiting value of completely reversed axial load F_a that can be superimposed on F_m at the midpoint of a side of the crossection without causing fatigue failure at 10^6 cycles.

P.T.O.

Part - B

Q.5 A square thin-walled tube of mean dimension $a \times a$ and a circular thin-walled tube of mean diameter c, both of the same material, length, thickness t, and cross-sectional area, are subjected to the same torque. Determine the ratios of the shearing stresses and angle of twist of the tubes.

Q.6 Cables AB and BC each have an effective area of 125mm^2. The length of the cables AB and BC are 500mm and 750mm, respectively. A vertical force of $P = 8\text{kN}$ is applied to joint B. If the cables are steel with $E = 200\text{GPa}$, determine the stresses in the cables and the deflection of point B. You *must* use the method of *virtual loads* to solve the problem.

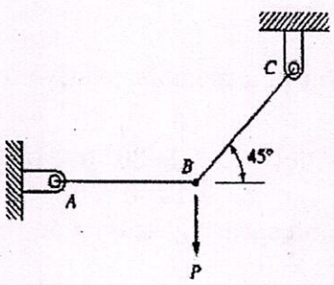

Figure: Q.6

Q.7 A three element rectangular rosette strain gage is mounted on a steel specimen. For a particular state of loading of the structure the strain gage readings are

$$\epsilon_A = 200\mu, \epsilon_B = 900\mu, \text{ and } \epsilon_C = 1000\mu.$$

Determine the principal strains and stresses and their orientation relative to the axis of the A gage. Let $E = 200\text{GPa}$ and $\nu = 0.285$

x-x-x