Exam. Code: 0940
Sub. Code: 33856

2055

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 equal marks.***

x-x-x

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

a. Give the expression for Lame's constants.
b. Write down the strain-displacement equations in three dimensions.
c. What is the bi-harmonic equation? How does it relate to Airy's stress function?
d. Explain twisting in open thin-walled beams with one axis of symmetry.
e. What is the complementary strain energy. How is it used in Castigliano's second theorem? Explain.

Part A

Q.2 Relative to an xyz coordinate system, the state of stress at a point is known to be

$$[\underline{\sigma}] = \begin{bmatrix} -10 & 20 & 30 \\ 20 & 10 & -20 \\ 30 & -20 & 40 \end{bmatrix} \text{MPa.}$$

(a) Evaluate the normal and shear stresses on a surface at the point where surface is given by the three points (1,0,0), (0,2,0), (0,0,-1). (b) Determine the direction cosines for the shear stress found in part (a) and in a rough sketch show the direction of the normal and shear stresses.

Q.3 Determine the resulting stress equations for σ_x, σ_y, and τ_{xy} given the Airy stress function

$$\Phi = a_1x^4 + a_2x^3y + a_3x^2y^2 + a_4xy^3 + a_5xy^4,$$

where a_i are constants. Also determine the restrictions between the constants, if any.

Q.4 Estimate the shear stress and total angle of twist of the thin-walled circular cylinder of outer diameter $d = 125$mm and thickness $t = 5$mm. The steel tube is 0.5m long and is transmitting a torque of 1kN·m. The material constants are $E = 200$GPa and $\nu = 0.29$.

P.T.O

Part B

Q.5 Using Castigliano's method determine the support reactions for the beam shown Figure 1.

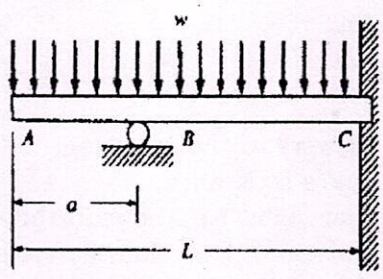

Figure 1

Q.6 Estimate the torque in a 10mm diameter steel shaft when yielding begins using (a) maximum shear stress theory (b) maximum distortion energy theory. The yield strength of steel is 140MPa.

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 $\epsilon_A = 200\mu$, $\epsilon_B = 900\mu$, and $\epsilon_C = 1000\mu$. Determine the values and orientations of the principal stresses and the value of the maximum shear stress at the point. Let $E = 200\,\text{GPa}$ and $\nu = 0.285$.

x-x-x