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BIMEE-005

B.Tech. – VIEP – MECHANICAL ENGINEERING (BTMEVI)

Term-End Examination

00746

June, 2015

BIMEE-005 : EXPERIMENTAL STRESS ANALYSIS

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt any **seven** questions. All questions carry equal marks. Assume any missing data, if required anywhere. Use of scientific calculator is permitted.*

1. The state of stress at a point is given by the following array of terms :

$$\begin{bmatrix} 200 & -100 & 50 \\ -100 & 200 & 100 \\ 50 & 100 & 50 \end{bmatrix} \text{kg/cm}^2$$

Determine the normal and shear stresses on a plane whose direction cosines are, $0, \sqrt{\frac{3}{2}}, \frac{1}{2}$. Also determine the direction of the shear stress. *10*

2. A straight torsion-tension member with a solid circular cross-section has a length L = 6 m and radius R = 10 mm. The member is subject to tension and torsion loads that produce an elongation ΔL = 10 mm and a rotation of one end of the member with respect to the other end of $\pi/3$ rad. Let the origin of the (r, θ, z) cylindrical coordinate axes lie at the centroid of one end of the member, with z-axis extending along the centroidal axis of the member. The deformation of the member is assumed to occur under conditions of constant volume. The end z = 0 is constrained so that only radial displacements are possible there.

   (a) Determine the displacements for any point in the member and the state of strain for a point on the output surface.

   (b) Determine the principal strains for the point where the state of strain was determined. *10*

3. Explain the construction and working of the following gauges : $4 \times 2\frac{1}{2} = 10$

   (a) Acoustical strain gauge

   (b) Pneumatic strain gauge

   (c) Scratch gauge

   (d) Diffraction strain gauge

4. Determine the stresses in a brittle coating applied to a component made of steel for which $E_s = 2 \times 10^6$ kg/cm^2, $\nu_s = 0{\cdot}30$ when the specimen stresses are $\sigma_1^s = 2100$ kg/cm^2 and $\sigma_2^s = -1400$ kg/cm^2 (a) for a resin based coating with $E_c = 1{\cdot}40 \times 10$ kg/cm^2 and $\nu_0 = 0{\cdot}42$ and (b) for a ceramic based coating with $E_c = 70 \times 10^4$ kg/cm^2 and $\nu_c = 0{\cdot}25$. If the threshold strain is 500 μcm/cm, what is the corresponding state of stress in the coating during calibration ? *10*

5. A strain gauge has gauge length of 10 mm and is looped around to a radius of 0·2 mm. Calculate its cross-sensitivity factor. If this gauge is to be used on steel in a strain field for which $\varepsilon_{yy} / \varepsilon_{xx} = 0{\cdot}3$, calculate corrected gauge factor if prescribed gauge factor is 2·1. What will be the gauge factor, if $\varepsilon_{yy} / \varepsilon_{xx} = 0{\cdot}8$? *10*

6. A delta rosette yields the following strain indication :

$$\varepsilon_a = -845 \text{ μcm/cm}; \quad \varepsilon_{ab} = 1220 \text{ μcm/cm}$$

$$\varepsilon_c = 710 \text{ μcm/cm}$$

Determine the maximum principal strain direction, the principal stresses and the maximum shear stress.

$$E = 2 \times 10^6 \text{ kg/cm}^2, \nu = 0{\cdot}285$$ *10*

7. (a) Describe the basic elements of a plane polariscope.

(b) Derive an expression for the intensity of the emergent light from a plane polariscope with a stressed model and show how it enables us to determine the isoclinic and the isochromatic. *10*

8. A photo-elastic coating CR-39 having material fringe value 17·2 kg/cm^2/cm per fringe, thickness h_0 = 2 mm, ν_0 = 3·5 and modulus of elasticity $E_0 = 2 \times 10^4$ kg/cm^2 is used to measure stresses on aluminum for which $E_s = 0{\cdot}7 \times 10^6$ kg/cm^2, ν_s = 0·32. At a point of interest the normal incidence gave the fringe order to be 4·25 and an isoclinic of 30° passed through that point. Oblique incidence measurement by a rotation about the maximum principal stress axis by 15° gave the fringe order to be 4·05. Determine the principal stresses at this point. *10*

9. Given a fringe order of 5, a model thickness of 6·25 mm, a fringe value of 16 kg/cm^2/cm per fringe and an isoclinic parameter of 25° defining the angle between σ_1 and x-axis, determine the shear stress τ_{xy}. *10*

10. Explain the Tardy's compensation method in detail. Why is this method preferred over other methods ? *10*
