No. of Printed Pages : 4

BIMEE-005

B.Tech. MECHANICAL ENGINEERING (BTMEVI)

00211

Term-End Examination

December, 2013

BIMEE-005 : EXPERIMENTAL STRESS ANALYSIS

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt **any five** questions, including question **No-1**, which is **compulsory.** Assume missing data suitably; if any. The symbols and notations have their usual meaning.*

1. (a) Discuss the need of compatibility equations. **2x7=14**

(b) Describe the Grid-method of strain Analysis in brief.

(c) Define the following :

(i) Strain gauge sensitivity,

(ii) Cross sensitivity

(d) Illustrate the Mohr's circle for the general state of stress.

(e) Describe the working of wave plates in brief.

(f) Sketch Delta- Rosette, arrangement of strain gauges.

(g) Write the equations of generalized Hook's Law.

2. (a) What are the stress invariants ? explain. 4

(b) State of stress at a point is shown in figure-1 Determine principal stresses, orientation of principal planes, and maximum shear stress. show the answers with the help of sketch. 10

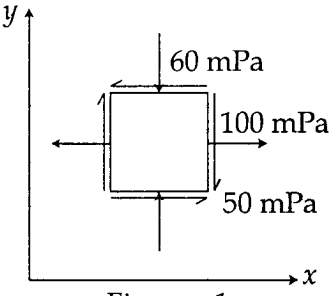

Figure - 1

OR

(a) Derive the relations for strain and displacement 4

(b) The state of strain at a point is given by the strain tensor Σ_{ij}. If the axes are rotated about y-axis so that $\alpha = \cos^{-1} 0.6$ and $\beta = \cos^{-1} 1.0$, find the strain invariants and all components of E'_{ij} with respect to rotated axes. 10

$$\Sigma_{ij} = \begin{bmatrix} 0.01 & -0.02 & 0 \\ -0.02 & 0.03 & -0.01 \\ 0 & -0.01 & 0 \end{bmatrix}$$

3. (a) What are the ideal requirements of strain gauges ? 4

(b) Show that the maximum value of principal stress σ_1^s required to crack the coating in a direct loading test (when $\sigma_2^s = 0$) is given 10

by $\sigma_0^d = \frac{E_s\left(1-\mu_c^2\right)}{E_c\left(1-\mu_c\mu_s\right)}\left(\sigma_4 - \sigma_R\right)$.

The symbols have their usual meaning. Derive also a relationship between threshold strain Σ_1^{Al} and the minimum value of σ_0^d.

4. (a) Derive the expressions for strain sensitivity and cross sensitivity of an electrical strain gauge. 6

(b) A rectangular rosette is mounted at a point on the surface of a steel plate. With respect to the x-axis the following strains are obtained : 8

$\Sigma_A = -500\mu\Sigma$, $\Sigma_B = 400\mu\Sigma$, $\Sigma_C = -100\mu\Sigma$.

Calculate the principal stresses in the system. Given $E_{steel} = 200$ GPa and $\mu = 0.3$.

5. (a) Describe the working of a wheat stone Bridge circuit and potentiometric circuit for the measurement of strain. 8

(b) A cantilever 20mm wide and 10mm deep in cross section carries two strain gauges on top and bottom at a distance of 500mm from the free end. The beam is loaded by a point load of 500 N at the free end. The two gauges are identical with following 6

characteristics:- ig = 200mA, Rg = 120 Ω and $G_F = 2.1$. calculate the potentiometer output and sensitivity of the circuit :

(i) When both gauges are used and

(ii) When only one gauge is used with a dummy gauge mounted on a similar material but not loaded. Modulus of elasticity for beam material

E = 210 GPa.

6. (a) Derive the relation for stress-optic law in terms of relative retardation. 6

(b) The material fringe constant for a certain photo elastic model is 18 kN/m when calibrated with sodium light of wave length $\lambda = 589.3$ nm. The model under investigation has a thickness of 6 mm. If the model is observed with mercury light ($\lambda = 548.1$ nm) and difference in principal stress $(\sigma_1 - \sigma_2) = 18$ kPa, what fringe order will be observed. 8

7. (a) Describe the features of "Isochromatic" and "Isoclinic" fringe patterns. 5

(b) Describe the 'shear difference' technique to seperate the principal stress in case of stress analysis using photo elasticity method. 5

(c) List the photo elastic materials with their specific features. 4