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**BIMEE-005**

00870

# B.Tech. MECHANICAL ENGINEERING (BTMEVI)

## Term-End Examination

## June, 2013

## BIMEE-005 : EXPERIMENTAL STRESS ANALYSIS

*Time : 3 hours* *Maximum Marks : 70*

***Note :*** *Answer **any seven** questions. Each question carry **equal** marks. Use of scientific calculator is **permitted.***

**1.** The fringe order observed at a point in a stressed model is 3.45 with mercury light ($\lambda = 548.1$ nm). The material fringe constant in tension is 20 kN/m. If the model has a thickness of 0.6 cm, calculate the maximum shear stress at the point. **10**

**2.** The material fringe constant in tension for a certain photoelastic model is 18 kN/m when calibrated with sodium light ($\lambda = 589.3$ nm). **10**

The model under investigation has a thickness of 6 mm. If the model is observed with mercury light ($\lambda = 548.1$ nm) and the stress $\sigma_1 - \sigma_2$ at a point is 18 kPa, what fringe order will be observed ? Assume that C is independent of $\lambda$.

3. What is optical strain gauge ? Explain any one optical strain gauge with the help of a neat diagram. **10**

4. Define gauge sensitivity and gauge factor. Prove that **10**

$$F_A = \frac{d\,R/R}{\epsilon_a} = (1+2\gamma) + C\,(1-2\gamma).$$

Where
- $C$ = Bridgeman constant
- $\gamma$ = Poisson's ratio
- $R$ = resistance of wire
- $\epsilon_a$ = axial strain in the wire
- $F_A$ = Strain sensitivity of metal

5. Four 600 Ω strain gauges are connected to form a wheat stone bridge as shown in figure 1. **10**

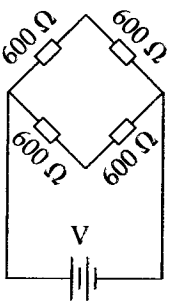


Figure - 1

Each gauge has a grid area of 50 $mm^2$. Calculate the permissible gauge current $I_g$, voltage V and bridge sensitivity in the following cases :

(a) Power density $P_d = 0.008\ W/mm^2$.

(b) $P_d = 0.001\ W/mm^2$,

(c) $P_d = 0.0004\ W/mm^2$

(d) $P_d = 0.00004\ W/mm^2$

Comment on the results obtained.

6. The state of stress at a particular point relative to the $xyz$ coordinate system is given by the following stress matrix : **10**

$$\begin{bmatrix} 15 & 10 & -10 \\ 10 & 10 & 0 \\ -10 & 0 & 40 \end{bmatrix} \text{ MPa.}$$

Determine the normal stress and the magnitude and direction of the shear stress on a surface intersecting the point and parallel to the plane given by the equation :

$2x - y + 3z = 9$.

7. At a point P in a body, $\sigma_x = 100$ MPa, **10**

$\sigma_y = -50$ MPa, $\sigma_z = -50$ MPa,

$\tau_{xy} = \tau_{yz} = \tau_{zx} = 100$ MPa.

Determine the normal and shearing stresses on a plane that is equally inclined to all the three axes.

8. An elastic body under the action of external forces has a displacement field given by : **10**

$$u = (x^2 + y)\,\hat{i} + (3 + z)\,\hat{j} + (x^2 + 2y)\,\hat{k}.$$

Determine the principal strains at (3, 1, $-2$) and the direction of the minimum principal strain.

9. Compute Lame's coefficients $\lambda$ and G for concrete with $E = 28 \times 10^6$ kPa, and $\gamma = 0.2$, where E = Young's modulus, and $\gamma$ = Poisson's ratio. **10**

10. If $\epsilon_{xx} = 0.001$, $\epsilon_y = -0.003$, $\epsilon_{zz} = 0$, $\gamma_{xy} = 0$, $\gamma_{yz} = 0.0003$, and $\gamma_{xz} = -0.002$, **10**

Determine the rectangular stress components, symbols carry usual meaning.

Assume $E = 207 \times 10^6$ kPa,

and $G = 80 \times 10^6$ kPa.