

**Diploma in Civil Engineering / Diploma  
in Electrical & Mechanical Engineering**

**Term-End Examination**

**June, 2008**

**BET-022 : STRENGTH OF MATERIALS**

*Time : 2 hours*

*Maximum Marks : 70*

**Note :** Question no. 1 is *compulsory*. Attempt any *four* questions from the remaining. Assume suitable data wherever necessary and mention it clearly. Use of calculator is allowed.

1. Choose the correct alternative.

7×2

(a) Bulk modulus (K) is equal to

- (i)  $E/3(1 - 2\nu)$
- (ii)  $E/3(1 + 2\nu^2)$
- (iii)  $E/3(1 + 2\nu)$
- (iv)  $E/3(1 - 2\nu^2)$

(b) If two principal stresses at a point are  $\sigma_1$  and  $\sigma_2$ , the maximum shear stress at that point is

(i)  $(\sigma_1 + \sigma_2)/2$

(ii)  $(\sigma_1 - \sigma_2)/2$

(iii)  $(\sigma_1 + \sigma_2)$

(iv)  $2(\sigma_1 - \sigma_2)$

(c) The maximum bending moment in a cantilever carrying a concentrated load at the free end occurs

(i) below the load

(ii) at mid-span

(iii) at the fixed-end

(iv) near the load

(d) Which is the correct bending formula ?

(i)  $\frac{M}{\sigma} = \frac{y}{I} = \frac{R}{E}$

(ii)  $\frac{M}{I} = \frac{y}{\sigma} = \frac{E}{R}$

(iii)  $\frac{M}{E} = \frac{I}{R} = \frac{\sigma}{y}$

(iv)  $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$

(e) The maximum deflection of a simply supported beam of span  $l$  carrying a u.d.l. of intensity  $w$  per unit length is

(i)  $\frac{5}{384} \frac{w l^4}{EI}$

(ii)  $\frac{5}{324} \frac{w l^4}{EI}$

(iii)  $\frac{w l^4}{38 EI}$

(iv)  $\frac{w l^3}{48 EI}$

(f) Torsional rigidity of a shaft is given by

(i)  $T/J$

(ii)  $T/\theta$

(iii)  $T/r$

(iv)  $T/G$

(g) A column of length ( $l$ ) is fixed at one end and free at the other end. Its equivalent length will be

(i)  $2l$

(ii)  $l/2$

(iii)  $l/\sqrt{2}$

(iv)  $l$

2. (a) Define the following :

4

(i) Modulus of elasticity

(ii) Elastic limit

(iii) Factor of safety

(iv) Poisson's ratio

- (b) A steel rod, circular in cross-section, tapers from 25 mm diameter to 12.5 mm diameter in a length of 500 mm. Find how much of this length will increase under a pull of 25 kN if  $E = 2.1 \times 10^5 \text{ N/mm}^2$ . 10

3. A rectangular block of material is subjected to a tensile stress of  $1000 \text{ N/mm}^2$  on a plane and a tensile stress of  $400 \text{ N/mm}^2$  on the plane at right angles to the former, together with shear stress of  $600 \text{ N/mm}^2$  on the same planes as shown in figure 1.

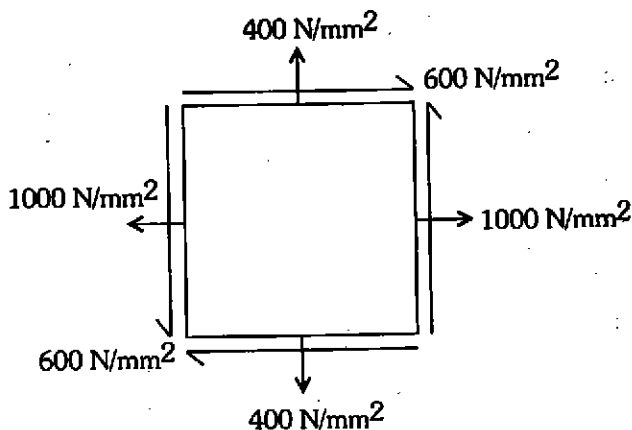


Figure 1

Find

- (i) Magnitude of principal stresses
- (ii) Magnitude of maximum shear-stress
- (iii) The direction of principal planes

14

4. Draw the Shear Force and Bending Moment diagram for a simply supported beam of span  $l$  carrying a point load  $W$  at a distance 'a' from the left end as shown in figure 2. Also determine the value of maximum bending moment. 14

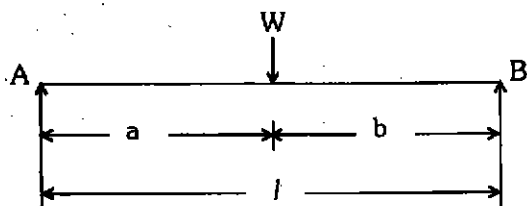


Figure 2

5. (a) Explain the following : 2x2
- Neutral axis
  - Moment of resistance
- (b) Starting from the basic principles, show that the value of maximum shear stress and average shear stress for a rectangular section can be expressed as

$$\tau_{\max} = 1.5 \tau_{\text{av}} \quad 10$$

6. Determine the slope and deflection of a cantilever beam of span  $l$  carrying a uniformly distributed load of  $w$  per unit length over the entire span as shown in figure 3. 14

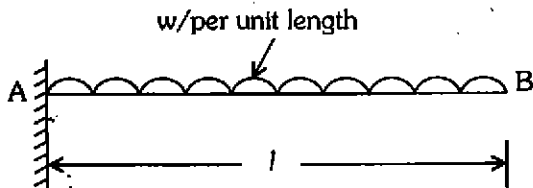


Figure 3

7. A solid aluminium shaft 1000 mm long and of 50 mm diameter is to be replaced by a tubular steel shaft of the same length and the same outside diameter, so that either shaft could carry the same torque and have the same angle of twist over the total length. What must be the inner diameter of the tubular steel shaft ? 14

Modulus of rigidity of steel may be taken as  $8.5 \times 10^4 \text{ N/mm}^2$  and that of aluminium as  $2.8 \times 10^4 \text{ N/mm}^2$ .

8. (a) Briefly discuss the buckling phenomenon and buckling load in a column. 4
- (b) Using Euler's theory, compare the buckling strength of two long columns of the same length, material and weight, one of solid circular section 20 mm in diameter, the other of solid square section. Both columns are hinged at both the ends. 10