B.E. (Mechanical Engineering) Fourth Semester (C.B.S.)

Mechanics of Materials

P. Pages : 4 **NIR/KW/18/3372**

Time : Three Hours Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Assume suitable data whenever necessary.
9. Illustrate your answers whenever necessary with the help of neat sketches.
10. Use of non programmable calculator is permitted.
11. Design data book is permitted.

1. a) Define Elastic constants(E), modulus of rigidity(G), & Poisson Ratio. **6**

b) A steel bar 600mm^2 cross-sectional area is carrying loads as shown in fig. 1(b). Determine the total elongation of the bar. Take E = 210 GPa. **7**

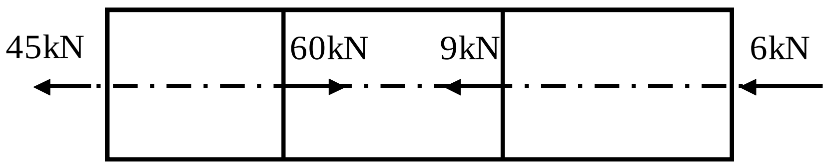

Fig. 1(b)

OR

2. a) A steel rod of 20mm diameter Passes centrally through a copper tube 40mm external diameter and 30mm internal diameter. The tube is closed at each end by rigid plates of negligible thickness and nuts are tightened. If the temperature of assembly is raised by 60ºC. Calculate stresses developed in copper and steel. **7**

$E_{st} = 200\,\text{GPa},\ E_{cu} = 100\text{GPa},\ \alpha_{st} = 12\times10^{-6}\text{per}^{\circ}\text{C}$

$\alpha_{cu} = 18\times10^{-6}\text{per}^{\circ}\text{C}.$

b) A steel cube block of SAE 1030 material of 60mm side is subjected to force of 10kN [Tension]; 6kN [Compression]; and 7 kN [Tension] along x, y and z directions respectively. Determine change in volume of the block. **6**

3. A simply supported beam having an over hang at one side is shown in figure [3]. Draw shear force and Bending Moment diagram for the beam. **14**

Find the maximum BM and point of contraflexure if any

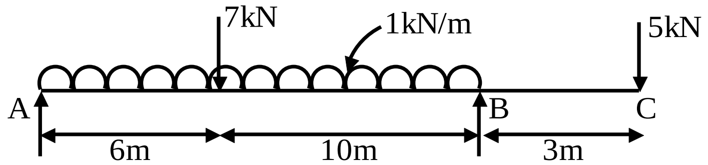

Figure 3

OR

4. a) Prove the relation: **7**

$$\frac{M}{I} = \frac{\sigma_b}{y} = \frac{E}{R}$$

Where:

M = Bending movement

I = Moment of Inertia

σ_b = Bending stress at distance 'y' from neutral axis.

E = Young's modulus of Elasticity

R = Radius of curvature.

b) A Rectangular section 40mm x 100mm is used as cantilever of span 0.82 meter. A point load 'W' kN is acting at free end. If bending about x-x axis. Determine the maximum value of 'W'. when permissible bending stress is 160MPa. What would be bending stress at end? **7**

5. A beam PQRS shown in figure '5' PQ=QR=1m, RS=2m is supported at P and S. It carries concentrated load of 20kN at Q and U.D.L. of 10kN/m on span RS. Determine deflection of the beam at Q and R. Also find slope at the centre of the beam. Take E = 200GPa $I = 20 \times 10^{-6} m^4$. **13**

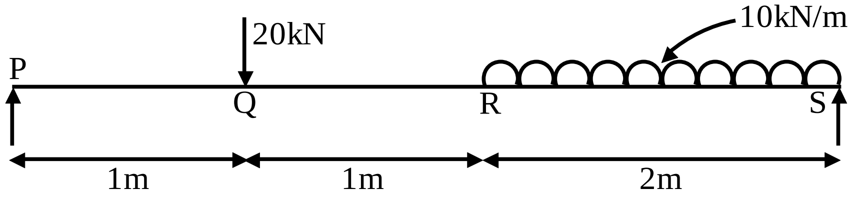

Figure. 5

OR

6. a) What do you mean by Principal planes & principal stresses. **4**

b) At a point within a body subjected to two mutually perpendicular directions the stresses are $80 N/mm^2$ and $40 N/mm^2$ tensile. Each of the above stresses is accompanied by a shear stress of 60 N/mm^2. Determine the normal stress, shear stress and resultant stress on an oblique plane inclined at an angle of 45° with the axis of minor tensile stress. Also justify your answers by Mohr's circle. **9**

7. a) If a shaft of diameter 'D' is subjected to bending moment 'M' and twisting moment 'T' simultaneously, then show that the maximum shear stress induced in a shaft is given by **6**

$$\tau_{max} = \frac{16}{\pi D^3}\sqrt{M^2 + T^2}$$

b) A solid shaft SAE 1030, has to transmit 375kW at 210 rpm. The angle of twist should not be greater than 1° in a length of 3 meters. Find suitable diameter of shaft. Check shaft for safety on the basis of strength, assume design strength of material equal to 30% of yield point shear stress. **7**

OR

8. a) Explain slenderness ratio. To what slenderness ratio Eulers formula for mild steel column is applicable. Justify your answer. **5**

b) Find the Eulers crippling load for a hollow cylindrical steel column of 38mm external diameter and 2.5mm thick. Take length of the column as 2.3m and hinged at its both ends. Take $E = 200\,GN/m^2$. Also determine the crippling load by Rankine's formula using constants as 335 MPa and 1/7500. **8**

9. a) Prove that strain energy stored in a body due to shear stress is given by: **4**

$$U = \frac{\tau}{2C} \times \text{Volume}$$

U = Strain Energy
C = Modulus of rigidity
τ = Shear Stress

b) A solid vertical steel bar of equilateral triangular section of side 20mm is firmly fixed at the top. A rigid collar is attached at the lower end at distance of 600mm from the top. Calculate the strain energy stored in each of following cases. **9**

i) When Pull of 10kN is applied gradually.
ii) When force 8kN is suddenly applied.
iii) When a weight of 4kN falls through 120mm before it strikes the collar.
E = 200GPa.

OR

10. a) What is creep? Explain in brief how fracture occurs due to creep with the help of creep curve. **6**

b) A cantilever of span L carries a concentrated load 'P' at the free end. Find the deflection under loading. **7**

11. a) What do you mean by stress concentration? Give the methods for reducing stress concentration. **4**

b) A machine component is subjected to flexural stress which fluctuates between $+100\,N/mm^2$ to $-50N/mm^2$. Determine the value of minimum ultimate strength according to : **10**

i) Gerber Criteria.

ii) Modified Goodman criteria

iii) Soderberg criteria.

Take

$\sigma_{yt} = 0.55\sigma_{ut}$

$S_{eb} = 0.5\sigma_{ut}$

Factor of safety = 2

OR

12. A cantilever made of SAE 1030 is 250mm long. It is subjected to an axial load which varies from 150N (C) to 450N(T) and also carries a transverse load at its free end which varies from 100N up to 150N down. The cantilever is of circular cross section with diameter 'd' as shown in fig(12). Determine the diameter of cantilever taking factor of safety two. Assume following value. **14**

Material of beam = SAE 1030

Size effect factor = 0.85

Surface finish factor = 0.90

Notch sensitivity factor = 0.90

Stress concentration factor = 1.44 (bending)

Stress concentration factor = 1.64 (for axial loading)

A = 0.7 (for axial loading)

A = 1 (for bending load)

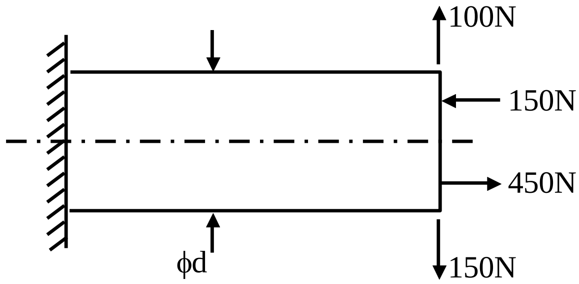

Figure 12

****