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

Mechanics of Materials Paper – V

P. Pages : 4 **KNT/KW/16/7287**

Time : Three Hours * 0 1 5 1 * 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. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.
12. Use of Design data book is permitted.

1. a) Explain with neat sketch the stress strain curve for a ductile material. **5**

b) Find the change in length of the bar ABCD subjected to axial forces as shown in fig 1 (b). Take E = 200 GPa. **8**

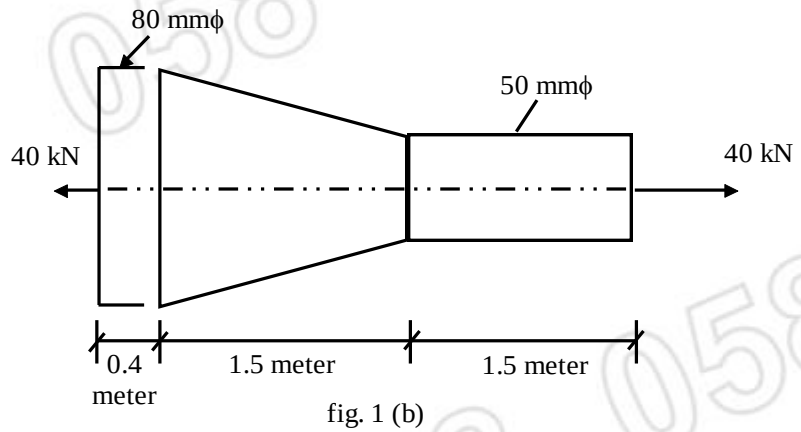

fig. 1 (b)

2. a) A steel rod of 20 mm diameter passes centrally through a copper tube of 50 mm external diameter and 40 mm internal diameter. The tube is closed at each end by rigid plate of negligible thickness. The nuts are tightened lightly home on the projecting parts of rod. If the temperature of assembly is raised by 65ºC, Calculate the stresses developed in copper and steel. **8**

Take : $E_{steel} = 200\,GPa \quad E_{copper} = 100\,GPa$

$\alpha_{steel} = 12 \times 10^{-6}/^{o}C \quad \alpha_{copper} = 18 \times 10^{-6}/^{o}C$

b) A steel bar of square cross-section 40mm x 40mm, 600 mm long is observed to stretch 0.225 mm under a pull of 120kN. The same bar in single shear test under a force of 125kN shows the distorsion of original right angle corners by 0.00125 radians. Determine the values of the four elastic constants (E, G, K, 1/m). of the material. **5**

3. Draw the shear force and Bending moment diagram for the beam shown in fig. (3). Also find the point of contraflexure if any. **14**

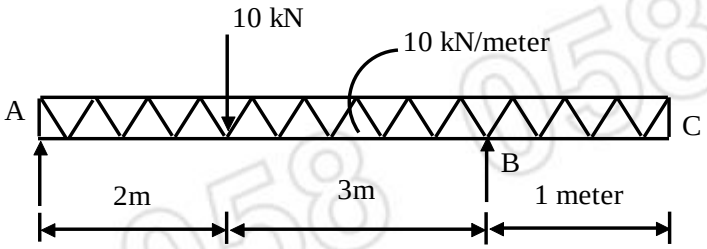

fig. 3

4. a) The chassis of an automobile is made of square hollow (mild steel) pipe. The load on chassis is shown in figure (4a). Find the cross-section of hollow square pipe if permissible bending stress is 100 MPa for the maximum bending moment. **10**

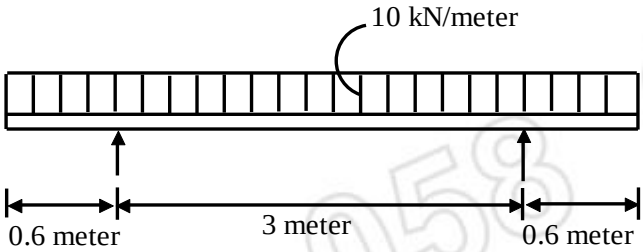

fig. 4(a)

b) Prove that the maximum shear stress over a rectangular section is $\frac{3}{2}$ time the average shear stress : **4**

$$\tau_{max} = \frac{3}{2}\tau_{average}.$$

5. A I-section shown in fig. 5(i) is loaded as shown in fig. 5 (ii). Using Macaulay's method, Calculate the slope at 'D' and defection at 'C'.
Take E = 200 GPa. **13**

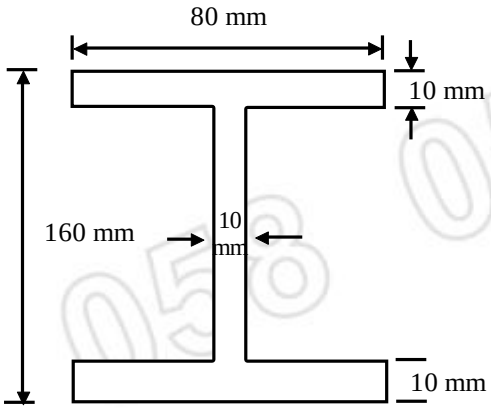

fig. 5 (i)

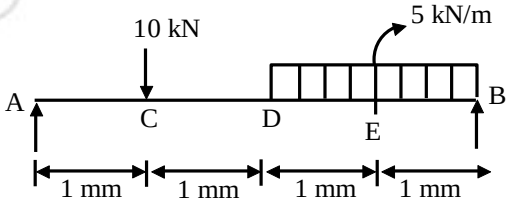

fig. 5 (ii)

6. a) Determine Analytically the principal stresses and location of principal planes and maximum shear stress for an element shown in fig. (6). Check the answer by using Mohr's circle method. **8**

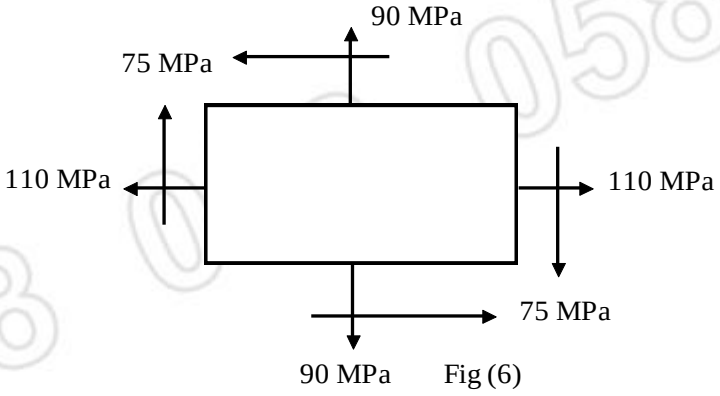

Fig (6)

b) Derive the differential equation of the deflection curve. **5**

$$EI\frac{d^2y}{dx^2} = M$$

7. a) A hollow steel shaft 3m long transmits a torque of 24kN.m. The total angle of twist is not to exceed 2.5º and the allowable shear stress is 90 MPa. Determine the inside and outside diameter of shaft. G = 85 GPa. **7**

b) Define Polar modulus (Zp). And derive the polar modulus values for solid circular bar and hollow circular section. **6**

8. a) A pin jointed strut is 2.5 meter long. It is tubular having inner diameter 30mm and outer diameter 40mm. Calculate crippling load by Rankine's theory. Assume crushing load 330 MPa and Rankines constant $a = \frac{1}{7500}$. **8**

b) What is equivalent length of a column? Enlist the equivalent length and the corresponding crippling loads for the various end conditions. **5**

9. a) A vertical steel bar 55 mm in diameter and 3 meter long has to transmit shock energy of 100 Joule. Calculate the maximum instantaneous stress induced and the maximum elongation? Take E = 200 GPa. **8**

b) Prove that the strain energy stored in a body due to shear stress is given by **5**

$$U = \frac{\tau}{2C}.v$$

$\tau \rightarrow$ shear stress; $C \rightarrow$ modulus of rigidity $v \rightarrow$ volume of the body.

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

b) An unknown weight falls by 30 mm on to a collar rigidly attached to the lower end of a vertical bar 4 meter long and 1000 mm^2 in cross-section. If the maximum instantaneous extension is found to 3.75mm, find the corresponding stress and the value of unknown weight. Take E = 200 GPa. **7**

11. a) Define and draw stress-time curve for fluctuating stress; repeated stress and reversed stress. **6**

b) A shaft shown in fig. 11 (b) is subjected to bending load of 4kN, pure torque of 1250 N.m and an axial pulling force of 18kN. Calculate the stresses at points P and Q. **8**

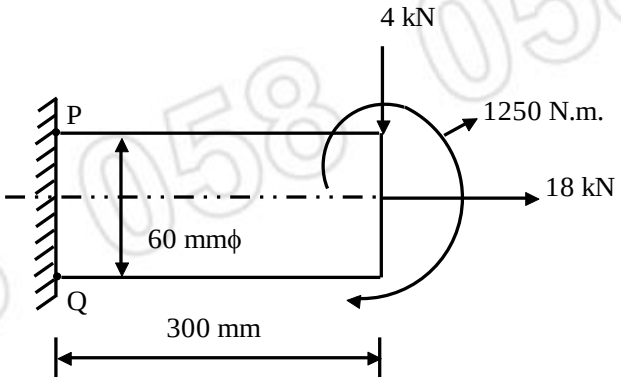

Fig. 11 (b)

12. A shaft made of Annealed SAE 1040 is subjected to a torsional moment that varies from 330 N.m clockwise to 110 N.m. counter clockwise and an applied bending moment at a critical section varies from 440 N.m to -220 N.m. The shaft is of uniform cross-section and no key-way is present at the critical section. Determine the required shaft diameter. Take facter of safety '2'; size factor of 0.85 and a surface finish factor of 0.62. The expected reliability is 95%; temperature factor is 1. **14**

****