B.E. Mechanical Engineering Fourth Semester

ME403 - Mechanics of Material

P. Pages : 4 **GUG/W/18/1581**

Time : Three Hours * 1 2 4 5 * Max. Marks : 80

Notes : 1. All questions carry equal marks.
2. Answer Q.1 OR Q.2, Q.3 OR Q.4, Q.5 OR Q.6, Q.7 OR Q.8, and Q.9 OR Q.10.
3. Assume suitable data wherever necessary.
4. Illustrate your answers wherever necessary with the help of neat sketches.
5. Use of DDB by prof. B. D. Shiwalkar is permitted.

1. a) Differentiate between normal stress and shear stress with suitable examples. **2**

b) The 80 kg block is supported by two rods AB and BC as shown in fig. 1(b). If AB has diameter of 10 mm and BC has diameter of 8 mm, Determine the tensile stresses induced in rod AB and BC. **6**

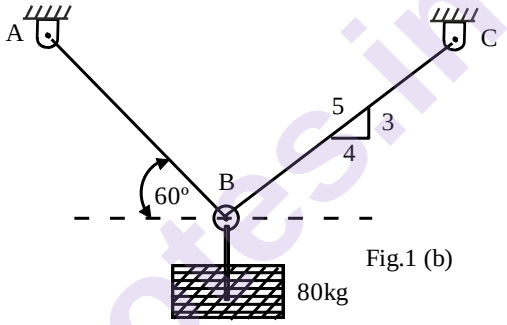


Fig.1 (b)

c) The casting made of steel having specific weight of $80 kN/m^3$. Determine average compressive stress developed at the lowest cross section of member AB fig. 1(c). **4**

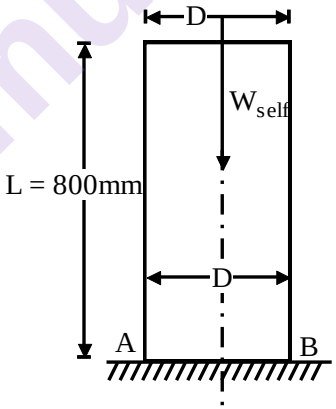
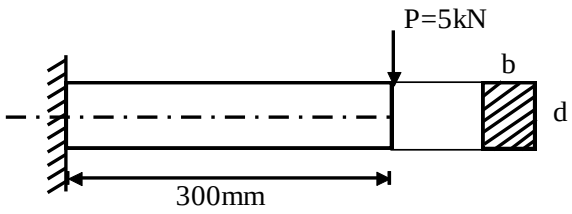


Fig. 1 (c)

The casting has circular c/s of diameter D = 400mm and Length 800mm
W_{self} = Self weight

d) Determine the maximum Bending stress induced in a cantilever beam. Shown in fig. 1(d) **4**



Assume that the beam is having rectangular c/s with b = 150mm and d = 300mm

OR

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2. a) The joint is fastened together using two bolts. Determine the required diameter (d) of the bolts if the allowable shear stress for bolts $\tau_{allowable}$ =110MPa. Assume each bolt supports an equal portion of a load (Fig. 2 (a)) **4**

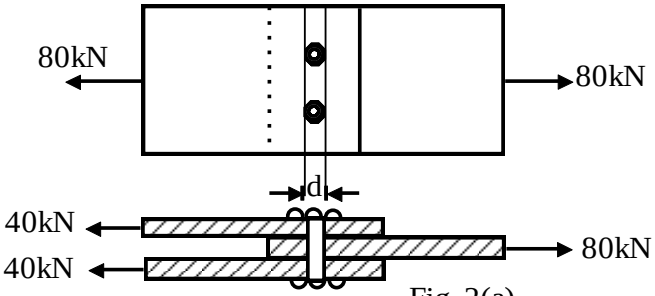

Fig. 2(a)

b) A lever is attached to the shaft A using a key that has width 'd' and length of 25mm. If the shaft is fixed and vertical force of 200N is applied perpendicular to the handle, determine the width 'd' of a key, if the allowable shear stress for key is $\tau_{allow} = 35MPa$ (see fig. 2 (b)). Diameter of shaft is 40mm. Determine also shearing force (F_S) **6**

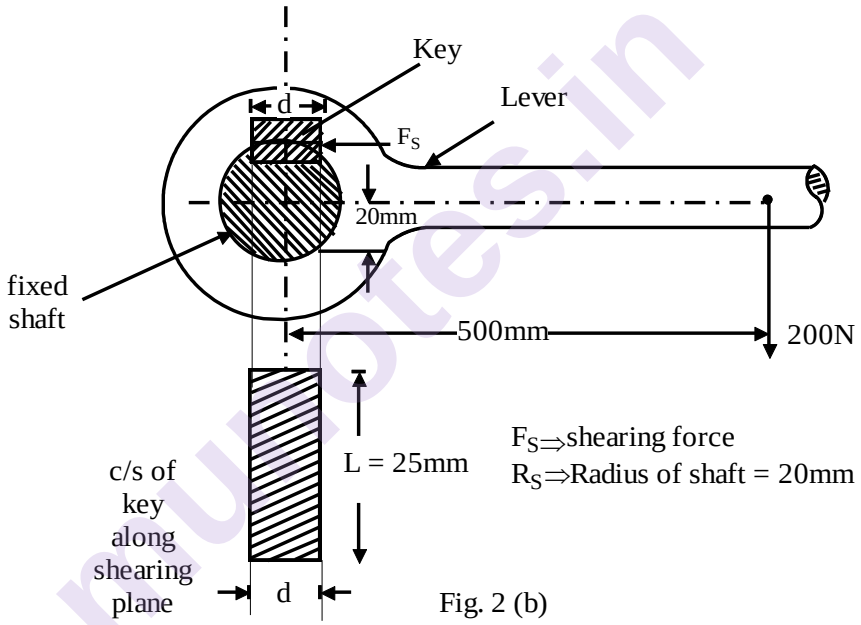

Fig. 2 (b)

c) Explain how the thermal stress is induced in a component? **2**

d) A steel bar having square c/s (10mm x 10mm) is constrained to just fit between two rigid supports when T_1 = 30ºC. If the temperature is raised to T_2 = 60ºC, determine the thermal stress developed in the bar. Fig. 2(d). **4**

Assume $\alpha = 12 \times 10^{-6}/ºC$, E = 200 GPa and Length of bar L = 1m.

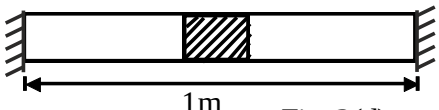

Fig. 2(d)

3. a) While designing a machine component, the allowable stress (le-Design stress) is always kept lower than the ultimate strength of the material of a component. Explain why? **3**

b) Explain 'stress concentration effect' in a machine component. **3**

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c) The state of stress at a point in a m/c component is as shown in fig. 3(c). Determine the principal stresses, maximum shear stress and the position (inclination) of principal planes by i) Analytical method ii) By Mohr circle method **10**

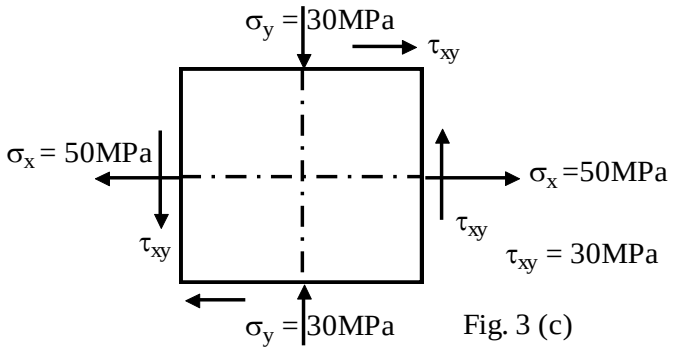

Fig. 3 (c)

OR

4. An overhung Beam ABCDE having total span of 7m is supported at A and D. It has overhung DE = 2.5m. AB = BC = CD = 1.5m. It carries the loads as shown in figure (4) **16**

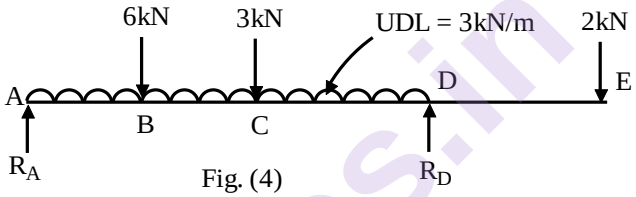

Fig. (4)

Draw shear force and Bending moment diagram for the beam and Determine Maximum Bending Moment and point of contraflexure if any

5. a) A cantilever beam of span 'L' is subjected to UDL of intensity 'w' N/m. over its entire span. Show that the Maximum deflection at it's free end is given by equation. **8**

$$y_{max} = \frac{wL^4}{8EI}$$

b) A simply supported beam as shown in fig. 5(b), carries the point loads at C and D. Determine the deflection of beam at points C and D. **8**

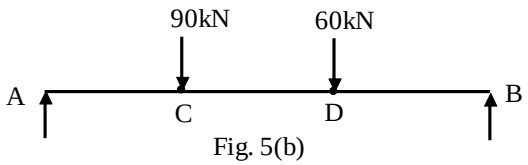

Fig. 5(b)

Take AC = 3m, CD = 6.5m and DB = 4.5m $I = 64 \times 10^{-4} m^4$ and $E = 210 \times 10^6 kN/m^2$

OR

6. A beam AB of 4m span is simply supported at its ends and loaded as shown in fig. (6) **16**

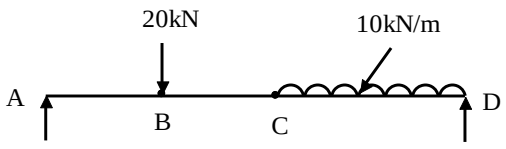

Fig. 6

Take AB = 1m, BC = 1m and CD = 2m, $E = 200 \times 10^6 kN/m^2$ and $I = 20 \times 10^{-6} m^4$
Determine deflections at B and C and Max^m deflection.

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7. a) Define Torsional shear stress and show that the torsional shear stress (τ_{xy}) induced in a shaft of diameter 'D', when it is subjected to torque 'T' is given by equation. **6**

$$\tau_{xy} = \frac{16T}{\pi D^3}$$

Also sketch the variation of τ_{xy} across, the c/s of shaft w. r. t. radius of shaft.

b) A solid circular shaft of diameter 'D' transmits 75kW power at 200 rpm. Calculate the shaft diameter, if the angle of twist is not to exceed 1º in 2m length of shaft and torsional shear stress is limited to 50 MPa. Take modulus of rigidity for shaft material (G) = 100 GPa. Use strength and Rigidity criterion to find 'D'. **10**

OR

8. a) A solid circular shaft of diameter 'D' is subjected torque (T) = 3580 N.m and Bending moment (M) = 2500 N.m, simultaneously. Determine diameter of shaft 'D' if the maximum shear stress induced in a shaft is not to exceed 75MPa. **8**

b) Differentiate between ' column' and 'strut' with examples. **2**

c) State and explain the classification of column. **3**

d) Define slenderness ratio, Buckling load and safe load for the column. **3**

9. a) Define the terms **3**

i) Strain energy.
ii) Resilience
iii) Modulus of Resilience

b) If the shaft of diameter 'D' and Right 'L' is subjected to Torque 'T', then show that the strain energy stored during twisting (torsion) U_T is given by expression **13**

$$U_T = \frac{\tau^2}{4G} \times \left(\frac{\pi}{4} D^2 \times L\right)$$

where $\tau \Rightarrow$ Torsional shear stress in MPa

$G \Rightarrow$ Modulus of Rigidity in MPa

$V = \left(\frac{\pi}{4} D^2 \times L\right) \Rightarrow$ volume of shaft

OR

10. Write short notes on **any four.** **16**

a) Principal planes and principal stresses.
b) Factor of safety and its selection.
c) Hertz contact stress.
d) Creep phenomenon.
e) Modes of fracture.

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