SAMSKRUTHI COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi & Affliated to JNTUH)

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Subject Name: MECHANICS OF SOLIDS

Year and Sem: II year – I Sem

DEPARTMENT OF MECHANICAL ENGINEERING

UNIT – I : SIMPLE STRESSES AND STRAINS

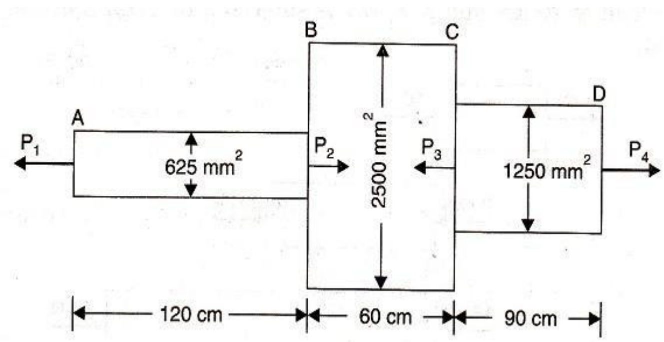
PART:- A (Short Questions)

1. Define
   a. Stress
   b. Shear stress
   c. Bearing stress
2. Explain simple and complementary shear stresses with neat sketches
3. Draw the stress strain diagram for mild steel and identity the significant points
4. Determine the volumetric strain of a rectangular bar of length l, width b and depth d subjected to an axial load P from first principle.
5. The volume of a hollow cylinder of 800.0mm diameter, 1.4m length and 10.0mm thickness increases by 1245.0mm when subjected to an internal pressure of 4.5Mpa. Determine the poisons ratio of the material, if E=190Gpa
6. Define modular ratio, thermal stresses and thermal strains
7. Define the following terms
   a. Resilience
   b. Proof resilience
   c. Modulus of resilience
8. A steel rod is 2m long and 100mm in diameter. An axial pull of 200kN is suddenly applied to the rod. Calculate the instantaneous stress induced and also the instantaneous elongation produced in the rod. Take E = 100GN/m^2.
9. Obtain a relation for the stress induced in a body if a load P is applied with an impact.
10. Give the relationship between Bulk Modulus and Young's Modulus.

PART:- A (Long Questions)

1.
   a. A member ABCD is subjected to point loads P1, P2, P3 and P4 as shown in figure below. Calculate the force P2 necessary for equilibrium, if P1 = 45kN, P2 = 450kN

and P4 = 130kN. Determine the total elongation of the member, assuming the modulus of elasticity to be $2.1x10^5$ N/mm^2.



b. A compound tube consists of a steel tube 140mm internal diameter and 160mm external diameter and an outer brass tube 160mm internal diameter and 180mm external diameter. The two tubes are of the same length. The compound tube carries an axial load of 900kN. Find the stresses and the load carried by each tube and the amount it shortens. Length of each tube is 140mm. Take E for steel as $2x10^5$ N/mm^2 and for brass as $1x10^5$ N/mm^2.

2.

a. A steel rod of 3cm diameter and 5m long is connected to two grips and the rod is maintained at a temperature of 95°C. Determine the stress and pull exerted when the temperature falls to 30°C, if (i) the ends do not yield, and (ii) the ends yield by 0.12cm. Take E = $2x10^5$ MN/m^2 and $\alpha = 12x10^{-6}$/°C.

b. A metallic block 250mm x 80mm x 30mm is subjected to a tensile force of 20kN, 30kN and 15kN along x, y and z directions respectively. Determine the change in volume of the block. Take E= $2x10^5$ N/mm^2 and Poisson's ratio = 0.30.

3.

a. A cast iron hub of 200 mm external diameter and 100 mm thickness is pressed on to a steel shaft of 75 mm diameter. Determine the radial stress required at the interface so that the shaft can transmit 740 MW at 630 rpm. Compute the necessary diametral interference and the stresses in the shaft and the hub. If the shaft is subjected to a compressive force of 180 kN, find the change in the stresses. Assume a frictional coefficient of 0.33, Poisson's ratio of 0.30, and Young's modulii of steel and cast iron to be 210 GPa and 180 GPa, respectively.

b. Write the relations between Modulus of Elasticity and Shear Modulus, Modulus for Elasticity and Bulk Modulus and hence derive the relation among the three elastic constants.

4.

a. A bar of 20mm diameter is tested in tension it is observed that when a lead of 40KN is applied the extension measured over a gauge length of 200mm us 0.12mm&contraction in diameter is 0.0036mm. Find poisson's ratio, young's modulus &bulk modulus & rigidity modulus.
b. The following are the result of a tensile on test on a molested rod is 16 mm gauge length is 50 mm, load at proportionality limit is 48.5 kN. Extension at the proportionally limit is 0.05mm. Load at yield point is 50.3 KN ultimate load is 90KN. Final length between gauge points is 64mm, Diameter of the neck at fracture is 13.7 mm. Determine the young's modules at elastic limit, Yield stress, Ultimate Stress, % of elongation & % of reduction in area.

5.

a. A solid brass cylinder of 20mm diameter is rigidly attached and surrounded by an aluminium tube of internal diameter 20mm and thickness 6mm. if the assembly is stress free at 30 degrees centigrade. Find the stresses in the two materials when the temperature rises to 100 degrees centigrade. For brass, young's modulus of elasticity is 90GPa and coefficient of linear expansion is $20x10^{-6}$ per degrees centigrade. For aluminium, young's modulus of elasticity is 75GPa and coefficient of linear expansion is $23x10^{-6}$ per degree centigrade.
b. A 12.5 m long steel rope supports a mass of 1000.0 Kg. Design the rope comprising 1.6mm strands with a yield stress of 1500.0MPa and young's modulus of 175.0GPa. assume a safe factor of 3.5, the elongation of the rope should not exceed 12.5mm.

6.

a. A steel rod of 30mm diameter is enclosed by a copper tube of 45mm external diameter and internal diameter 35mm. the composite bar of length 300mm is subjected to an axial tensile force of 50kn. Find the stresses in each bar and the load carried by each bar. Adopt E for steel is 210GPa and E for copper is 110Gpa.
b. A steel bar of 30mm diameter was subjected to a tensile load of $12x10^4$N. the extension in a length of 250mm was found to be 12mm. Find the young's modulus and modulus of rigidity and also the reduction in diameter. Assume poisson's ratio as 0.30

7.

a. A steel bar is 900 mm long; its two ends are 40mm and 30 mm in diameter and the length of each rod is 200 mm. The middle portion of the bar is 15 mm in diameter and 500 mm long. If the bar is subjected to an axial tensile load of 15 KN, find its total extension.

   Take $E=200GN/m^2$ (G stand for giga and IG = 10^0).
b. A steel tie rod 50 mm in diameter and 2.5 m long is subjected to a pull of 100 KN. To what length the rod should be bored centrally so that the total extension will increase by 15 per cent under the same pull, the bore being 25 mm diameter? Take E = 200GN / m^2.

8.

a. A 700 mm length of aluminum alloy bar is suspended from the ceiling so as to provide a clearance of 0.3 mm between in and a 250 mm length of steel bar as show in Fig. A_{al}=1250 mm^2, E_{al}= 70 GN/m^2, A_s=2500 mm^2 E_s=210 GN/m^2. Determine the stress in the aluminum and in the steel due to a 300 KN load applied 500 mm from the ceiling.

b. Two parallel steel wires 6 m long, 10 mm diameter are hung vertically 70 mm apart and support a horizontal bar at their lower ends. When a load of 9 KN is attached to one of the wires, it is observed that the bar is 2.4^0 to the horizontal. Find 'E' for wire.

9.

a. A copper sleeve, 21 mm internal and 27 mm external diameter, surround a 20 mm steel bolt, one end of the sleeve being in contact with the shoulder of the bolt. T he sleeve is 60 mm long. After putting a rigid washer on the other end of the sleeve, a nut is screwed on the bolt through 10 degrees. If the pitch of the threads is 2.5 mm, find the stresses induced in the copper sleeve and steel bolt.

b. A steel rod 15 m long is at a temperature of 15^0C. Find the free expansion of the length when the temperature is raised to 65^0C. Find the temperature stress produced when:

(i) The expansion of the rod is prevented;

(ii) The rod is permitted to expand by 6 mm.

Take: $\propto$ = 12 x 10^{-6} per^{0}C, And E =200 GN/m^2.

10.

a. A circular rod 0.2 m long , tapers from 20 mm diameter at one end to 10 mm diameter at the other. On applying an axial pull of 6 KN, it was found to extend by 0.068 mm. find the Young's modulus of the material of the rod.

b. A rigid bar is supported by three rods in the same vertical plane and equidistant. The outer rods are of brass and of length 600 mm and diameter 30 mm. The central rod is of steel of 200 mm length and 37.5 mm diameter. Calculate the forces in the bars due to an applied force P, if the bar remains horizontal after the load has been applied. Take E_s/E_b= 2

UNIT-II:
SHEAR FORCE AND BENDING MOMENT
PART:- A (Short Questions)

1. What do you mean by beam? Explain types of beam
2. Draw shear force and bending moment for a cantilever beam of span 2m carrying a point load 4kN at free end.
3. Define terms
   a. Shear force diameter
   b. Bending moment diagram.
4. Indicate the shape of bending moment diagram for uniform distributed load and varying load.
5. A cantilever beam of length 2m carries a U.d.l of 2kN/m over the whole length and a point load of 3kN at the free end. Draw the S.F and B.M diagrams.
6. A cantilever beam of length 2m carries a U.v.l of 2kN/m over the whole length and a point load of 3kN at the free end. Draw the S.F and B.M diagrams
7. Define point of contraflexure.
8. List any three important points to be kept in mind while drawing SFD and BMD.
9. Draw the SFD, BMD for a cantilever loaded with a clockwise couple of "M" at the free end.
10. Mention the different types of beams and types of supports.

PART:- B (Long Questions)

1.
   a. A cantilever beam of length 4m carries point loads of 1kN, 2kN and 3kN at 1, 2 and 4m from the fixed end. Draw the S.F and B.M diagrams for the cantilever.
   b. A cantilever of length 4m carries a uniformly distributed load of 2kN/m run over the whole span and a point load of 2kN at a distance of 1m from the free end. Draw the S.F and B.M diagrams for the cantilever.
2.
   a. A cantilever of length 6m carries two point loads 2kN And 3kN at a distance of 1m and 6m from fixed end respectively. In addition to this the beam also carries a uniformly distributed load of 1kN/m over a length of 2m at a distance of 3m from the fixed end. Draw the S.F and B.M diagrams for the cantilever.
   b. A cantilever of length 4m carries a uniformly distributed load of 3kN/m run over a length of 1m from the fixed end. Draw the S.F and B.M diagrams for the cantilever.
3.
   a. A cantilever of length 6m carries a gradually varying load, zero at the free end to 2kN/m at the fixed end. Draw the S.F and B.M diagrams for the cantilever.
   b. A simply supported beam of length 8m carries point loads of 4kN and 6kN at a distance of 2m and 4m from the left end. Draw the S.F and B.M diagrams for the beam.

4.

a. A simply supported beam of length 6m is carrying a uniformly distributed load of 2kN/m from the right end. Draw the S.F and B.M diagrams for the beam.
b. A beam of length 10m is simply supported and carries point loads of 5kN each at a distance of 3m and 7m from the left end and also a uniformly distributed load of 1kN/m between the point loads. Draw the S.F and B.M diagrams for the beam.

5.

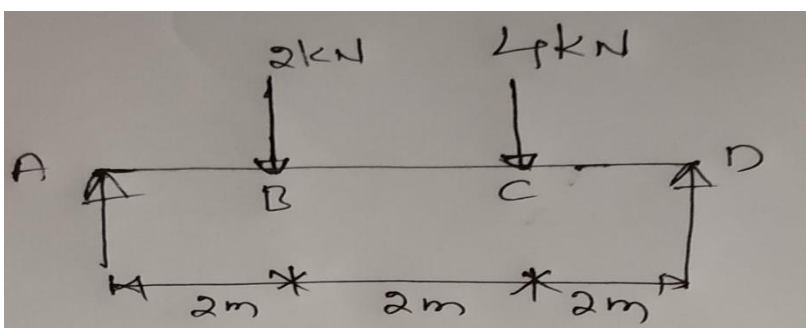
a. A beam of length 6m is simply supported at its ends. It is loaded with gradually varying load of 750N/m from left support to 1500N/m to the right support. Construct the S.F and B.M diagrams and find the position of maximum B.M over the beam.
b. A simply supported beam of length 8m rests on supports 6m apart, the right hand end is overhanging by 2m. The beam carries a uniformly distributed load of 1500N/m over the entire length. Draw S.F and B.M diagrams and find the point of contraflexure, if any.

6.

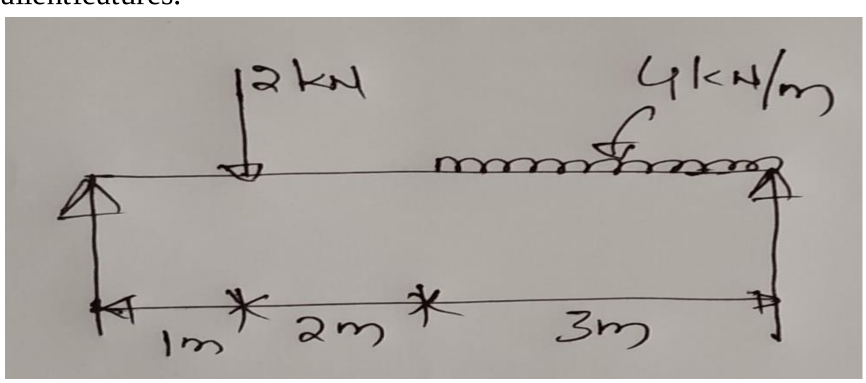
a. A cantilever of length 8m carries a gradually varying load, zero at the free end to 4kN/m at the fixed end. Draw the S.F and B.M diagrams for the cantilever.
b. A simply supported beam of length 6m carries point loads of 4kN and 7kN at a distance of 2m and 4m from the left end. Draw the S.F and B.M diagrams for the beam.

7.

a. Draw the shearing force and bending moment diagrams for the beam in figure and identify salientfeatures.

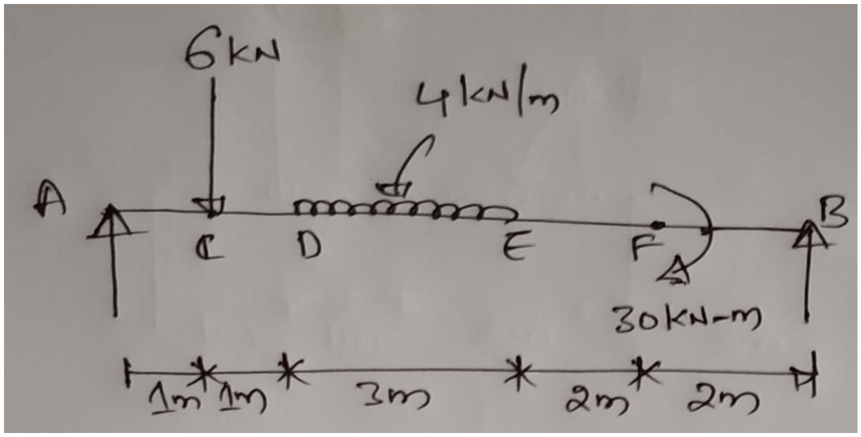


b. Draw the shearing force and bending moment diagrams for the beam in figure and identify salientfeatures.

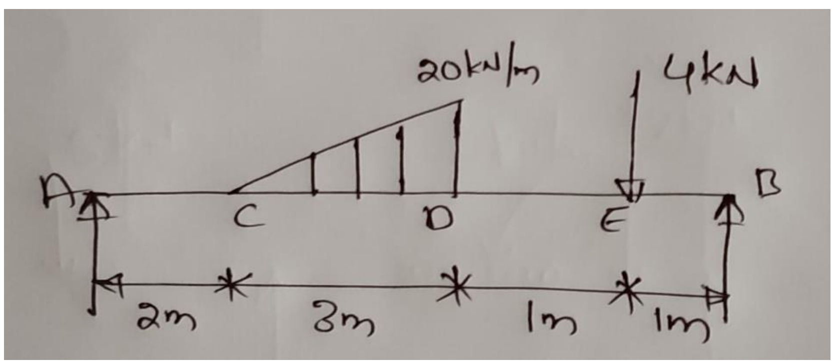


8.

a. Draw the shearing force and bending moment diagrams for the beam in figure and identify salientfeatures.

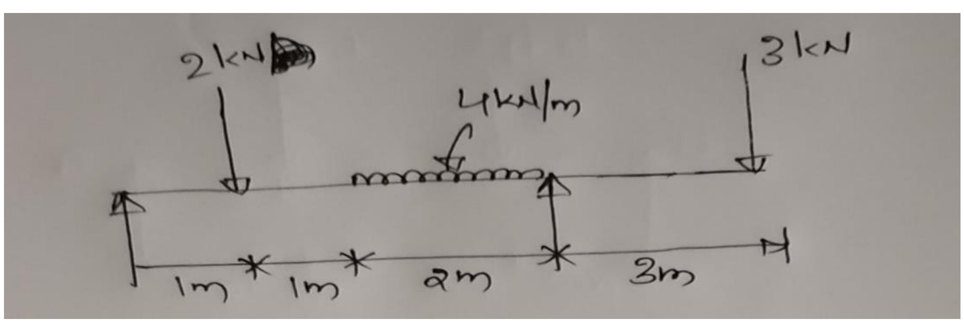


b. Draw the shearing force and bending moment diagrams for the beam in figure and identify salientfeatures.

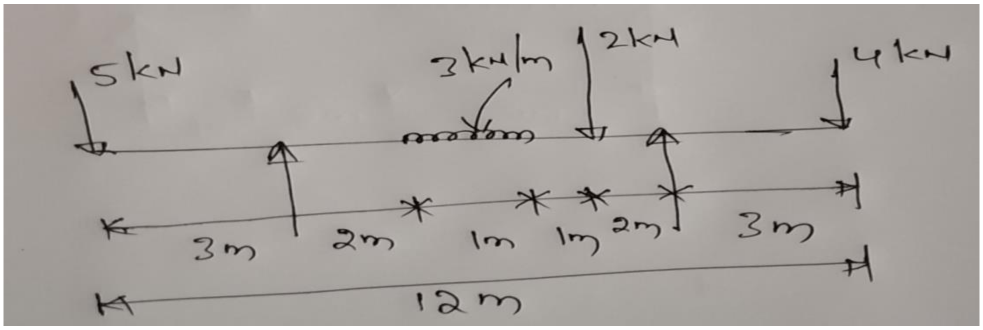


9.

a. Draw the SFD and BMD for a beam supported and located as shown in fig. locate the point of contraflexure.



b. Draw the SFD and BMD for a beam supported and located as shown in fig. locate the point of contraflexure.



10.

a. A cantilever of length 8m carries a gradually varying load, zero at the free end to 4kN/m at the fixed end. Draw the S.F and B.M diagrams for the cantilever.

b. A simply supported beam of length 8m carries point loads of 11kN and 9kN at a distance of 2m and 4m from the left end. Draw the S.F and B.M diagrams for the beam.