# GOVERNMENT POLYTECHNIC JAJPUR

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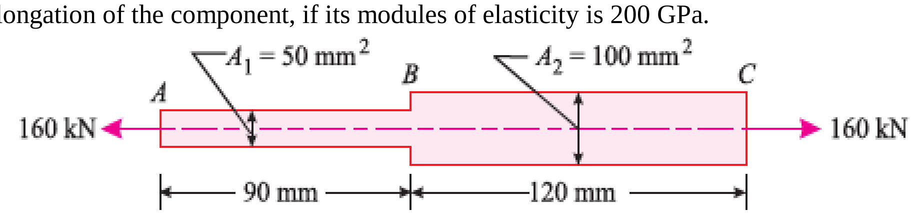
## QUESTION BANK

## STRENGTH OF MATERIAL (TH-2)

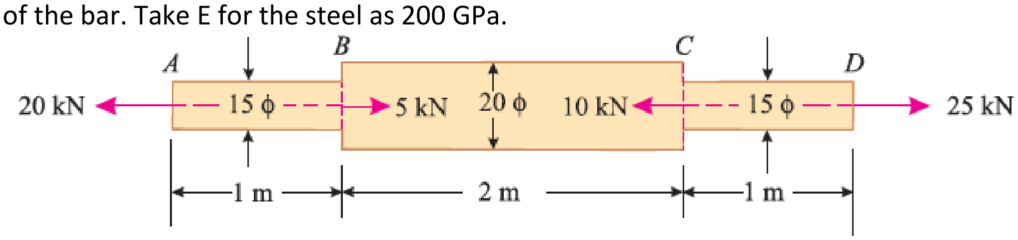
## MODULE 1

## SIMPLE STRESS AND STRAIN

1. SHORT TYPE QUESTIONS (2 MARKS)
   a) Define Hooke's law.
   b) Define poisons ratio.
   c) Define superposition principle.
   d) Define resilience.
   e) What is modulus of rigidity?
   f) Define bulk modulus.
2. BRIEF TYPE QUESTIONS (5 MARKS)
   a) A hollow cylinder 2 m long has an outside diameter of 50 mm and inside diameter of 30 mm. If the cylinder is carrying a load of 25 kN, find the stress in the cylinder. Also find the deformation of the cylinder, if the value of modulus of elasticity for the cylinder material is 100 GPa.
   b) A load of 5 kN is to be raised with the help of a steel wire. Find the minimum diameter of the steel wire, if the stress is not to exceed 100 MPa.
   c) An automobile component shown in Fig is subjected to a tensile load of 160 kN. Determine the total elongation of the component, if its modules of elasticity is 200 GPa.




   d) A steel bar ABCD 4 m long is subjected to forces as shown in Fig. 3.8. Find the elongation of the bar. Take E for the steel as 200 GPa.




   e) A circular bar 2.5 m long tapers uniformly from 25 mm diameter to 12 mm diameter. Determineextension of the rod under a pull of 30 kN. Take E for bar as 200 GPa.
   f) A brass rod 2 m long is fixed at both its ends. If the thermal stress is not to exceed 76.5 MPa, calculate the temperature through which the rod should be heated. Take the values of α and E as 17 × 10–6/K and 90 GPa respectively.
   g) A steel bar, fixed at its both ends, is heated through 15 K. Calculate the stress developed in thebar, if modulus of elasticity and coefficient of linear expansion for the bar material is 200 GPaand 12 × $10^{-6}$/K respectively.

h) An alloy bar 2 m long is held between two supports. Find the stresses developed in the bar,when it is heated through 30 K if both the ends (*i*) do not yield; and (*ii*) yield by 1 mm. Take thevalue of *E* and ⟨ for the alloy as 120 GPa and 24 × $10^{-6}$/K.

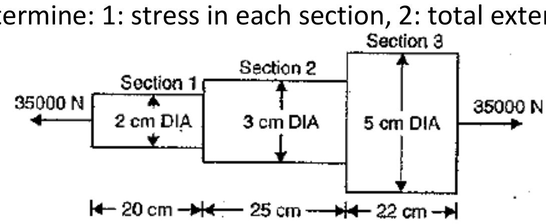
i) A steel bar 2 m long, 40 mm wide and 20 mm thick is subjected to an axial pull of 160 kN in the direction of its length. Find the changes in length, width and thickness of the bar. Take E = 200 GPa and Poisson's ratio = 0.3.

j) A metal bar 50 mm × 50 mm in section is subjected to an axial compressive load of 500 kN. If the contraction of a 200 mm gauge length was found to be 0.5 mm and the increase in thickness 0.04 mm, find the values of Young's modulus and Poisson's ratio for the bar material.

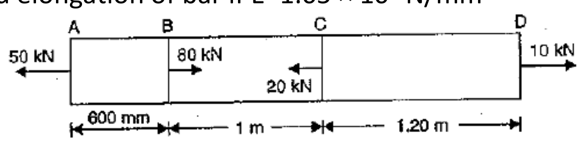
3. LONG TYPE QUESTIONS (10 MARKS)

a) The ultimate stress for a hollow steel column which carries an axial load of 1.9 MN is 480 M/mm$^2$. If the external diameter of the column is 200 mm determine internal diameter. Take FOS as 4

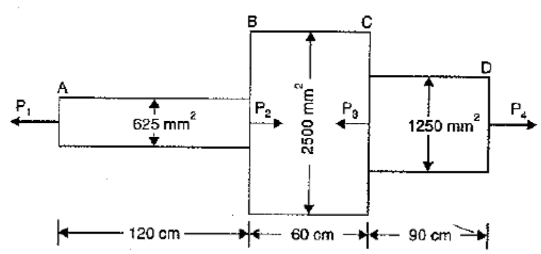
b) An axial pull of 35000 N is acting on a bar consisting of 3 lengths as shown in figure. If E= 1.5 × $10^5$ N/mm$^2$, determine: 1: stress in each section, 2: total extension of bar.




c) A brass bar having cross-sectional area of 1000mm2 is subjected to axial forces as shown in figure. Find elongation of bar if E=1.05 × $10^5$ N/mm$^2$




d) A member ABCD is subjected to point load $P_1$, $P_2$, $P_3$, $P_4$ as shown. Calculate force $P_2$ necessary for equilibrium if $P_1$=45Kn, $P_3$=450Kn and $P_4$=130Kn. Determine the elongation of the member assuming the value of E= 2.1 × $10^5$ N/mm$^2$




e) A bar of 30 mm diameter is subjected to a pull of 60 Kn. The measured gauge length extension on 200mm is 0.1 mm and change in diameter is 0.004 mm. Calculate: young's modulus, poisons ratio, bulk modulus

f) Determine poisons ratio and bulk modulus of a material for which E= 1.2 × $10^5$ N/mm$^2$ and modulus of elasticity is 4.8 × $10^4$ N/mm$^2$

g) Derive relation between young's modulus, bulk modulus and modulus of rigidity.

h) A bar of cross-section 8mm × 8mm is subjected to an axial pull of 7000 N. the lateral dimension of the bar is found to be changed to 7.9985mm × 7.9985mm. If modulus of rigidity is $0.8 \times 10^5$ N/mm$^2$, determine poisons ratio and modulus of elasticity.

## MODULE 2

## THIN CYLINDER AND SPHERICAL SHELL UNDER INTERNAL PRESSURE

1. **SHORT TYPE QUESTIONS (2 MARKS)**
    a) Define Hoop stress.
    b) What do you mean by principal plane?
    c) What are assumptions involved in the analysis of thin cylindrical shells?
2. **BRIEF TYPE QUESTION (5 MARKS)**
    a) A cylinder of internal diameter 2.5m and thickness 5cm contains a gas. If the tensile stress in the material is not to exceed 80 N/mm$^2$, determine internal pressure of gas.
    b) A cylinder of internal diameter 0.50 m contains air at a pressure of 7 N/mm$^2$. If the maximum permissible stress induced in the material is 80N/mm$^2$, find the thickness of the cylinder.
    c) A thin cylinder of internal diameter 1.25m contains a fluid at an internal pressure of 2n/mm2. Determine the maximum thickness of cylinder if i) longitudinal stress is not to exceed 30N/mm$^2$ ii) the circumferential stress is not to exceed 45N/mm$^2$
    d) A boiler is subjected to an internal pressure of 2 Kn/mm$^2$. The thickness of the boiler plate is 2.6 cm and permissible tensile stress is 120N/mm$^2$. Find the maxim diameter when efficiency of longitudinal joint is 90% and that of circumferential joint is 40%.
    e) A spherical shell of internal diameter 0.9m and thickness 10mm is subjected to internal pressure 1.4 N/mm$^2$. Determine increase in volume and diameter. E= $2\times 10^5$N/mm$^2$$\mu$ = 1/3.
    f) A vessel in the shape of a spherical shell of 1.20m internal diameter and 12mm shell thickness is subjected to pressure of 1.6 N/mm$^2$. determine the stress induced in the material of The vessel
    g) A spherical vessel 1.5 m diameter is subjected to an internal pressure of 2N/mm$^2$find the thickness of the plate required is maximum stress is not to exceed 150 N/mm$^2$and joint efficiency is 75%
3. **Long type questions (10 marks)**
    a) Calculate the change in diameter change in length and change in volume of a thin cylindrical shell 100 cm diameter 1 cm thick and 5 m long when subjected to internal pressure of 3 Newton per mm cube take the value of B is equals to $2\times 10^5$N/mm$^2$ and Poisson's ratio $\mu$ is equal to 0.3.
    b) A cylindrical drum 80 cm in diameter and 3 m long has a shell thickness of 1 cm. if drum s subjected to internal pressure of 2.5 N/mm$^2$, determine change in length, diameter, and volume.
    c) A cylindrical shell 90 cm long 20 cm internal diameter having thickness of metal as 8 mm filled with fluid at atmospheric pressure. If additional 20 cm$^3$ is pumped into the cylinder

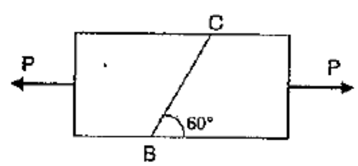
find: pressure exerted by the fluid on cylinder and hoop stressed induced. E =2× $10^5$N/$mm^2$, μ=0.3.

d) A thin cylindrical shell 80 mm internal diameter and 5mm thick is subjected to an internal pressure of 6 N/$mm^2$. A torque of 2009600Nmm is also applied on the tube. Find hoop stress, longitudinal stress, maximum and minimum principle stress and maximum shear stress.

## MODULE 3

## TWO DIMENSIONAL STRESS SYSTEMS

1. **SHORT TYPE QUESTIONS (2 MARKS)**
   **a)** Define principle stress
2. **BRIEF TYPE QUESTIONS (5 MARKS)**
   a) A rectangular bar of cross sectional area 1000 $mm^2$ is subjected to an axial load of 20 KN. determine the normal and shear stress on a section which is inclined at an angle of 30°with normal cross section of the bar.
   b) Find the diameter of a circular bar which is subjected to an axial Pull off 160 knif the maximum allowable stress on any section is 65 N/$mm^2$
   c) A rectangular bar of cross-sectional area 11000 $mm^2$ is subjected to a tensile load as shown in figure the permissible normal and shear stress on the oblique plane BC are given as 7 N/$mm^2$ and 3.5 N/$mm^2$respectively determine the safe value of p.




3. **LONG TYPE QUESTIONS (10 MARKS**
   **a)** At a point in a strained material the principal stresses are 100 N/$mm^2$ tensile and 40 N/$mm^2$compressive determine the resultant stress in magnitude and direction on a plane in client at 60° to the axis of major principal stress what is the maximum intensity of shear stress in the material at the point.
   **b)** At a point in a strained material the principal stresses are 100 N/$mm^2$tensile and 16 N/$mm^2$compressive determine the normal stress shear stress and resultant stress on a plane in client at 50°to the axis of major principal axis.
   **c)** At a point in a strained material the principal tensile stress across two perpendicular planes are 80 N/$mm^2$ and 40 N/$mm^2$. determine normal stress shear stress and the resultant stress on a principal plane in client at 20°with major principal plane determine also the obliquity what will be the intensity of stress which acting alone will produce the same maximum strain if poisons ratio is equals to ¼.
   d) The stress at a point in a bar or 200 N/$mm^2$tensile and 100N/$mm^2$compressive determine the resultant stress in magnitude and direction on a plane in client at 60°to the axis of major stress also determine the maximum intensity of shear stress in material at that point.

e) At a point within a body subjected to two mutually perpendicular directions the stresses are 80 N/mm$^2$ tensile 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.

## MODULE 4

## BENDING MOMENT AND SHEAR FORCE

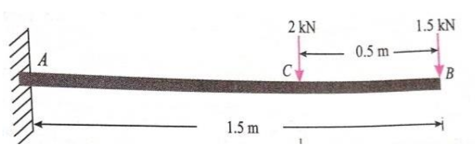
1. **SHORT TYPE QUESTIONS (2 MARKS)**
   - **a)** Define shear force.
   - **b)** Define bending moment.
   - **c)** What are the different types of beam ?
   - **d)** Define point of contraflexure .
   - **e)** Define simple supported beam and over hanging beam .
   - **f)** What are the different loads ?
   - **g)** Define point load and U.D.L .

2. **BRIEF TYPE QUESTION (5 MARKS)**

a) Draw the B.M. Diagram and S.F diagram for a long cantilever with point load of 10 tonnes at 2m from free end.

b) State the relation between Loading, Shear Force and Bending Moment.

c)




Draw shear force and bending moment diagrams for a cantilever beam of spam 1.5 m carrying point loads as given above.

d) Show diagrammatically different types of beams and loads.

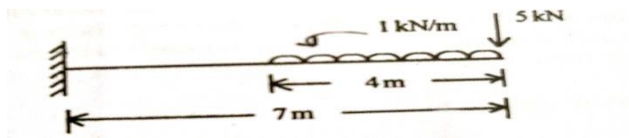
e) Draw the shear force and bending moment diagram for a simple supported beam with uniformly distributed load.

f) Define shear force and bending moment. Explain the sign convension for shear force and bending moment.

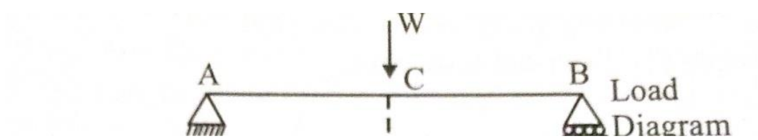
g) Draw the B.M Diagram and S. F diagram for a 8 m long cantilever beam with point load of 10 tonnes at 2 m from the free end.

h) A cantilever of 8 m length is loaded with a point load of 50 kg at the free end and U.D.L of 10 kg/meter over 4 meter from fixed end . Sketch the S. F diagram.

i) A simple supported beam of 6 m span carries a point load of 50 KN at a distance of 5 m from its left end . Draw S.F and B.M diagram for the beam.

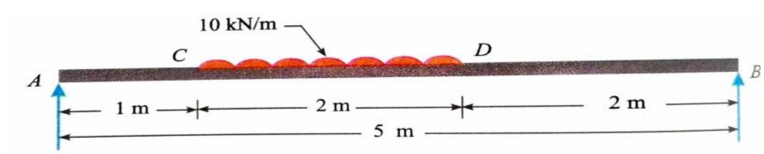
j) 


Draw S.F.D and B.M.D of the beam shown in above figure.

**h)** 

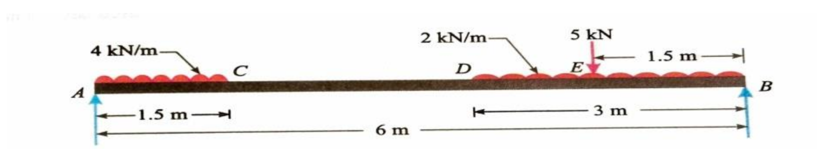

Draw S.F.D and B.M.D for the above simple supported beam.

## 3. LONG TYPE QUESTIONS

**a)** 

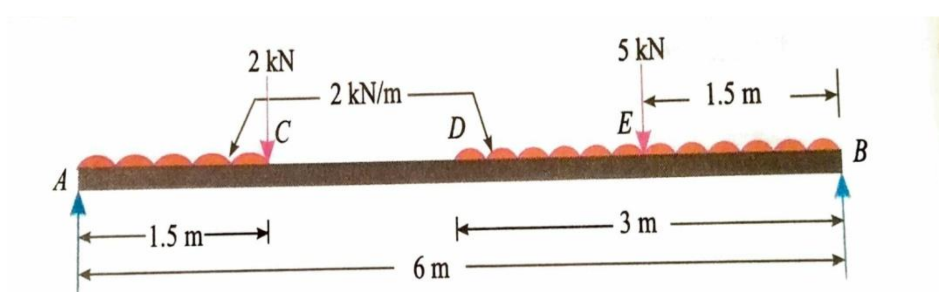

A simple supported beam 5m long is loaded with a uniformly distributed load of 10KN/m over a length of 2m as shown in the figure.. Draw shear force and bending moment diagrams for the beam indicating the value of maximum bending moment.

**b)** A simple supported beam AB **,** 6 m long is loaded as shown in fig.



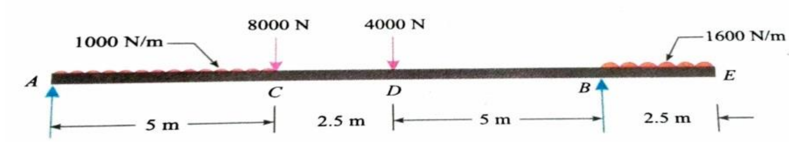

Construct the shear force and bending moment diagrams for the beam and find the position and value of maximum bending moment.

**c)** A simple supported beam AB , 6m long is loaded as shown in figure



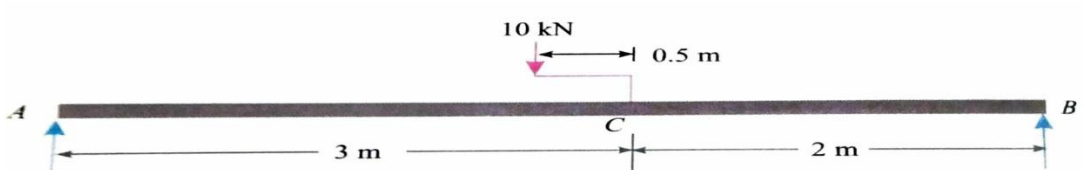

Draw the shear force and bending moment diagram for the beam.

**d)**



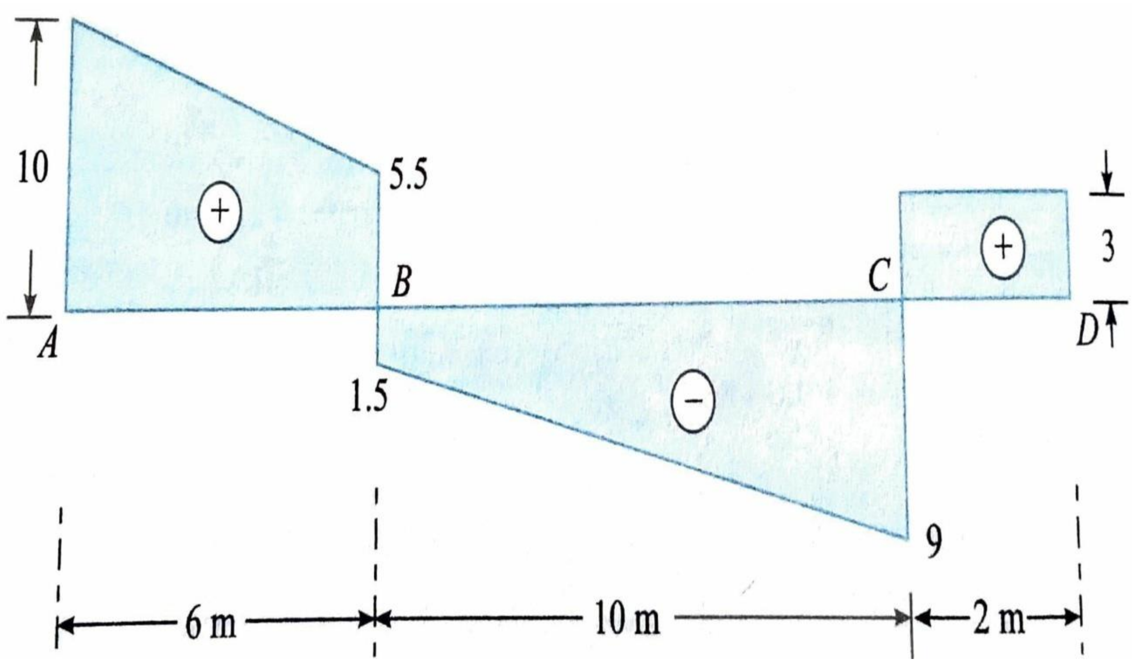

Draw the shear force and bending moment diagrams for the beam shown in the figure .. Indicate the numerical values at all important sections.

**e)** A simple supported beam 5 metres long carries a load of 10 KN on a bracket welded to the beam as shown



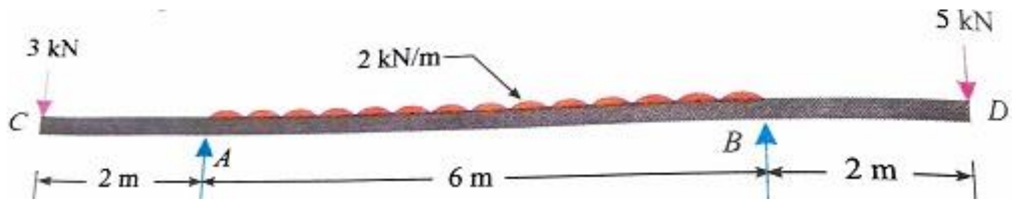

Draw the shear force and bending moment diagrams for the beam

**f)** The diagram shown is the shear force diagram in metric units, for a beam, which rests on two supports, one being at the left hand end.




Duduce directly from the shear force diagram ,(a) loading on the beam, (b) bending moment At 2 m intervals along the beam and (c) position of the second support. Also draw bending moment diagram for the beam and indicate the position and magnitude of the maximum value on it.

**g)** A beam 10 m long carries load as shown in figure




Draw shear force and bending moment diagrams for the beam and determine the points of Contraflexures , if any.

**h)** A horizontal beam of 20 m long simply supported at ends carries concentrated vertical loads of 10 KN, 20 KN, 15 KN, 20 KN, at 2m, 8m, 16m, and 18 m respectively from right hand side of the beam. Draw B. M and S F diagram . Find maximum B M and and maximum SF.

## MODULE – 5

### THEORY OF SIMPLE BENDING

### 1. SHORT TYPE QUESTIONS (2 MARKS)

**a)** Define bending stress.

**b)** What do you mean by pure bending.

**c)** Define bending moments as applied to a loaded beam.

**d)** What is moment of resistance.

**e)** Where is the position of neutral axis of a beam ?

**f)** Write the formula for section modulus of rectangular and circular section

### 2. BRIEF TYPE QUESTIONS (5 MARKS)

**a**) State the assumptions made in theory of simple bending.

**b)** Using bending equation , find out the expression of bending stress developed in a circular shell subjected to bending moment 'M'.

**c)** Derive the relationship $\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$

**d)** Prove that neutral axis in a loaded beam is the cenrtoidal axis.

**e)** Write short notes on sectional modulus.

### 3. LONG TYPE QUESTIONS

- **a)** A beam 3 m long has rectangular section of 80 mm width and 120 mm depth . If the beam is carrying a uniformly distributed load of 10KN/m . Find the maximum bending stress developed in the beam.
- **b)** A rectangular beam 300 mm deep is simply supported over a span of 4 m. What uniformly distributed load the beam may carry if the bending stress is not exceed 120 MPa . Take I = $225 \times 10^6$ $mm^4$.
- **c)** A wooden beam 1.8 long, simply supported at the ends, has a rectangular section 150 mm wide and 600 mm deep and carries a uniformly distributed load of 80 KN per metre run over the entire span. Determine the maximum bending stress developed in the beam.
- **d)** A rectangular beam 8 cm × 6 cm is 2 m long and is simply supported at the ends . It carries a load of 3 KN at mid span . Determine the maximum bending stress induced in the beam.
- **e)** A timber beam of rectangular section supports a load of 20 KN uniformly distributed over a span of 3.6 m. If depth of the beam section is twice the width and maximum stress is not to exceed 7 MPa, find the dimensions of the beam section.
- **f)** A hollow square section with outer and inner dimensions of 50 mm and 40 mm respectively is used as a cantilever of span 1 m. How much concentrated load can be applied at the free end of the cantilever , if the maximum bending stress is not to exceed 35 MPa?
- **g)** A cast iron water pipe of 500 mm inside diameter and 20 mm thick is supported over a span of 10 meters. Find the maximum stress in the pipe metal, when the pipe is running full. Take density of cast iron as 70.6 $KN/m^3$ and that of water as 9.8 $KN/m^3$.

## MODULE – 6

## COMBINED DIRECT AND BENDING STRESSES

### 1. SHORT TYPE QUESTIONS (2 MARKS)

- **a)** What do you mean by eccentric load on column.
- **b)** Define columns
- **c)** Define buckling load.
- **d)** What is crippling load ?

### 2. BRIEF TYPE QUESTIONS (5 MARKS)

- **a)** State expression for buckling load under various end condition.

### 3. LONG TYPE QUESTIONS

**a)** Derive the maximum stress developed in short column under eccentric loading.

**b)** A rectangular column 200 mm wide and 150 mm thick is carrying a vertical load of 120 KN at an eccentricity of 50 mm in a plane bisecting the thickness. Determine the maximum and minimum intensities of stress in the section.

**c)** A hollow rectangular masonary pier is 1.2 m × 0.8 m wide and 150 mm thick . A vertical load of 2 MN is transmitted in the vertical plane bisecting 1.12 m side and at an eccentricity of 100 mm from the geometric axis of the section.

Calculate the maximum and minimum stress intensities in the section.

d)

# MODULE – 7

## TORSION

### 1. SHORT TYPE QUESTIONS (2 MARKS)

**a)** state any four important assumptions for shear stress in a circular shaft subjected to torsion.

b) Define Torsional Rigidity.

c) Define Torsion ?

## 2.BRIEF TYPE QUESTIONS (5 MARKS)

**a)** Derive the relation $\frac{T}{J} = \frac{G\theta}{l} = \frac{Z}{r}$

**b)** Write down the assumptions taken for finding out the torsion formula.

**c)** Derive the formula $\frac{T}{J} = \frac{q_s}{R}$

Where T = Torque , J = Polar momentum of inertia

$Q_s$ = Maximum shear stress , R = Radius of circular shaft.

d) Derive the formula for crippling load under various end conditions.

e) A solid steel shaft is to transmit a torque of 10KN-m. If the shearing stress is not exceed 45 MPa , find

the minimum diameter of the shaft.

f) A hollow shaft of external and internal diameters as 100 mm and 40 mm is transmitting power at 120

r.p.m. Find the power the shaft can transmit, if the shearing stress is not to exceed 50 MPa.

## 3.LONG TYPE QUESTIONS

**a)** A solid shaft of 80 mm diameter is to be replaced by a hollow steel shaft of same material . The internal diameter of the hollow shaft is 60% of the external diameter . Find the diameter of the hollow shaft and saving in material, if the maximum allowable shear stress ia same for both shafts.

**b)** Determine the diameter of a solid shaft which will transmit 90 KW at 160 rpm , the shear stress in the shaft is limited to 60 $N/mm^2$ . Find also the length of the shaft if the angle of twist must not exceed 1° over the entire length . Take C = Rigidity modulus = $8\times10^4$ $N/mm^2$.

**c)** A solid shaft of 120 mm diameter is required to transmit 220KWat 100 rpm . If the angle of twist is not exceed 2° , find the length of shaft .Take G = 90 GPa.

**d)** A solid shaft of 200 mm diameter has the same cross sectional area as that of a hollow shaft of the same material with inside diameter 150 mm . Find the ratio of power transmitted by the two shafts at the same speed.

**e)** A hollow shaft is to transmit 200 kW at 80 r.p.m. If the shear stress is not to exceed 60 MPa and internal diameter is 0.6 of the external diameter, find the diameter of the shaft.

***Find the angle of twist per meter length of a hollow shaft of 100 mm external and 60 mm internal diameter , if the shear stress is not exceed 35 MPa. Take C = 85 GPa.***

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**f)** A solid shaft of 200 mm diameter has the same cross sectional area as a hollow shaft of the same material with inside diameter of 150 mm . Find the ratio of

a) powers transmitted by both the shafts at the same angular velocity.

b) angles of twist in equal lengths of these shafts , when stressed to the same intensity.