

GOVERNMENT POLYTECHNIC SHEOHAR

(DEPARTMENT OF SCIENCE TECHNOLOGY AND TECHNICAL EDUCATION)

(Govt. of Bihar)



DEPARTMENT OF MECHANICAL ENGINEERING

Previous year Questions and important questions' bank

(As per SBTE old syllabus)

SEM: 4 TH	SUB: STRENGTH OF MATERIALS	<u>SUB. CODE:</u> 2025402
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Unit:1

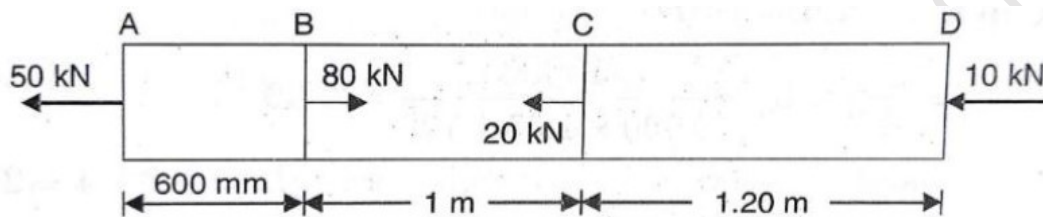
(Simple Stresses and Strains)

Section A (Objective questions)

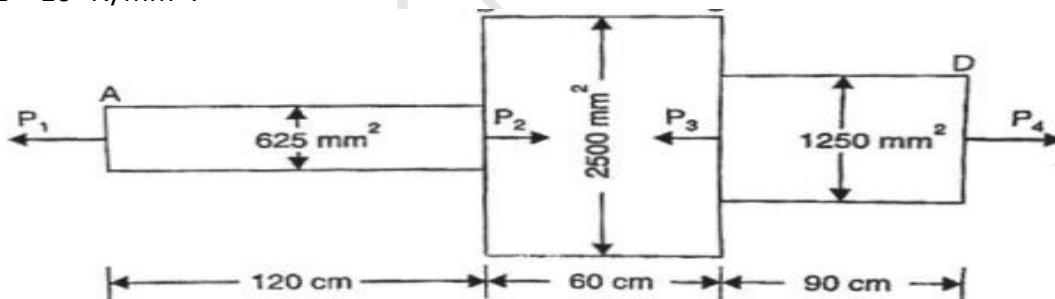
1. In a stress-strain diagram, _____ is the point where material exhibits elastic behavior whereas, _____ is the point where the material transitions from elastic to plastic behavior.
(Elastic point / Yield point / Breaking point / ultimate point)
2. **Match** the following type of forces with their effects:
- | (Forces) | (Effects) |
|------------------|---|
| 1. Tensile Force | A. Causes material to elongate |
| 2. Shear Force | B. Causes material to shorten |
| | C. Causes material to slide parallel layers |
3. For a composite bar made of two materials with different coefficients of thermal expansion, when subjected to a temperature increase, the material with the higher coefficient of thermal expansion will expand more than the other material. (True/False)
4. The ability of a material to absorb energy when elastically deformed and to return it when unloaded is called _____.
(Elasticity / Resilience / Plasticity / Modulus of Resilience)
5. The principal plane is defined as the plane on which the shear stress is _____.
(Maximum / Minimum/ Zero)
6. The radius of Mohr's Circle represents the maximum _____ on the plane.
(Tensile stress/ compressive stress / shear stress)
7. The ratio between direct stress and volumetric strain is _____.
(Bulk modulus/poissons ratio/factor of safety/Modulus of rigidity)
8. Principal planes are those planes on which
- Normal stress are either maximum or minimum
 - Tangential stress is zero
 - Both A & B
 - None
9. Modulus of resilience is
- | | |
|---|----------------------------------|
| a) % elongation of elastic body | b) strain energy per unit volume |
| b) Strain energy stored in elastic body | d) All of these |

Section B (Short & Long Questions)

1. Define Factor of safety and Poisson's ratio.
2. Define proof resilience and toughness.
3. Define (a) Young's modulus of Elasticity (b) Elastic limit
4. State and explain different types of load.
5. Draw stress-strain curve of mild steel and explain its salient points.
6. A brass bar, having cross-sectional area of 1000 mm^2 , is subjected to axial forces as shown in figure. Find the total elongation of the bar and stress devolved in the BC section. (Take $E = 2 \times 10^5 \text{ N/mm}^2$)



7. A rod is 2 m long at a temperature of 10°C . Find the expansion of the rod when the temperature is raised to 90°C . Also find the stress induced in the material of rod if the expansion is restricted. (Take Young's Modulus $E = 10^5 \text{ MN/m}^2$ and coefficient of thermal expansion $\alpha = 10^{-5} / ^\circ\text{C}$).
8. A Composite section ABCD is subjected to point loads of **P1, P2, P3 and P4** as shown in figure. Calculate the force **P2** necessary for equilibrium, if $P1 = 45 \text{ kN}$, $P3 = 450 \text{ kN}$ and $P4 = 130 \text{ kN}$. Determine the total elongation of the ABCD, assuming the modulus of elasticity to be $2.1 \times 10^5 \text{ N/mm}^2$.



9. Prove that the total elongation ' δL ' of a uniformly tapered rod of larger diameter ' D ', smaller diameter ' d ' and length ' L ', when the rod is subjected to an axial load P is given by

$$\delta L = \frac{4PL}{\pi E D d}$$

10. A rod of 3 m long is at a temperature of 15°C . Find the expansion of the rod, when the temperature is raised to 95°C . If the expansion is prevented, find the stress induced in the material. (Take Young's Modulus $E = 10^5 \text{ MN/m}^2$ and coefficient of thermal expansion $\alpha = 1.2 \times 10^{-5} / ^\circ\text{C}$)
11. Define (a) Axial load and (b) Eccentric load

Unit 2

(Shear Force & Bending Moment Diagrams)

Section A (Objective questions)

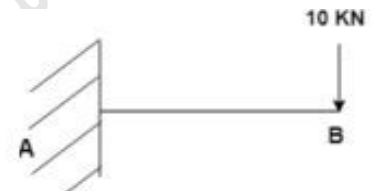
1. **Match** the type of beam with its description:

Type of Beam	Description
1. Cantilever beam	A. Supported at both ends with no overhang
2. Fixed beam	B. Fixed at one end, free at the other
	C. Both ends fixed

2. At the point of contraflexure, the value of bending moment is _____.
(Zero / Maximum / Minimum)

3. _____ will be the variation in BMD for the diagram.
(Rectangular / Trapezoidal / Triangular)

4. _____ will be the variation in SFD for the diagram.
(Rectangular / Trapezoidal / Triangular)



5. The radius of Mohr's Circle represents the maximum _____ on the plane.
(Tensile stress/ compressive stress / shear stress)

6. **Match** the following term with their definition:

Column A (terms)

1. Thermal Stress
2. Elastic Limit

Column B (Definition)

- A. The point on the stress-strain curve where material can no longer return to original shape after removal of load.
- B. The stress developed due to a change in temperature
- C. The point on the stress-strain curve where material return to original shape after removal of load.

7. A beam supported on more than two supports is called _____.
(Simply supported beam/continuous beam /overhanging beam)

8. The bending moment at the free end of a cantilever beam is _____.
(Zero /maximum/minimum/average)

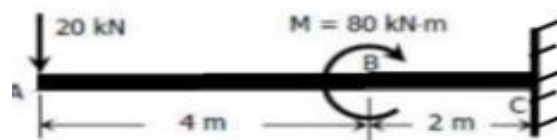
9. The variation of bending moment due to uniformly distributed load (UDL) is _____.
(Uniform /linear/parabolic/hyperbolic)

10. Maximum bending moment in a cantilever beam carrying a UDL is _____.

$$\left(\frac{wl^2}{8} / \frac{wl^2}{4} / \frac{wl^3}{8} / \frac{wl^2}{2} \right)$$

Section B (Short & Long Questions)

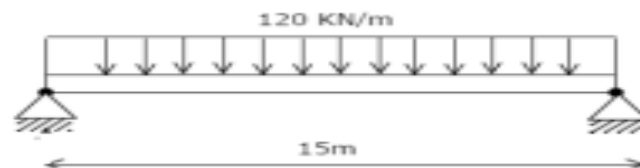
1. List and sketch any four types of beams.
2. List any two types of support and draw the reaction developed in it.
3. State point of contraflexure in a beam with suitable sketch.
4. **Draw** the Shear force diagram (SFD) and bending moment diagram (BMD) for the loaded cantilever beam having point load of 20 kN at **point A** and moment of 80 kN-m at **point B** as shown in figure. Also determine the maximum Shear force and maximum bending moment.



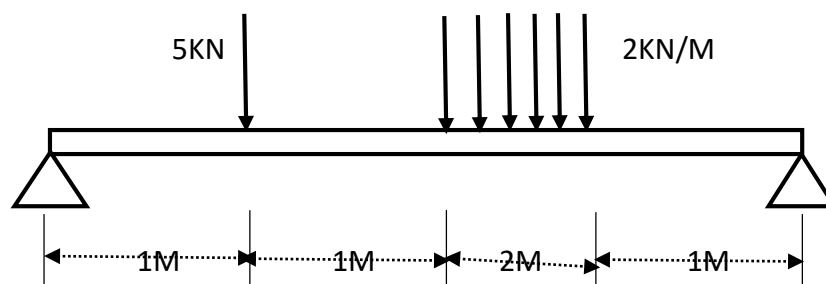
5. Draw the Shear force diagram and bending moment diagram for the simply supported beam of span length '4a'. Also find the section where the beam is in pure bending.



6. Draw the Shear force diagram and bending moment diagram for a simply supported beam under UDL of 120 kN/m as shown in figure. Also find the maximum bending moment developed.



7. Draw the Shear force diagram and bending moment diagram for a cantilever beam of length 'L' carrying a point load 'W' at the free end. Also find the maximum bending moment developed.
8. Draw the Shear force diagram and bending moment diagram for the beam carrying load as shown in figure below.



Unit 3

(Theory of Simple Bending and Deflection of Beams)

Section A (Objective questions)

1. In the bending equation $\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$, “I” represents _____ and “R” represents _____.

(Bending Moment / Moment of Inertia / Modulus of Elasticity / Radius of Curvature)

2. The maximum deflection in cantilever beam of span ‘L’ and loading at free end is ‘W’ is _____.

$$\left(\frac{wl^3}{EI}, \frac{wl^3}{2EI}, \frac{wl^3}{3EI} \right)$$

3. In a simply supported beam of length L is loaded with a point load P at the center, the maximum deflection ($\delta_{\max}$) occurs at the center will be

$$\left(\frac{PL^3}{16EI}, \frac{PL^3}{24EI}, \frac{PL^3}{48EI}, \frac{PL^3}{96EI} \right)$$

4. **Match** the type of beam with its description:

Type of Beam	Description
1. Cantilever beam	A. Simple supports
2. Propped Cantilever Beam	B. Fixed at one end, free at the other end
	C. Fixed support at one end and simple support at other end

5. The deflection in a beam is maximum where slope is _____

(Maximum / minimum / zero / any value)

6. The flexural rigidity of a beam is _____

$$(E/I, EI, E/Y, E^2I)$$

7. If the depth of a beam is doubled, then changes in its section modulus will be _____.

(Remains same/ decrease / be doubled/ increases by four times)

8. The section modulus of a circular section about an axis through its C.G. is _____.

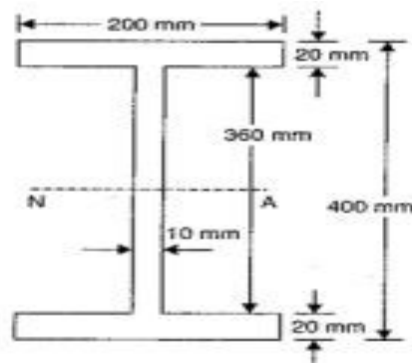
$$\left(\frac{\pi D^2}{4}, \frac{\pi D^2}{16}, \frac{\pi D^3}{16}, \frac{\pi D^3}{32} \right)$$

9. The stress induced in a body when suddenly applied load is _____ the stress induced when the same load is applied gradually.

(Equal to, one-half, twice, four time)

Section B (Short & Long Questions)

1. List any four assumptions made in theory of simple bending.
2. State point of contraflexure in a beam with suitable sketch.
3. A cantilever beam of length 5 m carries a point load of 10 kN at free end. If flexural rigidity $EI = 30000 \text{ kN.m}^2$, Find the maximum deflection.
4. Find the moment of inertia of I-section about the **neutral axis (NA)** as shown in figure.



5. A steel plate of width 120 mm and thickness 20 mm is bent into a circular arc of radius 10m
Determine: (Take $E = 2 \times 10^5 \text{ N/mm}^2$)
(a) The maximum stress induced (b) maximum bending moment
6. Define neutral axis (**N.A**), radius of curvature(**R**) and moment of resistance (**M**) in terms of bending equation.
7. Using standard notation, Derive the expression for bending equation $\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$
8. A cantilever of length 4 m carries a point load 20 kN at the free end. Find the **deflection** at the free end if $E = 2.1 \times 10^5 \text{ N/mm}^2$ and $I = 6.667 \times 10^7 \text{ mm}^4$.
9. A cantilever beam with cross section $40 \times 50 \text{ mm}^2$ and span 3m carries a point load of 3KN at the free end. Find the **maximum bending stress** induced in beam.
10. For a simply supported beam of length **L** carrying a uniformly distributed load **W** over the whole length **L**. Derive the expression for its maximum bending moment.
11. Derive an expression for strain energy of a circular rod of diameter **D** and length **L** due to gradually applied load of magnitude **P**.
12. List any four mechanical properties of a mild steel bar.

Unit 4

Torsion in Shafts and Springs

Section A (Objective questions)

- For a given shaft under pure torsion, the shear stress developed at the outer surface of shaft is _____.
(Minimum / Maximum / Zero)
- Match** the following nomenclature with its description for closely coil spring.

Nomenclature	Description
1. Pitch	A. Load per unit deflection
2. Stiffness of Spring	B. Distance between two consecutive coils
	C. Maximum load a spring can handle without Permanent deformation
- For a given shaft under pure torsion, the shear stress developed at the Centre axis of shaft is
(Minimum / Maximum / Zero)
- In helical springs, the shear stress is uniform across the cross-section of the wire. (True/ False)
- Modulus of resilience under simple tension is _____.
($2\sigma^2/E$, σ^2/E , $\sigma^2/2E$, $\sigma^2/4E$)
- The polar modulus of a solid shaft of diameter **D** is _____.
($\pi D^2/4$, $\pi D^3/32$, $\pi D^3/16$, $\pi D^4/64$)
- The angle of twist is _____proportional to the twisting moment.
(Directly, inversely, both, none)
- The thermal stress is a function of _____.
(E , α , ΔT , all of these)
- The torsional rigidity of a shaft is defined as _____.
(G/J , GJ , TJ , T/J)
- When a closely coiled spring is subjected to an axial load, it is said to be under _____.
(Bending, shear, torsion, none)
- The strength of a hallow shaft for the same length, material and weight is _____ than a solid shaft.
(more, less, same, twice)

Section B (Short & Long Questions)

1. A solid circular shaft is subjected to under pure torsion with twisting moment 20 N-m having diameter 20 mm. Find the shear stress (τ) developed at the outer fiber of shaft.
2. Using standard notation, Derive the expression for torsion equation.

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{L}$$
3. A closely coiled helical spring made of 10 mm diameter steel wire has 15 coils of 100 mm mean diameter. The spring is subjected to an axial load of 150 N. (Take $G = 80 \text{ Gpa}$). Calculate
 (a) The maximum shear stress induced ($\tau_{\max}$)
 (b) the deflection (δ)
 (c) Stiffness of the spring (K)
4. Derive the expression for ratio of power transmission capacity of a solid shaft and hollow circular shaft of same length, material and same outer diameter rotating at same rpm. (Take the ratio of outer diameter to inner diameter for hollow shaft as 2).
5. Write the expression for torque transmitted by a solid shaft of diameter D when subjected to pure torsion having maximum induced shear stress ' τ '.
6. Define helical springs. Name two important type of helical spring.
7. A hollow shaft of external diameter 120 mm transmits 300 kW power at 200 rpm. Determine the maximum internal diameter if the stress in the shaft is not to exceed 60 N/mm^2 .
8. The stiffness of a closed coiled helical spring is 1.5 N/mm of compression under a maximum load of 60N. The maximum shearing stress produced in the wire of the spring is 125 N/mm^2 . The solid length of the spring is 5 cm. Find
 (a) Diameter of wire (D) (b) Mean diameter of coils (d) (Modulus of rigidity, $G = 45000 \text{ N/mm}^2$)
9. Write the assumptions of torsion equation.
10. A solid shaft transmits 50KW power of 750 rpm. Calculate the torque produced by shaft.
11. A closely coiled spring is used to carry a load of 450 N. its mean coiled diameter is to be 9 times that of wire diameter. Calculate the diameters if the maximum shear stress in the spring is to be 100 mpa.
12. Define the term polar modulus. Write the expression for polar modulus for a solid shaft and for a hollow shaft.

Unit 5

Thin Cylindrical Shells

Section A (Objective questions)

1. For a thin spherical pressure vessel, the ratio of hoop stress to longitudinal stress is _____.
(1 / 2 / 3 / 4)
2. For a thin cylindrical pressure vessel, the ratio of hoop stress to longitudinal stress is _____.
(1 / 2 / 3 / 4)
3. The equation for Hoop stress (σ_h) in a thin-walled cylindrical shell with internal pressure ' P ', radius ' r ' and thickness ' t ' is _____.
($\frac{Pr}{t}$ $\frac{Pr}{2t}$ $\frac{Pr}{4t}$)
4. For a thin walled shells, the diameter-thickness ratio (D/t) is _____.
(Equal to 20/ less than 20/ more than 20)
5. In a cylindrical shell, hoop stresses formed will act through _____.
(Longitudinal section, circumferential section, radial section)
6. In a cylindrical shell, longitudinal stresses formed will act through _____.
(Longitudinal section, circumferential section, radial section)
7. The thickness of the cylindrical shell is designed on the basis of _____.
(Longitudinal stresses, hoop stresses, radial stress)
8. The volumetric strain, e_v is expressed as, $e_v =$ _____.
($2e_r + 2e_h$ / $2e_r + 4e_h$ / $e_r + e_h$ / $e_r + 2e_h$)
9. The equation for longitudinal stresses (σ_l) in a thin-walled cylindrical shell with internal pressure ' P ', radius ' r ' and thickness ' t ' is _____.
($\frac{Pr}{t}$ $\frac{Pr}{2t}$ $\frac{Pr}{4t}$)
10. A cylindrical pipe of diameter 1.5m and thickness 1.5cm is subjected to internal fluid pressure of 1.2N/mm². Determine the longitudinal stress developed in the pipe _____ N/mm²
(45 / 60 / 15 / 30)

Section B (Short & Long Questions)

- Find the expression for change in volume for thin spherical vessel subjected to internal fluid pressure 'P'.
- Show that in thin cylinder shell subjected to internal fluid pressure the hoop stress is twice the longitudinal stress.
- A thin cylindrical pressure vessel of inner diameter 200 mm and thickness 10mm is subjected to an internal pressure of 200 MPa. Calculate the longitudinal stress (σ_l) and hoop stress (σ_h) developed.
- Calculate the Safe Working Pressure for the thin spherical pressure vessel of Internal diameter, $d = 2$ m, Wall thickness, $t = 20$ mm. Allowable tensile stress of the material, $\sigma_{allow} = 100$ MPa.
- Derive the expressions for the longitudinal stress (σ_l) and hoop stress (σ_h) in a thin cylindrical shell.
- A cylindrical shell of diameter 150mm and wall thickness 3mm is subjected to internal fluid pressure of MPa. Calculate the maximum shearing stress (τ_{max}) induced in the shell.
- Derive an expression for volumetric strain for a thin cylindrical shell of diameter 'd' with thickness 't' and having young's modulus of elasticity E.
- Derive the expressions for the hoop stress (σ_h) in a thin spherical vessel.
- Derive the expression for maximum shear stress (τ_{max}) induced in the thin cylindrical shell.
- A thin cylinder of internal dia. 1.25m contains a fluid at an internal pressure of 2 N/mm^2 . Determine the maximum thickness of the cylinder if:
 - Longitudinal stress (σ_l) is not to exceed 30 N/mm^2 .
 - Hoop stress (σ_h) is not to exceed 45 N/mm^2 .

- For the Bi-axial plane state of stress as shown in figure, Draw the Mohr's Circle and find
 - Maximum principal stress
 - Maximum shear stress

